2nd International Symposium

on

Smart Cities Challenges, Technologies and Trends

(SCCTT2023)

11th January 2024

Organized by

Department of Computer Science & Engineering

Maharaja Agrasen Institute of Technology, New -Delhi

International Symposium
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Smart Cities Challenges, Technologies and Trends
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Organized by
Department of Computer Science & Engineering
Maharaja Agrasen Institute of Technology
Agrasen Chowk, Sector-22, Rohini, New Delhi

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Preface

We hereby are delighted to announce that Maharaja Agrasen Institute of Technology, Delhi, India, has hosted the eagerly awaited and much coveted “International Symposium on Smart Cities Challenges Technologies and Trends” (SCCTT-2023) in Hybrid Mode. The second version of the symposium was able to attract a diverse range of engineering practitioners, academicians, scholars and industry delegates, with the reception of abstracts including more than 300 authors from different parts of the world. The committee of professionals dedicated towards the symposium is striving to achieve a high-quality technical program with track on Smart Cities, Smart Homes, Smart Hospitals, Smart Campuses, Green Computing, Smart Transportation System, Cyber Attacks, Smart light System, Smart Education, Smart urban pollution management, Smart urban waste management, IoT and Smart Applications. Therefore, a lot of research is happening in the above-mentioned track and its related sub□areas. More than 90 full-length papers have been received, among which the contributions are focused on theoretical, computer simulation-based research, and laboratory-scale experiments. Amongst these manuscripts, 8 papers have been included in the CEUR workshop proceedings after a thorough two-stage review and editing process. All the manuscripts submitted to the SCCTT-2023 were peer-reviewed by at least two independent reviewers, who were provided with a detailed review proforma. The comments from the reviewers were communicated to the authors, who incorporated the suggestions in their revised manuscripts. The recommendations from two reviewers were taken into consideration while selecting a manuscript for inclusion in the proceedings. The exhaustiveness of the review process is evident, given the large number of articles received addressing a wide range of research areas. The stringent review process ensured that each published manuscript met the rigorous academic and scientific standards. It is an exalting experience to finally see these elite contributions materialize into a book volume as SCCTT-2023 proceedings by CEUR workshop proceedings entitled “International Symposium on Smart Cities Challenges Technologies and Trends”. All the contributing authors owe thanks from the organizers of SCCTT-2023 for their interest and exceptional articles. We would also like to thank the authors of the papers for adhering to the time schedule and for incorporating the review comments. We wish to extend my heartfelt acknowledgment to the authors, peer-reviewers, committee members and production staff whose diligent work put shape to the SCCTT-2023 proceedings. We especially want to thank our dedicated team of peer-reviewers who volunteered for the arduous and tedious step of quality checking and critique on the submitted manuscripts. The management, faculties, administrative and support staff of the college has always been extending their services whenever needed, for which we remain thankful to them. Lastly, we would like to thank CEUR workshop proceedings for accepting our proposal for publishing the SCCTT-2023 symposium proceedings

Prof. Namita Gupta, Dr. Deepak Gupta, Dr. Yogesh Sharma

Organizers, SCCTT-2023

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Message from Founder Chairman & Chief Advisor's Desk

I am delighted to share my heartfelt appreciation for the upcoming International Symposium on Smart Cities Challenges, Technologies, and Trends (SCCTT-2023), scheduled to take place on January 11th, 2024, at the Maharaja Agrasen Institute of Technology in Delhi.

SCCTT-2023 promises to be a momentous event, uniting scholars, researchers, industry experts, and policymakers from across the globe. This symposium is designed to facilitate comprehensive discussions on the latest developments, challenges, and trends in the dynamic field of smart cities.

I extend my sincere gratitude to all the contributors, organizers, and partners who have devoted their time, expertise, and efforts to make this symposium a reality. I commend the Department of Computer Science and Engineering, particularly Prof. Namita Gupta, Head of the Department, for their dedicated and meticulous organization of this symposium.

As we anticipate the success of SCCTT-2023, I would like to express my best wishes to all involved, hoping for fruitful discussions, valuable networking opportunities, and the exchange of groundbreaking ideas.
Once again, congratulations to everyone involved, and I wish you all enduring success in your future endeavors.
Warm regards,

20.12.2023

Dr. Nand Kishore Garg
Founder & Chief Advisor, MATES

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Message from Chairman's Desk

It is with great pleasure that I acknowledge the remarkable efforts of the Department of Computer Science and Engineering at Maharaja Agrasen Institute of Technology in organizing the 2nd International Symposium on Smart Cities Challenges, Technologies, and Trends (SCCTT-2023), scheduled to take place on January 11th, 2024.

SCCTT-2023 will serve as a valuable platform for interdisciplinary exchange of ideas, fostering innovative solutions, and contributing to the advancement of our understanding of the complex issues involved in transforming urban areas into smart, sustainable, and resilient cities.

I extend my heartfelt congratulations to Prof. Namita Gupta and her dedicated organizing team for their efforts in bringing together this momentous event. Additionally, I commend them on the successful creation of the souvenir magazine for SCCTT-2023.

May this symposium be a resounding success, and may the endeavors of all those associated with SCCTT-2023 continue to prosper and contribute to the betterment of our society.

Wishing you all the success in your future endeavors.

Warm regards.

Sh. Vineet Kumar Gupta

Chairman, MATES

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Ref. No..... Date.....

Prof. (Dr.) Neelam Sharma
DIRECTOR, MAIT

MESSAGE

It gives me immense pleasure to know that a souvenir is being published by the Department of Computer Science and Engineering, MAIT for its 2nd International Symposium on Smart Cities Challenges Technologies and Trends organized on 7th December 2023.

Main objective of the symposium is to contribute significantly in area of research through high-quality research papers that present innovating ideas, novel approaches, developments, technologies, best practices, tools and techniques and provide future directions to young researchers and practitioners in the field of engineering.

Research material forming the contents of the souvenir will definitely be a developing tool to the readers.

I applaud the Symposium Chair Prof. Namita Gupta and her team to publish this issue. I wish them success.

Prof. (Dr.) Neelam Sharma
Director, MAIT

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Ref. No..... *Date.....*

Prof. (Dr.) S. S. Deswal

Dean, MAIT

Message

It is gratifying to know that Department of Computer Science and Engineering, MAIT is organizing its 2nd International Symposium on Smart Cities Challenges Technologies and Trends (SCCTT-2023) organized on 7th December 2023.

Organizing such an event at this point of time reinforces our objective of developing an environment for the exchange of ideas towards technological development. I wish the Symposium would be able to deliberate on the current smart cities' challenges.

I extend my grateful wishes to Prof. Namita Gupta and her organizing team of SCCTT, 2023 for making the Symposium a great success.

Prof. (Dr.) S. S. Deswal

Dean, MAIT

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Ref. No..... *Date.....*

Prof. Namita Gupta
Head of the Department, CSE
Message from Symposium Chair

The Department of Computer Science and Engineering takes great pleasure in organizing the 2nd International Symposium on Smart Cities Challenges Technologies and Trends (SCCTT-2023) at Maharaja Agrasen Institute of Technology, Delhi. The Symposium is organized in association with various Partners and is scheduled on 7th December, 2023. The Department of Computer Science and Engineering, established in the year 1999 has been the principal academic mover in the institute. The Department is known for its uniqueness in academic programs, state of art laboratories, research projects, industry collaboration, professional society activities, student and faculty development activities. The symposium shall see contributions in varied tracks like Smart Cities, Energy-efficient Communications in Smart Cities, Green Computing, Big Data, and Analysis, Smart Transportation System, IoT and Smart Application. We are extremely happy to host distinguished personalities from academics as guest in the symposium. These talks along with the presentations of selected papers are expected to be feast for the academics and research community.

On behalf of the organizing committee, I thank CSIR for sponsoring the symposium and being our Financial Partners, I thank CEUR Workshop Proceedings being our Partners. I thank ISTE for being our Technical Partners. I thank the Management of Maharaja Agrasen Technical Education Society, the Director and Dean of MAIT for giving us the opportunity to organize this Symposium. Hope that the symposium leaves positive memories for you to cherish.

1/12/23

Prof. Namita Gupta
Symposium Chair and Head of Department
Computer Science and Engineering, MAIT

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(11th January 2024)
Mode: Hybrid

Symposium Schedule

Time	Program
9:30 am	**Registration** *Venue: outside room no. 131/132*
10:00 am – 11:45am	**Inauguration** **10:00am - 10:10am: Welcome and Saraswati Vandana** **10:10am - 10:20am: Introduction of SCCTT - 2023** **10:20am - 10:30am: Welcome Address by Prof. Namita Gupta, General Chair, SCCTT - 2023** **10:30am - 11:10am: Invited Talk by Prof. Anurag Jain, USICT, GGSIPU, Delhi on "Cyber Security of Smart Cities"** **11:10am - 11:20am: Address by Prof. Neelam Sharma, Director MAIT, Patron, SCCTT - 2023** **11:20am – 11:30am: Address by Dr. Nand Kishore Garg, Founder & Chief Advisor, MATES** **11:30am – 11:45am: Vote of Thanks** *Venue: Lab no. 131/132*
11:45am – 12:00pm	**Tea Break**
12:00 pm –1:00 pm	**Session (Offline)** **Session Chair: Dr. Shivani Jain, Sr. Data Analyst at AICTE** *Venue – Room No. 131/132*
1:00 pm –2:00 pm	**Lunch and Networking**
2:00 pm- 3:00 pm	**Session resume (Online)** **Session Chair: Dr. Shivani Jain, Sr. Data Analyst at AICTE**
3:00pm - 3:45pm	**Valedictory Session** **3:00 pm – 3:30 pm: Certificate Distribution ceremony** **3:30 pm – 3:45 pm Vote of Thanks** *Venue – Room No. 131/132*

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Accepted Papers

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[Paper Id – 6]Leveraging Zero-shot Promt Design for Multi-modal Animal-Vehicle Collision Avoidance*

Ashima Garg*[1], Dr. Sonali Gupta[2] and Dr. Payal Gulati[3]

J.C. Bose University of Science and Technology, Y.M.C.A. Faridabad, Haryana

Abstract

In recent years, technology has rapidly advanced, leading to a growing demand for smarter architecture. Smart cities, born from this progress, have become an essential requirement in today's world. What sets these smart cities apart from traditional ones is their integration of advanced infrastructure and technology. Ensuring the safety of citizens on the road, especially with the rapid development of parallel industries like self-driving cars, is a primary concern. However, there isn't an abundance of data that comprehensively covers every aspect of data distribution present in the real-world environment for cars, such as various weather conditions like "rainy," "sunny," "foggy," etc. Additionally, the process of gathering and subsequently training on this data can be both computationally and financially demanding. In light of the aforementioned challenges, we present an advanced animal classification model using zero-shot learning, leveraging CLIP—a pre-trained multi-modal model trained on 400 million images, with 63 million for the text encoder and 340 million for the image encoder. Our model surpasses the benchmark for zero-shot learning, outperforming even human performance, with an accuracy of 93.5% compared to human performance at 53.7% for zero-shot learning. The model also excels in one-shot and two-shot performance, achieving 75.7%. Furthermore, we assess the model's accuracy on the ImageNet dataset, where it significantly enhances accuracy from 11.5% to 76.2%, even matching the performance of ResNet-50, despite the use of a mere 1.28 million crowd-labeled dataset for training. Finally, we evaluate our dataset on the *ST L*10 dataset, where our model achieves nearly 100% or more specifically 99.3% accuracy in identifying the animals present in the dataset, despite not being trained on this dataset.

Keywords

Zero-Shot Learning, Prompt-Engineering, Classification, CLIP, Foundation Models

1. Introduction

With the ongoing growth of the human population, the significance of sustainable development becomes increasingly apparent. Achieving sustainable development requires a careful equilibrium between preserving the environment and progressing human activities. Consequently, our research now shifts its focus to tackle the issue of animal identification on roadways within smart cities. Our primary objective is to reduce road accidents resulting from encounters with animals, thus improving overall safety. Recognizing the critical nature of this problem, our investigation has uncovered a shortage of available datasets. Although datasets exist, their suitability for the specific context is lacking, posing a serious risk if systems are built upon

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them. To tackle this, we harness the power of pre-trained large multi-modal models using zero-shot learning to fine-tune it on animal classification. Recently, it has been discovered that the pre-trained model consist *emergent qualities* that are able to train on very few-data. Taking it as reference we focus our system to achieve the desired task using zero-shot learning or more specifically *prompting*. These models consists of the ability to efficiently encode both images and text. Therefore, we apply prompting to classify the animals classes proposed using this ability of these pre-trained models. This encoding facilitates the classification of our animal subset within the proposed classes. What sets our system apart is its capacity to effortlessly expand the range of detectable classes. This is attributed to the inherent capability of these pre-trained models to efficiently encode both visual and textual data. We encode different combinations of the prompts consisting of all entities consisting of the following classes: 'cow', 'dog', 'goat', 'cat', 'zebra', 'lion', 'leopard' .'cheetah', 'tiger', 'bear', 'crocodile', 'polar bear', 'bull', 'camel', 'cattle', 'duck', 'elephant', 'rhinoceros', 'horse', 'monkey', 'panda', 'gorilla', 'ground hog', 'donkey', 'hippopotamus', 'ape', 'hyena', 'jackal', 'meerkat', 'chimpanzee', 'deer', 'lamb', 'panther', and 'pig'. For example we build the text as *"The image contains a* ***<label>*** *on the road."* and we find the similarity with the encoded image by the image encoder module of the pre-trained large model in terms of logits. We have used different prompts and after scrutinizing them we were able to extract the most appropriate prompt to classify theanimals on theroad. We used different prompts, and through extensive experimentation we optimized the prompts manually, some of the other appropriate prompts were: *"There is a picture with a cow on the road"*, *"The image shows a cow standing on the road"*, and *"Cow is seen standing in the middle of the road in the picture"*. Consequently, our objective is to determine whether an animal is present in the recorded media from devices, such as a camera mounted on the car's hood. To achieve this, we leverage the Contrastive Language-Image Pre-Training (CLIP) model, which has been trained on both text and image data. Contrastive learning, an unsupervised representation learning approach, enables the discovery of hidden data representations without the necessity for manual labeling. This implementation involves grouping similar items together and pairing dissimilar items in other combinations. The optimization process in contrastive learning aims to encourage the model to reduce the distance between entities with similar labels and increase the distance between those with differing labels. They have used this technique using text paired with images found across the internet to predict from the 32, 768 randomly sampled text snippets, to which the image was actually paired. As for the evaluation, we have evaluated our method optimized via different engineered prompts on ImageNet, Animal-10 Dataset, and COCO datasets. Basically, we can summarize our contribution using the three points:

- We have proposed a novel system for classification of animals on the road to avoid accidents in smart cities. In our knowledge this system is first of its kind to get proposed which harness the power of pre-trained large multi-modals in order to identify the presence of animals on road to avoid accidents.
- The system is optimized and built on the concept of zero-shot learning, i.e. by leveraging

the prompt tuning methodology. This allievates the need to collect a vast amount of data without mitigating the comptetiveness of the proposed model.

- We have proposed a system that is capable of easily adapting to detect new classes in a zero-shot format without any samples but only with the help of prompt engineering.

The paper is structured by intializing the discussing prior research in the field and our optimizations in Section 2. Then, in Section 3, we present our approach, procedures, and methods applied during the study. This section also outlines how we fine-tune the CLIP model for animal detection. Lastly, we provide a comprehensive summary of our discoveries in Section 4.

2. Related Work

In recent years there has been a tremendous progress in the domain of pre-trained large models. This does not come as a surprise due to their outstanding performance on various independent and identically distributed (IID) dataset and out-of-distribution (OOD) datasets. However, due to their vast size with million and billion of parameters, they are not the first choice that comes to mind when low on computational budget. This is due to their high demand for computational resources to get fine-tuned or trained upon. The concept of "*emergent qualities*" has played a major role to make these models accessible to common researchers. The emergent qualities of these pre-trained large models or *Foundation Models*–a term coined by the research community for these models, consist of using these models via zero-shot learning methodologies, like prompt tuning or in-context learning. In-context learning is the process of sending multiple prompts with labels to the model in a sequence format in one-go to adapt the model to a task with the last prompt with no labels, motivating the model to predict the answer based on the prior prompt and labels received. However, the concept of in-context learning is out of the scope of this paper. As a result, we will be focusing more on prompt-learning–it is process of sending incomplete sentences to the model, motivating it to complete the sentence, revealing the answer/prediction in the process. The goal is to give prompts that are similar to the ones PLM saw during training so as to achieve the downstream task with minimal or no training. These prompts are easy to generate requiring design expertise from humans but for complex downstream tasks, the efficiency of generalization is not good. Automated prompting as the name suggests are the ones that are generated by algorithms. As a result, pre-trained large models are able to perform few-shot [1] and zero-shot learning [2] eliminating the need for expensive data collection to fine-tune for downstream tasks. Prompts given to the model can be either manually or automatically generated. Manual Prompting [3] is done by humans generating prompts that can probe the PLM. Automated prompting has been a recent area of research attraction, which can be categorized as hard prompting [4, 5, 3, 6] and soft prompting [7, 8, 9].

The first method involves using explicit prompts or queries in natural language to interact with the language model. The model processes these prompts, comprehends the context, and generates responses accordingly. In contrast, the second approach involves working with the underlying vector representations (embeddings) of words or phrases within the language model's

internal embedding space. In this embedding space, each word or phrase is represented as a high-dimensional vector. Rather than providing explicit prompts in natural language, embeddings are directly manipulated to achieve the desired outcome. Prompt engineering encompasses more than just reordering words; it also encompasses conveying desired styles, aesthetics, layouts, lighting, and textures. Unlike fine-tuning and pre-training, prompt engineering doesn't have an impact on model [10, 11] but has a contextual impact on the result being produced. There have been notable works in the field of animal detection. For example, [12] use a convolutional neural network with an extensive 3.2 million dataset promising real-time detection of 48 animal species and using deep neural networks to automatically annotate the images. Ensuring the quality of such a large dataset is a daunting task, moreover, there can be a higher representation of some animal species leading to biases, and training a deep CNN on a dataset of substantial size necessitates significant computational resources, including powerful GPUs and ample memory, resulting in prolonged training times and resource demands. However, the use of such large models and datasets introduces the risk of overfitting, where the model memorizes training data instead of learning meaningful features. This could impede the model's ability to generalize effectively to new and diverse data, potentially compromising its real-world performance. Careful consideration and mitigation strategies are essential to strike a balance between resource requirements and the risk of overfitting, ensuring the model's robustness and adaptability for accurate and reliable results.

Mitigating the above problem [13] propose a two-stage network having ResNet-50 as background and self-attention leading to a feature-pyramidal structure. Two datasets are used for training nearly 60, 000 samples which are then fed to the model. Although this study offers a potential solution for object detection challenges. However, its increased complexity may lead to higher resource demands during training and inference, potentially escalating costs. [14] and [15] bring the state-of-the-art YOLO detection models to light. This intricacy might also reduce model interpretability, impacting transparency and accountability. Although trained on a substantial dataset, the model's ability to generalize to diverse scenarios outside its training distribution could be uncertain. Moreover, the additional complexity might compromise real-time performance, hindering applications with low-latency requirements. The effectiveness of the solution heavily relies on dataset quality, and hyperparameter tuning for the two-stage architecture introduces further intricacies. The former study introduces the YOLOv2 architecture with the inclusion of deformable convolutional layers to address the challenge of geometric variations faced by CNNs. Meanwhile, the latter study employs YOLO-Animal, which utilizes YOLOv5 for detection enhancement through the fusion of a weighted Bidirectional Feature Pyramid Network (BiFPN) and an Effective Channel Attention (ECA) module.

While both approaches contribute to improved geometric generalization, they may encounter limitations in detection tasks. The incorporation of deformable convolutional layers in YOLOv2 could introduce computational complexity and require extensive fine-tuning for optimal performance. Similarly, the fusion of BiFPN and ECA in YOLO-Animal might increase model complexity, potentially impacting real-time processing and hardware deployment. Furthermore, both methods may heavily rely on the quality and representativeness of the training data, poten- tially struggling with novel scenarios not well-covered by the training dataset. This increased

complexity may also compromise interpretability, making it challenging to understand the rationale behind detection decisions. Consequently, it is essential to carefully weigh these trade-offs and conduct thorough validation to ensure the practical applicability and reliability of these approaches across a variety of detection settings.

Noting all the previous works and their contribution, we have proposed a system that is capa- ble of zero-shot learning. The method proposed unlike the aforementioned is computationallycheap and easy to deploy. Additionally it does not require one to need more data to fine-tune the model for the specific problem. We have proved these points using an extensive evaluation on different datasets which we will cover in the Section 3.

3. Implementation Details

This section is devoted to provide the information about the proposed method in detail. Additionally, through this section we hope to provide the information about the experiments for confirming our hypothesis and credibility of our proposed system. Based on the above details and need we have introduced two subsection, where the former called Proposed Method 3.1 is focused on providing the detailed information about the system proposed in this work. Similarly, in the latter Section 3.2 we showcase the results and performance of our system on various datasets.

a. Proposed Methods

We leverage the pre-trained zero-shot ability to adapt to novel tasks. Based on it, we have used prompt tuning to adapt the CLIP model on our custom task of classifying animals on roads. CLIP acts as one of the most thoughtful selection from the existing as models as it is trained on 400 million text-image pairs, granting it the ability of zero-shot learning.

Similar to models like GPT [8], which has popularized these emergent qualities. It creates a 512−dimensional image and text vector which are compared using the cosine similarity using the same vector space. The cosine similarity can be defined using the equation 1. It can be defined as the metric of quantifying the similarity between the two vectors. It measures the cosine similarity between the two vectors, which indicates the similarity between these vectors.

$$\text{cosine similarity} = cos(\theta) = \frac{A \cdot B}{||A||\,||B||} \quad \ldots\ldots (1)$$

Here A and B denotes the two multi-dimensional vectors, where the numerator produces the similarity of the magnitude and therefore to purely extract the angle we divide the numerator with the magnitude of these vectors. In other words, firstly the CLIP text encoder module encodes the text into rich text embedding, which is analogous to the vector A, defined above. Similarly, the image encoder module of CLIP encodes the image into rich image features embedding with respect to the textual features. The image features embedding can be related to the multi-dimensional vector B defined in equation 1, which is scaled by a temperature $\mathcal{T}$ and normalized into a probability distribution via the softmax activation function. The highest score of the image-text pairs indicates the close proximity between the image and corresponding text pair. Figure 1 briefly describes the process being referred to, the CLIP model harnesses the text and image where the text encoder derives meaningful feature representations that are semantically rich with all the entities present in the module and being referred to in the prompt leveraging meaningful contextual representations a similar process is executed by the image encoder extracting embeddings out of the image. The extracted embeddings are compared using cosine similarity leading to the classification of animal in the picture. The efficient execution of this task holds significant potential for the advancement of smart cities, where the classification of animals on roads could be seamlessly integrated into self-driving cars to enhance road safety

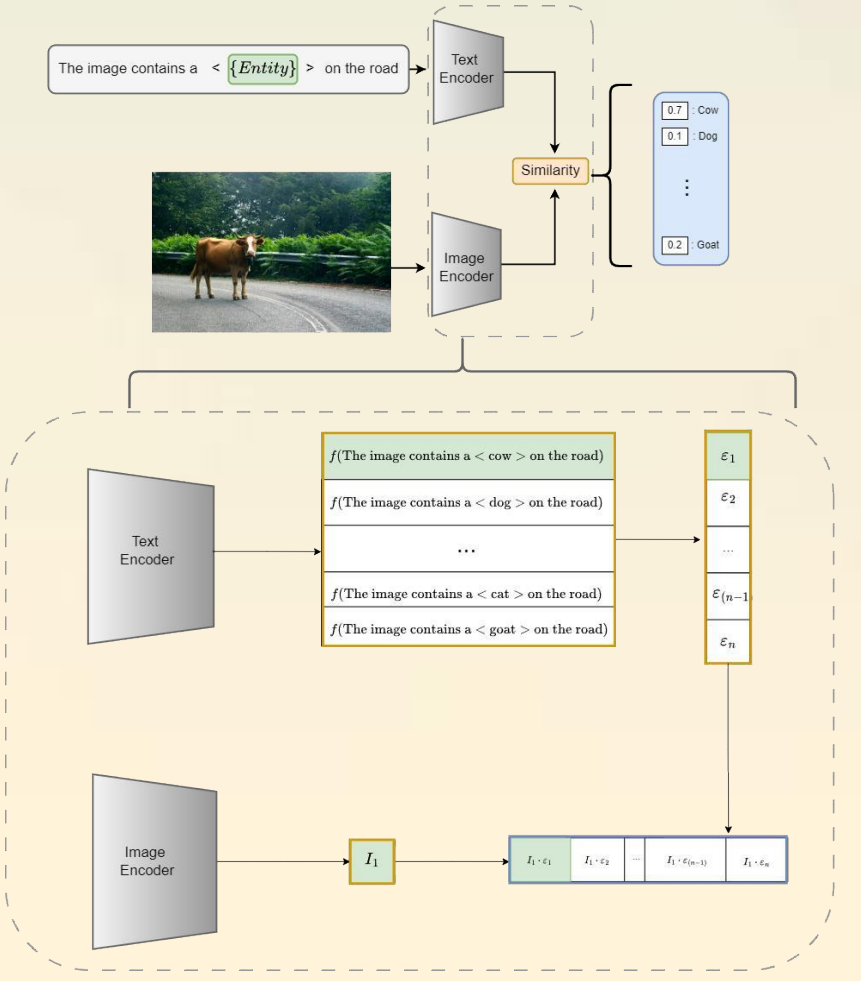

Figure 1: The prompt and the image is leveraged by the CLIP model, where the text encoder is used to obtain the rich semantic feature representation of the text with all the entities available in the {*Entity*} module. Similarly, the image encoder is used to obtain the embeddings of image. These are both then compared using the cosine similarity to obtain the most appropriate description of image, as a result classifying the animal in the picture.

in India. As previously mentioned, one of the key and distinctive features of our system is its ability to add new classification categories without the need for re-training. While this capability offers substantial benefits, its performance on specific classes must be rigorously evaluated through extensive experimentation.

Prompt Engineering emerged as the most critical and challenging aspect of our system development process. However, it presents a conundrum due to the rapid evolution of Deep Learning, which has made interpretability a substantial challenge. Consequently, crafting the perfect prompt to inspire the model to produce the desired response has become a significant contemporary challenge. Thus, it constituted one of the initial hurdles that we had to overcome.

To overcome it, we leveraged the ChatGPT[1] to build the set of sentences which could be leveraged as prompts for retrieving the classification of the model. We used the query "*paraphrase the sentence given below: a* **<*label*>** *is there on the road*" to get these paraphrased examples from ChatGPT. Specifically, we generated various examples and tested them on our model. The Table 1 describes the top 30 text examples or prompts generated for the model. Furthermore, the table gives a brief overview of the prompts by *ChatGPT* and *Bard* which then served as the prompts guiding the model towards contextual extraction. The variances in prompts by the two models lead to a diversification which in turn enhances the contextual representation ability.

Table 1
Generated Prompts using **ChatGPT** and **Bard** for classification of an animal on the road.

S. No.	Generated Prompt by ChatGPT	Generated Prompt by Bard
1.	There's a <**label**> present on the road.	A <**label**> is present on the thoroughfare.
2.	A <**label**> can be observed on the roadway.	A <**label**> is blocking the pathway.
3.	On the road, a <**label**> is visible.	A <**label**> is occupying the street.
4.	A <**label**> has positioned itself on the road.	A <**label**> is obstructing the road.
5.	The road features the presence of a <**label**>.	A <**label**> animal is on the highway.
6.	A <**label**> has made its way onto the road.	A dairy <**label**> is on the main road.
7.	In the path, you'll find a <**label**> on the road.	A <**label**> is on the asphalt.
8.	A <**label**> is situated on the roadway.	A <**label**> is on the concrete.
9.	The road is home to a <**label**>.	A <**label**> is on the blacktop.
10.	On the road, one can notice a <**label**>.	A <**label**> is on the roadway
11.	A <**label**> occupies space on the road.	There is a <**label**> on the road.
12.	The road hosts the presence of a <**label**>.	A <**label**> can be seen on the road.
13.	There is a <**label**> located along the road.	There is a <**label**> on the road.
14.	A <**label**> is placed on the road.	A <**label**> can be seen on the road.
15.	The roadway accommodates a <**label**>.	There is a <**label**> on the road.
16.	A <**label**> is positioned within the road area.	A <**label**> can be seen on the road.
17.	The road has a <**label**> situated on it.	There is a dairy <**label**> on the road.
18.	Present on the road is a <**label**>.	A <**label**> can be seen on the road.
19.	A <**label**> is situated upon the road.	There is a <**label**> on the road.
20.	On the road, there's the presence of a <**label**>.	A <**label**> can be seen on the road.
21.	A <**label**> is positioned in the road's vicinity.	The <**label**> is on the road.
22.	On the road, a <**label**> can be found.	The <**label**> is on the road.
23.	A <**label**> has taken its place on the road.	The <**label**> is on the road.
24.	A <**label**> is right there on the road.	The <**label**> is on the road.
25.	The road encompasses the presence of <**label**>.	The <**label**> is on the road.
26.	In the path, a <**label**> has appeared on the road.	The dairy <**label**> is on the road
27.	A <**label**> occupies the space of the road.	The <**label**> is on the road.
28.	The road showcases a <**label**>'s presence.	The farm <**label**> is on the road.
29.	There's a <**label**> positioned on the road.	The livestock <**label**> is on the road.
30.	There's a <**label**> positioned on the road.	The <**label**> is on the road.

[1]https://chat.openai.com/

b. Results and Experimentation

We implemented the proposed technique using Python 3 on the Google Compute Engine backend. At the outset, the code pipeline was constructed with an Nvidia Tesla K80 GPU, endowed with 24 GB of high-speed GDDR5 memory, available at no cost with Colab. Although this GPU served well for executing initial code segments, tasks demanding substantial computational power necessitated careful consideration. The Nvidia Tesla K80 GPU boasts 4992 CUDA cores operating at 560 MHz, translating to training durations spanning approximately 3 to 4 hours. However, training sessions remained confined to 2 to 3 iterations due to sporadic runtime disconnections and GPU memory limitations, rendering the process somewhat intricate and demanding vigilant supervision. To surmount these constraints, we transitioned to Colab Pro, affording us access to the Nvidia Tesla T4 GPU.

We conducted extensive experiments on two distinct datasets, namely ImageNet and STL10. The ImageNet dataset contains a wide range of categories, with the "animal" category alone comprising roughly 3.8 thousand subcategories and 2.8 million images. From this extensive collection, we selected 10 images per unique category, resulting in a total of 38, 000 images. Shifting our focus to the STL10 dataset, it encompasses classes like cat, deer, dog, horse, and monkey, each with approximately 800 images.

In addition, we assessed our system's performance in comparison to human abilities. Our model exceeded the benchmark for zero-shot learning, demonstrating superior performance even when compared to human capabilities. Specifically, our model achieved an impressive accuracy of 93.5%, surpassing the human accuracy of 53.7% in zero-shot learning scenarios. Furthermore, our model exhibited commendable performance, achieving an accuracy of 75.7% in both one-shot and two-shot learning scenarios.

Moreover, we evaluated the model's accuracy using the ImageNet dataset, resulting in a significant improvement from an initial accuracy of 11.5% to an impressive 76.2%. Notably, our model's performance aligns with that of ResNet-50, even after utilizing a dataset of 1.28 million crowd-labeled instances for training.

To conclude our assessment, we extended our analysis to the STL10 dataset, where our model achieved nearly flawless accuracy of 99.3% in accurately identifying animals within the dataset. This achievement is particularly noteworthy as our model was not specifically trained on the STL10 dataset.

4. Conclusion

In conclusion, our model presents a compelling stride forward in addressing the challenges posed by diverse environmental conditions, data scarcity, and resource constraints. By harnessing the capabilities of CLIP and zero-shot learning, we contribute a powerful tool for animal classification, not only demonstrating benchmark-beating performance but also showcasing a remarkable ability to generalize beyond its training data. Our proposed model surpasses existing benchmarks for zero-shot learning, outperforming human capabilities with an accuracy of 93.5%, compared to the human score of 53.7% for zero-shot learning. The performance

extends to one-shot and two-shot learning scenarios as well, reaching accuracies of 75.7%. Furthermore, our research evaluates the model's prowess on the ImageNet dataset, showcasing a significant enhancement in accuracy from 11.5% to an impressive 76.2%. Therefore, our model serves as an ideal solution for addressing the challenges of data scarcity and road classification, demonstrating its capacity to detect various environmental conditions encountered in the real world, spanning from "rainy" to "sunny" and "foggy," among others.

However, our model is not without limitations. One prevalent concern is Polysemy, which arises when CLIP's text encoder is provided with only the class name as information. This limitation affects the text encoder's ability to differentiate between different word senses since the absence of context hampers accurate disambiguation.

Furthermore, the introduced model occasionally exhibits limited performance, detecting animals even when they are not present on the road but rather captured by the camera. While this characteristic may be seen as a system limitation, it could potentially serve as a valuable driver warning mechanism to prevent collisions.

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[Paper Id – 9] Investigation and Implication of Advanced SensoryComputing in Military and Defense Applications

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Abstract

This research paper explores the various applications of the Internet of Things (IoT) technology in the defence sector. The Internet of Things (IoT) and the development of defence technologies are both topics covered in this paper. IoT is now seen as a path-breaking technology that has the potential to reshape a number of industries, including the defence industry. The term "Internet of Things" (IoT) describes the networked interconnection of physical entities, including machinery, infrastructures, and other things, that are equipped with sensors, applications, and inter-networking. For defence organizations, the potential of IoT to collect, analyze, and distribute data in real-time presents enormous opportunities to improve situational awareness, decision-making abilities, and operational efficiencies. The study centers on the utilization of smart units and sensory modules to improve combat tactical awareness, logistics and supply chain management, and military hardware predictive repair. Several case studies are provided in the paper to demonstrate these uses, including the use of autonomous aerial vehicles (UAVs) for real-time data gathering, IoT devices for monitoring equipment and people movement, and predictive repair for increasing operational availability. The study finds that the use of IoT technology in defense has the potential to greatly improve military operations by allowing leaders to make better choices based on real-time data and increasing total combat efficiency and efficacy. The paper emphasizes the significance of real-time data gathering and analysis in the military context, as it enables commanders to make informed choices swiftly and react to rapidly shifting battlefield conditions. The usage of smart approach in logistics and supply chain management guarantees that crucial resources are in the right location at the right moment, improving total operational efficiency.

Keywords

Internet of Things, Defense technology, Cybersecurity, Surveillance, Smart computing, Data privacy.

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1. Introduction

Network centrality has significantly changed military strategy and war fighting since the final period of the twentieth century. The Internet of Things (IoT), the next rung on the networking scale, has already begun to fundamentally alter how society operates by connecting a vast number of intelligent devices that are interconnected and capable of communicating with one another. IoT is expected to proliferate at a similar rate in the military in the near future, which will fundamentally alter how they operate and conduct operations. This paper examines various aspects and provides an evaluation of the IoT centrality of futuristic defense activities driven by IoT idea, obstacles and evolutionary paths of major power. Recent studies [1] have discussed about IoT and their vital utilization in military domain. The use of sensors in work zone may enhance military authorities' situation based alert level, risk management, and execution delay. IoT-based solutions can help the military detect the adversaries, keep track of the physical and mental health of the armed personnel, and coordinate the armed personnel with defence systems. Armed personnel's positions and vital signs can be obtained using military outfits and helmets with embedded sensor devices. To protect life of defense staffs, the command center has the ability to respond immediately. Some of the sensors that can be utilized to create intelligent military gear are the climatic sensor, heart sensor, accelerometer, ECG sensor, mobility sensor, and oxygen level sensor.

Connecting devices and objects to the internet enables them to gather and share data in real-time. This technology trend is denoted as the "Internet of Things" (IoT). IoT is being used inthe defence sector to build smarter, more interconnected systems that can help boost situational awareness, increase communication, and improve decision-making. In order to secure a nation’s defense sector, its military unit should be efficient. Army staffs who are on warzone or who are allotted any special task are going to be benefited from this. As discussed by Sujitha, v et al. [2] GPS would be used to track the soldiers' whereabouts, well-being, and other details (Global Positioning Systems). Mobile Medicare approaches, including robust computing devices, clinical sensors, and transmission methodologies, are used to continuously monitor the health of troops from a distance. Smart sensors including temperature and heart rate sensors, aswell as bomb detectors and panic buttons, are coupled to the suggested system, which will use apersonal server to accomplish full mobility. The CPU receives the parameters gathered by the real-time sensors attached and processes them further. Internet of Things (IoT) is emerging as aquickly adapting concept which leads to fast and reliable information transfer. Several countriesare unable to monitor events leading to any casualty of staffs regardless of any alert or prior data securing. The lives of war fighters cannot be replaced, so it is important to protect their lives. Controlling military ammo is a crucial and essential aspect of military operations. The creation of intelligent military tools is a significant application of IoT in the defence sector. This covers everything from drones and tanks to smart weapons and military equipment. In their work Utsav, A et al. [3], have proposed internetworking models on basis of IoT for military applications. There are several geographical areas that the military is unable to monitor and detect any unauthorized signal or activity. To make things simpler and so that their system can locate a specific place wherever surveillance is required. They allocated a

In [4], various radio frequency detection modules, cameras, sensory units, positioning units and other perception interfaces are discussed in context to military tasks. Networking interface is responsible for routing packets from perception interface to the application interface facing various constraints in network. Smart systems make use of small range-based network transmission methods like Bluetooth and Zigbee to forward signals from perception interface to routers on basis of abilities of transmitting entities. Networking techniques like 3G and 4G or any energy communicative line can route data over long route distance. As, applications intend to develop smart environment, this will boost the creation of smart military facilities, which is another use of IoT in defence. These bases have a network of sensors and other connected devices that can track everything from security and surveillance to electricity and water use. Military leaders can optimize operations, boost security, and cut expenses by gathering and analyzing this data. While the use of IoT in defense technology offers several benefits, there are also some cons that need to be considered. One of the primary concerns is thecybersecurity risks associated with IoT. Das, M L et al. [5] have discussed IoT security and privacy concerns would be far more difficult to address than they are in traditional wireless contexts. To ensure that IoT takes on the intended form, restricted contexts in particular call for lightweight primitives, secure design, and efficient embedding into other settings. With a focus on the security goals and privacy requirements for resource-constrained contexts, also examined secure authenticity issues in smart use cases in the article. IoT devices are susceptibleto hacking, and a security lapse on their part might have grave repercussions. Defense organizations deal with highly sensitive information, and a security breach could compromise the safety of troops and compromise national security. There are concerns about the privacy of personnel who are required to use IoT devices. Wearable and other IoT devices may collect personal information about the user, and there is a risk of this information being misused or hacked.

This study explores the impact of the Internet of Things (IoT) on defence technology, focusing on its role in improving situational awareness, communication, and decision-making inmilitary operations. It will analyze case studies and literature to assess its advantages, challenges, and future prospects. The study aims to contribute to ongoing discussions on IoT's application in defense technology and offer a framework for weighing its advantages and disadvantages. Challenges include cybersecurity risks, interoperability issues, the need for reliable network infrastructure, and privacy concerns.

1. Related Work

Atul Pant et al. [6] provides a comprehensive overview of the potential of IoT technology in shaping the future of military operations. The author highlights the potential benefits of IoT technology in enhancing situational awareness, improving communication and coordination, and optimizing resource management. However, the author also notes that there are significant

challenges associated with the implementation of IoT technology, including cybersecurity risks and interoperability issues. The author emphasizes the importance of a coordinated and collaborative approach to the development and implementation of IoT technology in military operations, and highlights the need for strategic planning and investment in research and development to ensure that the full potential of IoT technology is realized in the future of military operations.

Vishal Gotarane et al. [7] emphasizes the importance of real-time data collection and analysisin military operations, and explains how IoT-enabled devices can provide valuable data on troop movements, equipment status, and other critical information. The work also explores various applications of IoT technology in military operations, including surveillance and reconnaissance, logistics and supply chain management, and battlefield healthcare.

Martinez-Caro, J.-M. et al. [8] note that the integration of IoT technology in unmanned systems, such as drones and autonomous vehicles, can improve their capabilities in terms of sensing, decision-making, and communication. The paper highlights the potential of IoT-enableddrones for reconnaissance, surveillance, and target acquisition, and how they can be used to gather real-time data on enemy positions and movements. The author also cover how IoT can be used to improve the powers of smart weapons.

Ninad V. Joshi et al. [9] discusses the deploy and implementation of an IoT driven sensory vest and helmet for the defense sector. The smart vest and helmet are designed to provide various features such as real-time monitoring of vital signs, GPS tracking, and communication capabilities. The vest and helmet consist of various sensors and devices such as a heart rate sensor, a temperature sensor, a GPS module, a micro-controller, and a communication module.

Iyer, Brijesh et a.l [10] in their work on "IoT enabled tracking and monitoring sensor for military applications" Report an IoT-based system for battlefield health surveillance and analysis. The sensory module acts as a cost-effective and accurate alternative for troop surveillance. For determining human life, various human vital indicators and combat circumstances such as body temperature, pulse rate, smoke recognition, and oxygen saturation are used. A distress buzzer is also included, which may be helpful for the solder to summon immediate assistance on the battleground. The new technology described by Eszter Katalin Bognar et al. [11] provides vital growth in various defense zones. The author agrees that the implementation of exploratory data security necessitates a novel approach and points to recent projects in the internetwork army, IoT based medical tracking, driving units, sensory logistics, IoT based defense bases, and embedded intelligent specific analytics units as the initial trend and significant rise in this field are anticipated in the future.

Mariani, Joe et al. [12] provides a comprehensive overview of the Internet of Things (IoT) in the military context. They describe the IoT in the military's historical growth, present condition, and possible future developments and possibilities. The writers' thorough examination of the development of IoT historically and in the context of warfare is one of this paper's strong points. Beginning with the use of radio technology for transmission during World War II, they trace the early evolution of IoT in the military. The growth of IoT in the military context is then described,including the creation of different transmission technologies, the application of unmanned systems, and the appearance of connected devices. Overall, the author offers a thorough analysisof IoT in the military context, covering everything from its

historical development to its present state and potential future developments.

In their work Kang, James Jin et al. [13] have proposed a generic energy constrained model for assisting defence staffs in critical events-based tasks. Various military network uses are included in the suggested framework. Health data and biometric for employee identity have been used to improve multi-factor verification. To minimize power usage, multi-layer inference methods were used to increase accuracy and efficiency. The subsequent inference interface enhanced with savings rate of datasets grew while precision got reduced by only 0.9% as compared with the first layer inference algorithm, which had already improved savings and accuracy rates.

Sehrish Mudassar et al. [14] discusses Wireless Sensor Networks (WSN), a branch of the Internet of Things that is a new field of research. A key application field for sensing nodes and IoT has been recognized as military reconnaissance, which is a crucial part of defense and military activities. Link scheduling systems were the subject of a study of the literature. This research focuses on resource scheduling for the military because there isn't a specific scheduling plan discussed in the literature. Additionally, a paradigm for resource scheduling that finds a compromise between competing demands for quality of service for two different traffic groups is created.

Abhishek, R et al. [15] in the work highlights IoT Driven Defence Vehicle System and concentrates on developing a prototype man less ground vehicle with multiple functions. This device can move objects with the help of DC motors. The process makes use of DC gear motors, which are operated at 500 RPM and 12.5 kgcm torque. For various purposes, the prototype is fitted with various sensors, including PIR, Ultrasonic, Temperature, Gas, Accelerometer, and Metal Detector. When explosives are discovered, the robotic arm is used to transfer the items. This man-less ground vehicle is built to operate anywhere in the globe and to perform in hazardous conditions.

Sabarimuthu, M. et al. [16] in their work established private data transmission among army staffs and base node. Poisonous gas attacks could be discovered early with the help of gas sensors. Motion sensors can track the assailants' movements and alert the troops to their whereabouts. Metal items that are concealed inside of other objects can be found using a metal detector. The GPS device also sends the soldier's location information to the base station. When in need, a soldier can press the SOS icon to signal for help from other troops. As a result, the suggested method offers the best option for a system of monitoring and protection for soldiers. The micro-controller is provided a power supply for use in their job. It has a gas monitor that can detect poisonous chemicals. Metal that is hidden beneath is found using a metal detector.

Dhananjay et al. [17] have spoken about the battlefield's health and weapon state control system while keeping deployed troops in mind. The command center (commander) and troops can communicate with each other in both directions using the hierarchical IoT communication design. As a result, the leader can keep an eye on the health of the soldiers (parameters like body temperature, heart rate sensor, blood circulation, sugar levels, ECG levels, etc.) and the condition of the weaponry before making military choices that are important for the army.

Mishra, L. et al. [18] in their work provided a detailed review of the usage of IoT in the defense perspective. Drone-based surveillance is the most important of the mentioned aspects because it detects the presence of intruders or harmful weaponry without the direct participation of humans, providing security to our troops. Furthermore, they have proposed a new idea of

smart camps, which is merely a hypothesis. After this theory is implemented, we will be able to detect the presence of intruders and explosives around the camps, preventing an assault and potential devastation.

2. Role of IoT sensors in Defence Technology

The way we engage with technology has been completely transformed by the Internet of Things (IoT). IoT allows things to interact and share data with one another by utilizing sensors and wireless connectivity, leading to the development of smarter, more effective systems. IoT technology has been applied in the military and defense industries to increase situational awareness, decision-making, and operational efficiency. We will talk about the use of IoT sensors in military and security technology in this piece. Figure 1 shows the different applications of IoT in military use cases.

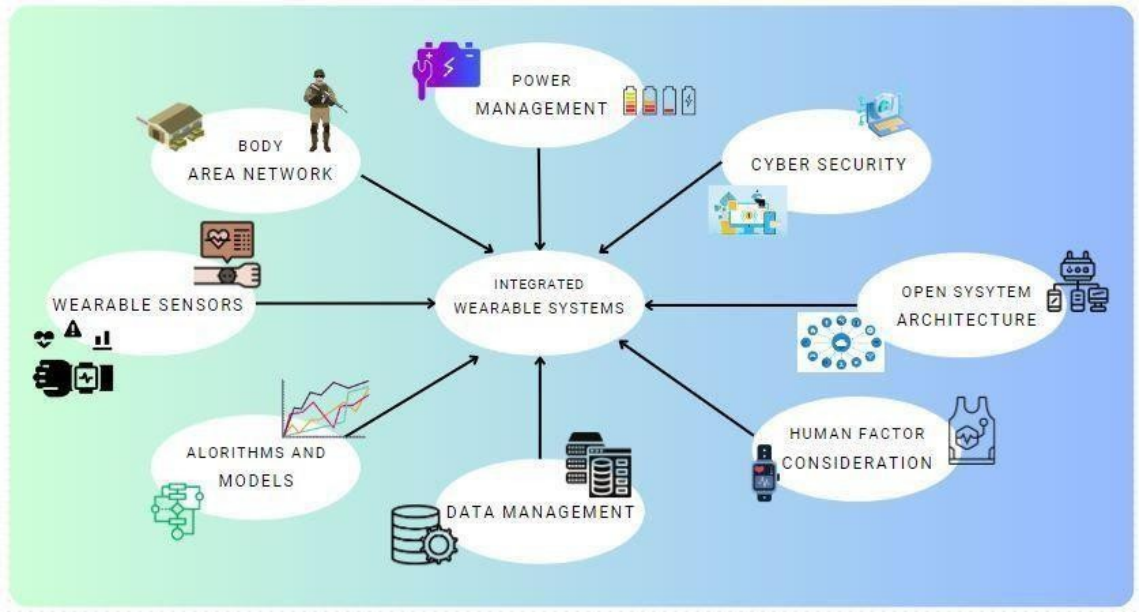

Figure 1: Depiction of IoT application in military

2.1. Awareness of the situation

In the military and security industries, situational alertness is essential. A variety of apps use IoT devices to assist with situational awareness. Unmanned aerial vehicles (UAVs), for instance, use IoT devices to collect real-time information on the positions of enemies, the topography,and the weather. The command center receives this data, which is then examined there toreveal information about the battleground. Additionally, smart helmets donned by troops utilize IoT sensors. These headgears have sensors and cams inside that record information about the surroundings. The information is then real-time processed to give troops

a 360-degree picture of their surroundings. By increasing environmental awareness, troops are better able to make choices.

2.2. Prevention-based maintenance

Equipment malfunction can have disastrous consequences in the military and security industry. IoT devices are used in a variety of military hardware, such as ships, tanks, andairplanes, to keep track of the condition of vital parts. IoT sensors can forecast when machinery is likely to malfunction by examining data on component performance. As a result, proactive repair can be carried out by maintenance teams, cutting delay and raising dependability.

2.3. Management of the supply chain and logistics

In the military and security industry, supply chain management and logistics are essential. Real-time monitoring of people, equipment, and supply movements is done with the help of IoT devices. Following an analysis of this data, logistics processes are optimized for cost and productivity savings. IoT devices are also used to keep an eye on the state of goods while they are being transported. For instance, monitors can be installed on shipping crates to track vibration, humidity, and temperature. This guarantees that goods, including medical gear and ammunition, are delivered in the best possible manner.

2.4. Cybersecurity

Cybersecurity is essential in the military and defense industry. Network monitoring and danger detection are carried out using IoT devices. For instance, monitors can be used to track network activity and spot any oddities that might point to an assault. This lowers the possibility of data leaks and hacks by enabling Cybersecurity teams to react rapidly to threats.

Applications for real security, like access control systems, also use IoT devices. Security teams can identify and stop unauthorized entry efforts by using sensors to watch doors and exits. The security and military sectors have been changed by Internet of Things sensors.

3. Different types of IoT sensros in Defence Technology

3.1. Global positioning system (GPS) sensors

GPS sensors are one of the most essential tools in the defense industry. By giving precise, real-time position data, GPS sensors have completely changed how the military conducts business. This information is essential for a variety of military uses, including aiming and guidance. In-depth descriptions of GPS devices and their applications in the defense industry are given in this piece. A circuit model for GPS sensor is shown in Figure 2.

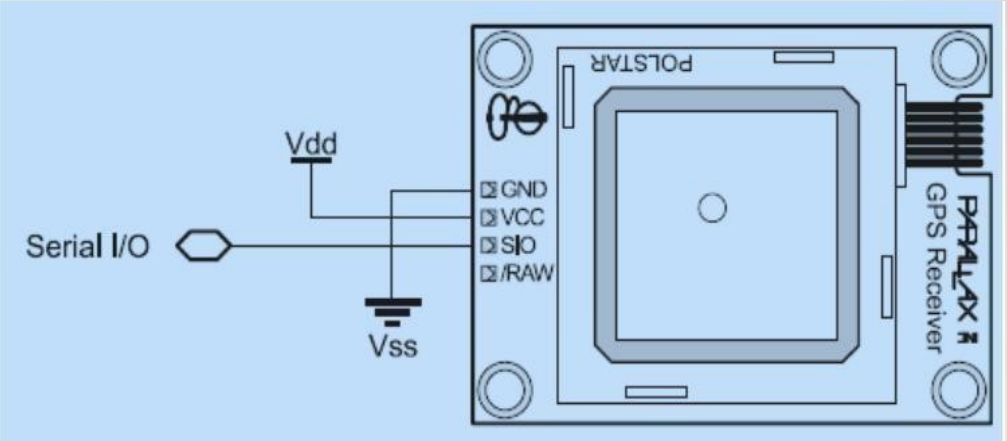

Figure 2: Circuit diagram of GPS sensor

The GPS sensor uses trilateration to determine its distance from each satellite by measuring the amount of time it takes for messages to move from the satellites. The GPS sensor can determine its exact position by adding this distance information to the location data transmitted by the satellites. In the field of defense, GPS devices are used for a variety of tasks, including targeting and guidance. The following are a few of the most significant uses for GPS sensors in the armed forces. Navigation: In the military, GPS devices are frequently used for tracking. Targeting: In the military, GPS devices are also used for aiming. Reconnaissance: In the military, GPS sensors are also used for surveillance. They can be used to follow the movements of hostile forces' soldiers and vehicles, giving crucial information for strategizing military actions. Additionally, friendly troops can be tracked and located using GPS devices to make sure they are working in the proper areas and are not in danger of ambush. Communication: In the military, GPS devices are also used for contact.

4.2 Infrared sensors

Infrared (IR) sensors are crucial in the defense sector for identifying and analyzing the environment through thermal radiation. They are used in both civil and military defense systems, with military systems focusing on tactical and strategic components and civilian defense encompassing homeland security. Despite technical challenges, infrared sensors are desirable due to their passive capabilities, lower bulk and power consumption, and use in all missile defense operations. Nanotechnology offers potential for infrared components with unique material and physical features, advancing rapidly. An infrared sensor is shown in Figure 3.

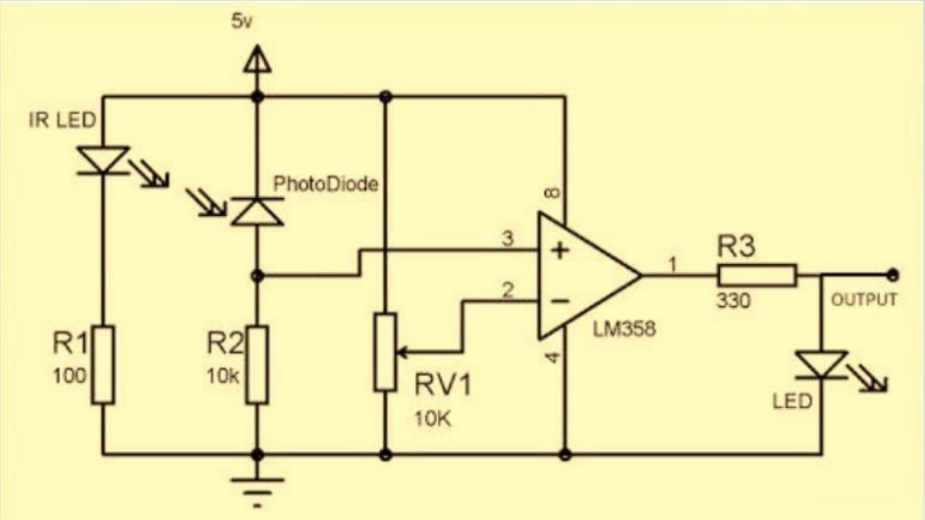

Figure 3: Circuit diagram of infrared sensor

Infrared sensors detect and analyze thermal energy released by objects in their surroundings. These electrical devices consist of a detector, signal generator, and display. The signal processoranalyzes data and creates a display for the user. IR sensors come in various forms, including inactive, active, and semi-active ones. Active sensors generate their own infrared radiation and detect reflections, while passive sensors sense infrared radiation from objects. Semi-active sensors emit infrared radiation and sense both emitted and reflected radiation. The effectiveness of IR sensors depends on factors like sensor temperature, substance type, and atmospheric conditions. Other infrared radiation sources, such as sunlight or artificial sources, can also conflict with IR sensors.

4.3 Acoustic sensors

Acoustic sensors are electronic devices designed to detect, measure and analyze sound waves. They are commonly used in the defense sector for various purposes, including detecting and tracking submarines, aircraft, and missiles. These sensors can be deployed on a wide range of platforms, from ships and submarines to airplanes and drones, and can provide valuable information to commanders on the battlefield. The acoustic sensors have helped in designing gun positioning approach with defense alternative as its origin for self-protection tasks and currently it led to intelligent rule-based business policies on demand basis. Basics of gun activities forecasting within muzzle signal projection of super-fast missiles are analyzed. These gun related events are moreover defined in context to sensory captures and its consequences in gun positioning outcome. Figure 4 shows an acoustic sensor model. There are various kinds of acoustic sensors used in the defense sector, including hydrophones, Sonobuoys, acoustic arrays, and acoustic cameras.

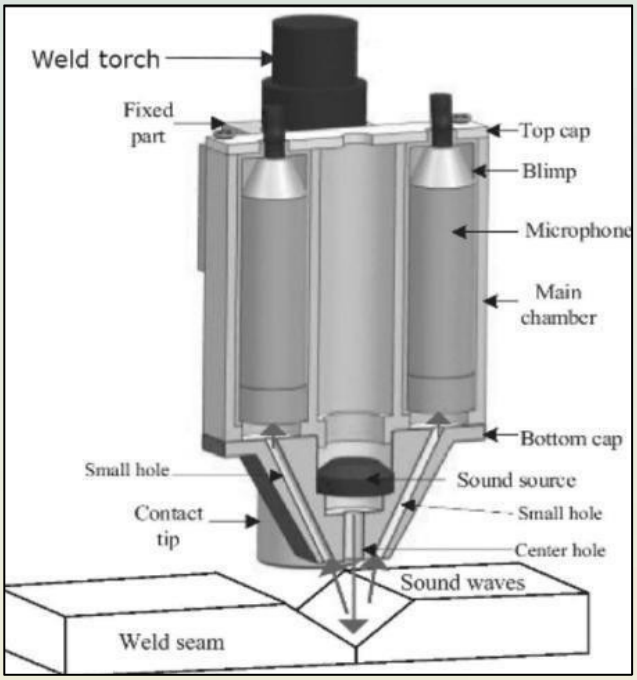

Figure 4: Depiction of acoustic sensor model

4.4 Optical sensors

Electronic tools called optical sensors are created with the purpose of detecting and measuring light or electromagnetic waves. They function by reacting to variations in the brightness, wavelength, or polarization of light and have a variety of uses, such as environmental tracking, process management in industry, and medical diagnoses. Optical sensors are a crucial piece of equipment used in the military and defense industry for a number of tasks, such as locating and recognizing targets, following and directing weapons, and giving military people situational awareness. A sample ray diagram of an optical sensor is shown in Figure 5.

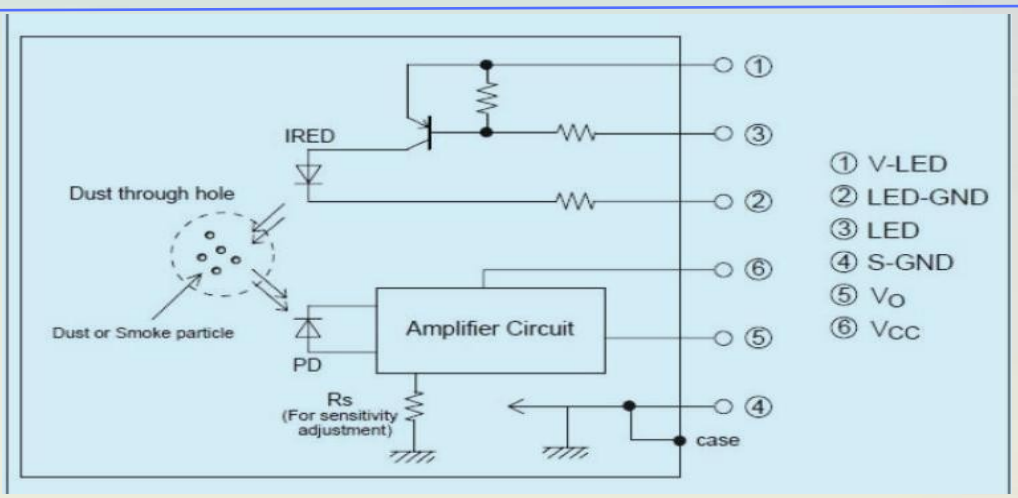

Figure 5: Ray diagram for optical sensor

Optical sensors can typically sense light in a specific electromagnetic spectrum, such as the visible, infrared, and ultraviolet ranges. The photoelectric effect is used by this sensor to easily identify the polarization of light, wavelength, or frequency and convert it into an electric signal. The primary determinant of an optical sensor's detecting principal is a shift in the properties of the optical signal. Since light is primarily used as the carrier in this sensor's operation, its sensing range is very broad. Transmitter (also known as an optical source) and receiver are the two basic parts of optical detection. (optical detector). Any item that gets between the transmitter and receiver causes the light beam's characteristics to shift. In optical detection, the five important properties of light—intensity, phase, wavelength, polarization, and spectral distribution—are detected.

4. Different types of IoT sensors in Defence Technology

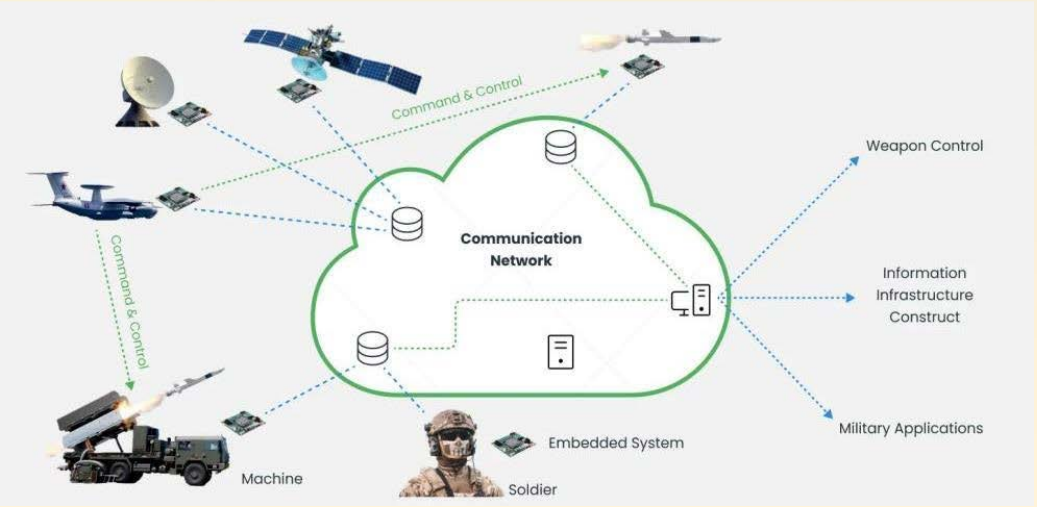

Figure 6: Depiction of application of IoT in military for communication

As you can see in Figure 6, IoT military smart devices significantly contribute to troop lifesaving. However, a sophisticated system like this can only function continuously if there is continual and uninterrupted communication between all of the connected components, including soldiers, warehouses, trucks, equipment, operators, and the command centre. Breaking the connection between its components might decrease efficiency or possibly render it inoperable because all of its pieces must operate as a single complex system. Wire transmission was the most reliable and unbroken form of data transmission for many years, yet for contemporary combat operations, such a technology is not only obsolete but also impractical. Today, the majority of other biometric data is transmitted using encrypted radio transmission, much like regular IoT.

In order to aid in their tactical planning, live simulation is used as shown in Figure 7. That is, real humans run real instrumented devices, and only the impacts of the weapon appear emulated. The drills may affect each sub-team, mix activities and events, and expose the master' abilities. The replay and post-action evaluation of actor decisions and person acts are also essential lessons for improving actor response. In this situation, the vertices of the tetrahedron correlate to the following live simulation actors:

- Process: Combat training activities such as injury management, target identification, penalty impacts, and so on. Data from sensors, armed vehicles, tanks, and other devicesis combined and evaluated to build quick frameworks and equipment control schedule-based processes. This could aid to enhance system efficiency and general tasks of model.
- Person: Soldiers, unit commandants, operations control center employees, and staffs (group discussions, vehicles prime tenant and clinical facilitator).
- Intelligence based entities: Sensors, actuators, tools, and vehicles capable of producing a precise image of real-time activities in order to allow real-time management. Tactile suits, combined head-based devices, and other intelligent items are examples.
- Technological ecosystem: Sensors, actuators, tools, and vehicles capable of producing aprecise picture of real-time activities, allowing for real-time management. Intelligent items may include tactile suits, combined head-based devices, and so on.
- Privacy: seeks to minimize the danger of confidential data disclosure (troop) where shared with a modern environment. Anonymity, encrypted process, aggregated data, amalgam, and synchronized approach are data management methods that can be used to conceal private details while still giving important information for the pertinent usecases.
- Trust: focuses on soft privacy (technical environment) to build reciprocal confidence between intelligent entities and staffs, as well as to provide security assurances and openness during military exercises. As a result, the worldwide system is able to provide timely and trustworthy data where it is required, timing of need, and who will require it. Trust will be established based on two factors: the intelligent object's ability to defend itself against a dangerous environment, and the person's ability to question the node to determine whether it is still trustworthy.
- Identification / Access control: Controlling unauthorized intrusions of persons/objects into limited regions. They may concern the identity and location of

ordnance andweapons, the measurement of explosives and poisonous chemicals, the monitoring of troops, the detection of shooters, and the management of surveillance parameters in sensitive areas.

- Reliability: concentrates on the dependability of information gathered and outcomes relayed by the technological ecosystem during the military process. For example, if models do not produce the same stress as a real battle, the impact on the dependability of a virtual simulation is inaccurate, because people react differently when stressed. Furthermore, tools or vehicles may rarely crash because unreliability was not adequately simulated. To compensate for this shortcoming, the simulated equipment behavior may mimic task failure, gasoline usage, or ammunition utilization based on real-world values [19].
- Safety: seeks to satisfy the demand for intelligent objects, guarantee their safety throughout their entire life cycle, and enhance people's safety by decreasing accidents and deaths during activities. In military operations, an attacker may leverage a medical device's weakness, such as cardiac pacemakers or diabetic machines, and kill victims. Another situation is when a combatant is cautioned about dehydration, elevated pulse rate, low blood sugar, and so on. Monitoring tools may allow for an effective health system and/or the provision of health services as needed.
- Auto-immunity: It deals with how to defend intelligent objects from physical assault in highly harsh military operations settings, as well as providing resilience to shock and tremor; with the ability to self-monitor and report. It also concentrates on improving the resistance of intelligent devices and communication routes to disturbance andjamming.

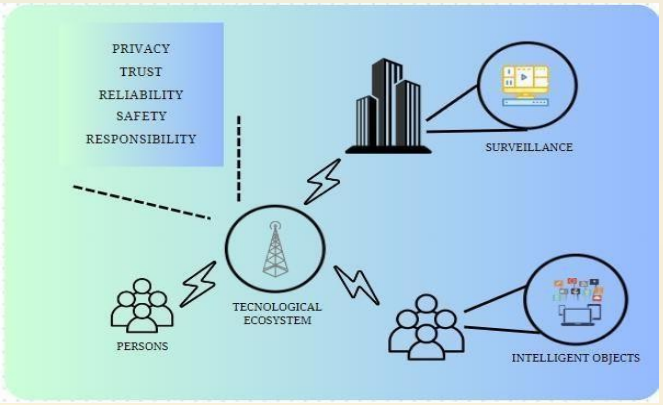

Figure 7: Military life simulation and security issues

5. Challenges of smart sensors deployment in military applications

The paper also discusses the challenges associated with implementing IoT in the military, including:

5.1. Resource security

Implementing IoT devices in defense can bring many benefits, but it also introduces several security issues that need to be addressed. Some of the significant security issues in implementing IoT devices in defense are:

- Data Security: IoT devices gather sensitive information and transmit it over the network, which can be intercepted by hackers. Unauthorized access to such information can be disastrous and compromise national security.
- Device Security: IoT devices can be physically tampered with, allowing the attacker to modify or steal information. Therefore, proper device security measures are necessary to prevent unauthorized access [20-21].
- Network Security: IoT devices communicate with each other and with the cloud through networks that can be vulnerable to cyber-attacks. An attacker who gains access to the network can cause significant damage to the defense system.
- Authentication and Authorization: IoT devices require authentication and authorization mechanisms to ensure that only authorized personnel can access them. Failure to do so can lead to unauthorized access to the system.
- Remote Access: IoT devices can be accessed remotely, and remote access can lead to security vulnerabilities. It's essential to limit remote access to authorized personnel only.

5.2. Interoperability

The implementation of IoT devices in defence raises several interoperability issues due to the complex and heterogeneous nature of the defence systems. Some of the key interoperability issues are:

- Compatibility: IoT devices may not be compatible with existing defence systems, making it difficult to integrate them seamlessly. This may require extensive modifications to the existing infrastructure, which can be time-consuming and expensive.
- Privacy: Defence systems must be highly secure and protected from cyberattacks. IoT devices may not have the same level of security, which can make them vulnerable to attacks and compromise the entire system [22].
- Data integration: IoT devices generate large volumes of data, which must be integrated with existing defence systems. This can be challenging because the data generated by IoT devices may be in different formats and require different protocols for processing and analysis.
- Scalability: Defence systems are large and complex, and IoT devices must be scalable to handle the volume of data generated. This requires a robust and reliable infrastructure that can handle the data generated by IoT devices.
- Maintenance: IoT devices require regular maintenance to ensure that they continue to function properly. In defence systems, this can be challenging because maintenance may require taking the system ofline, which can disrupt operations.
- Physical security: IoT devices in defense settings may be vulnerable to physical attacks,such as theft or tampering. It is important to ensure that these devices are properly secured and monitored to prevent unauthorized access or interference [23-24].

Table 1
Advanced sensors features in defense use cases

Sensor Type	Functionality	Power Consumption	Accuracy	Applications
Acoustic	Detect and measure sound waves underwater or in air	Low to Moderate	High	Anti-Submarine Warfare (ASW) and Missile Detection
Hydrophones	Detect underwater sound waves	Low to Moderate	High	Submarines, Ships, Underwater platforms
Sonorous	Track undersea targets	Low	High	Anti-Submarine Warfare (ASW)
Acoustic Arrays	Identify sound waves in specific directions	Low to Moderate	High	Underwater object detection
Acoustic Cameras	Produce images using sound waves	Low to Moderate	High	Underwater imaging, Object detection
Optical Sensors	Detect and measure light or electromagnetic waves	Low to Moderate	High	Target Detection, Weapon Tracking and Situational Awareness.

Table 1 highlights the scope and utilization of vital sensors used in military applications. Feaures like types of sensors, functionalities, accuracy level and applications of these sensorsare summarized.

6. Conclusion and Future Work

Modern military tactics are changing as Internet of Things (IoT) technology is being adopted more widely. Military organizations now have access to unprecedented levels of tactical awareness and operational effectiveness thanks to the Internet of Things (IoT), which enables the connection and real-time monitoring of a wide variety of devices and sensors. The ability to gather and evaluate data from various sources is one of the main advantages of IoT in military technology. Everything from cars to weapon systems can use sensors and devices to provide real-time data on position, performance, and upkeep requirements. Machine learning and artificial intelligence algorithms can be used to evaluate this data in order to produce predictive analytic and actionable insights that can assist armed groups in making better choices. IoT is giving military groups unprecedented levels of tactical

awareness and operational effectiveness by enabling the connection and real-time monitoring of a wide variety of devices and sensors. The capacity to gather and evaluate data from a variety of sources is one of the main advantagesof IoT in military technology. To provide real-time information on position, performance, and upkeep requirements, sensors and devices can be installed in everything from vehicles to weapon systems. This data can be examined using machine learning and artificial intelligence tools to produce predictive analytic and actionable insights that can assist armed groups in making better choices. In summation, the IoT is playing an increasingly important role in military activities and is quickly evolving in the field of defense technology. IoT is giving military companies a wealth of new powers and insights, from boosting situational awareness to increasing operational effectiveness. To guarantee the dependable and efficient functioning of these systems, it is crucial to handle the issues related to IoT in defense technology, such as security and environmental variables. IoT is likely to play an even bigger part in military technology in the years to come with ongoing innovation and investment, revolutionizing how militaries function and engage with the outside world.

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[Paper Id – 11] Cloud of Things (COT) in Healthcare: Applications,Benefits, challenges and A Way Forward to Smart Healthcare

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Abstract

Healthcare in India has become the fastest growing sector, which suffers from the existence of multiple challenges on its way. Technology, especially the IoT and cloud computing significantly contribute to the growth of healthcare and introduce a new way of smart healthcare. There is a growing application of the Cloud of Things (CoT) in healthcare. The present review defines the meaning and current status of CoT in healthcare. The CoT is the integration of cloud computing and IoT technologies. CoT and healthcare are two terms that are related to the use of cloud computing and IoT technologies in healthcare. The potential application, benefits, challenges, and solutions to overcome challenges faced in the application of CoT in healthcare are important areas discussed in this review. The future of CoT in healthcare has also been highlighted in this study.

Keywords

Healthcare, Smart healthcare, IoT, Cloud computing, Cloud of Things (CoT)

1. Introduction

Healthcare is one of the fastest-growing sectors in the context of services, revenue, and employment generation. The worldwide healthcare market was estimated at USD 362.1 billion in2022, and from 2023 to 2030, it is anticipated to increase at a CAGR of 7.96%. By 2027, it is projected that the healthcare industry would produce revenues with a compound annual growth rate (CAGR) of 10.40% and a market volume of US$ 85.9 billion. There will be 1.57 billion usersin the healthcare industry by 2027[1].

Healthcare is growing at an exceptional rate because of the aging population, lifestyle diseases, demand for affordable healthcare services, increasing awareness towards health, attitude transformation towards preventive healthcare, advancement in the area of healthcare technology, continuous health insurance penetration, and initiatives taken by the government are driving the healthcare sector. Healthcare can be segmented into three broad domains i.e. primary care, secondary care, and tertiary care. Figure: 1 presents the different segments of healthcare along with the care given in each segment.

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Figure: 1 Domains of Healthcare [2]
Source: Walshe K, Smith J, editors. Healthcare management. McGraw-Hill Education (UK); 2011 Sep 1[2].

But healthcare has downsides too. An overburdened healthcare system, challenges to the supply chain, less patient access to healthcare data, disrupted healthcare business activities, etc. are some prevailing challenges the healthcare facing. The Current ways to avail healthcare facility are inconvenient and time-consuming, which is not capable of fulfilling the healthcare requirement of the growing population. This situation of the existing healthcare system enhances the need for smart healthcare facilities which support lowering the burden on the healthcare system by providing low-cost, fast, and convenient healthcare facilities for common people. Due to this, the use of technology has become increasingly important to reduce workloadand improve efficiency within healthcare systems. Technology, enabled by cloud and IoT may contribute remarkably to the growth of smart healthcare. "Smart healthcare" describes the application of technology to raise the standard, accessibility, and effectiveness of medical care. Numerous applications, including telemedicine, wearable technology, artificial intelligence, big data analytics, cloud computing, and IoT can be used in smart healthcare. The amalgamation of cloud and IoT also known as cloud IoT or cloud of Things (CoT) offers an efficient solution for smart healthcare surveillance systems [3]. The present review focuses on the integration of CoT in healthcare that helps manage patients and other remote services.

2. Cloud of Things (CoT)

The integration of cloud computing and IoT technologies is known as CoT [4]. It focuses on bringing IoT to the cloud, where all IoT capabilities and devices can be approached as a service through the cloud (e.g., sensing as a service SenaaS). In CoT, as a middleware cloud makes a transparent interaction between users/applications and things [5]. This interaction between Cloud and IoT benefits each other. The virtual unlimited storage and computing resources of the cloud can benefit IoT, whereas IoT provides the cloud the chance to extend its services to real- world things [6].

The CoT offers data monitoring, storage, processing, analysis, and visualization capabilities for IoT devices, as well as enables communication and collaboration among users [3]. The scope of CoT is promoting smart applications and services that promote the extension of the cloud through things, which opens new issues as well as opportunities [6, 7]. It can be practiced for

different purposes and areas such as healthcare, education, environmental monitoring for smart homes, smart cities, villages, mobility, surveillance and logistics, etc. [3]. It develops communication links between heterogeneous devices and handles ever-increasing data demands[8, 9].

3. Cloud of Things (CoT) and Healthcare

CoT and healthcare are two terms that are related to the application of IoT technologies and cloud computing in healthcare. Cloud computing refers to the on-demand availability of data storage and computing resources managed by external service providers over the Internet. The network of physical devices and objects that are linked with connectivity, software and sensors, which help them to gather and exchange data is known as IoT. By using cloud-based platforms and IoT devices, CoT creates a system that allows healthcare providers and patients to analyze and share health-related data accessed through different locations and sources and thus empowers them by enabling healthcare services more accessible and affordable. It involves the collection, dissemination, and analysis of data gathered from various medical devices, sensors, and wearable through a network of cloud-based platforms [10]. The data so collected securely transmits to the cloud, where it can be stored, processed, and analyzed. Additionally, by streamlining the process of collecting patients' essential data, CoT enhances the quality of healthcare processes and the actual healthcare services.

In healthcare, CoT offers numerous benefits such as remote patient care, real-time monitoring of vital signs, data analytics, medication adherence, and improved healthcare delivery. This allows timely intervention and personalized care by detecting abnormalities and changes in health conditions. For the purpose of handling large volumes of healthcare data cloud-based platform offers storage capacity, scalability, and computational power[3,4,11] which further offers advanced analytics techniques such as artificial intelligence and machine learning for gathering valuable insights from the collected data. These insights further contribute to early disease detection, predictive modeling, and recommendation of personalized treatment. It also supports in seamless integration and interoperability of diverse healthcare systems, devices, and platforms, enabling efficient exchange of data and collaboration among healthcare providers Figure: 2 presents the functioning of the cloud in case of remotemonitoring of patients.

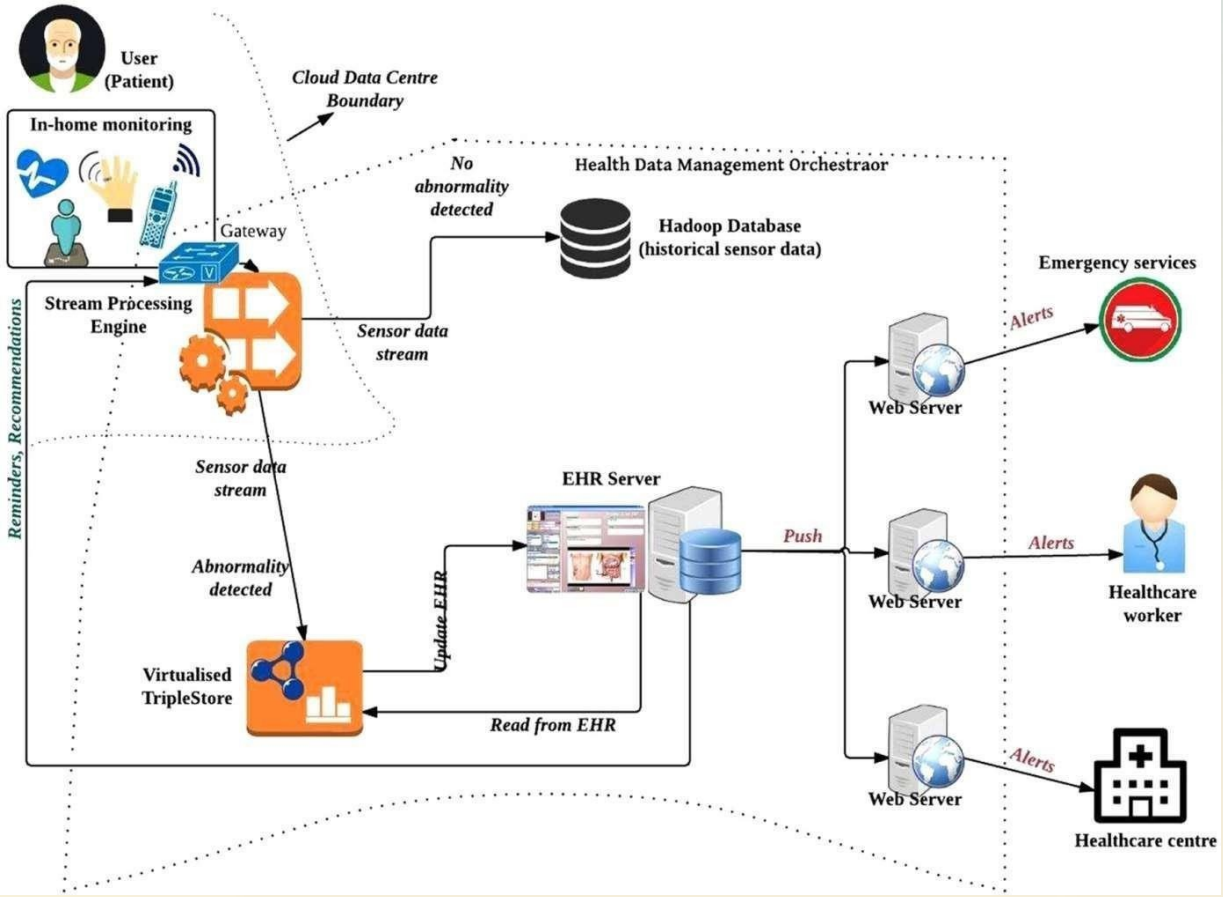

Figure: 2 Remote Healthcare applications using the CoT
Source: Shah, T., Yavari, A., Mitra, K., Saguna, S., Jayaraman, P. P., Rabhi, F., & Ranjan, R. (2016). Remote health care cyber-physical system: quality of service (QoS) challenges and opportunities.IET Cyber-Physical Systems: Theory & Applications, 1(1), 40-48 [11].

Moreover, CoT in healthcare offers opportunities for telemedicine and remote patient care. It enables virtual consultations, remote diagnosis, and treatment, allowing healthcare providers to reach and serve patients in remote or underserved areas. This technology can increase access to healthcare services, reduce healthcare costs, and improve patient outcomes. CoT in healthcare presents numerous opportunities to medical IT infrastructure and can enhance healthcare services. Additionally, by streamlining the procedure, CoT enhances the quality of the actual healthcare services as well as the processes involved in providing them. It also poses challenges related to data security, privacy, regulatory compliance, and ethical considerations [12]. Addressing the applications and benefits of CoT in healthcare is essential

to ensure the successful adoption and implementation of CoT solutions in the healthcare ecosystem and a way towards smart healthcare.

4. Applications and benefits of CoT in healthcare

IoT devices are smart devices that can collect and transmit data from various sources, such as sensors, wearables, implants, etc. Smart watches, sensors, and cameras monitor and transmit patients' vital signs and health data to cloud servers for real-time analysis and feedback [13]. These devices monitor and transmit patients' vital signs, such as blood pressure, heart rate, glucose level, and oxygen saturation, to cloud servers for real-time analysis and feedback [14, 15,16, 17]. They can be used for various purposes in health care, such as monitoring vital signs, tracking medication adherence, detecting falls, etc. [13]. For IoT devices cloud computing provides storage, processing, analysis, and visualization of data along with remote access and control.

Platforms like Telemedicine and e-health make it possible for people to quickly and remotelyaccess healthcare services online. It consists of distant diagnosis, therapy, advice, instruction, etc.[18]. The CoT can make it easier for patients and various healthcare providers to share and save medical data including electronic health records (EHR), radiological pictures, lab results, etc. TheCoT can also support telehealth applications that make use of IoT gadgets and sensors, such as video consultations, remote patient monitoring, personal health monitors, etc. [19]. Besides this Medical imaging and analysis entails the collection and analysis of substantial amounts of medical images, including X-rays, CT scans, MRI scans, and others. For storing and analyzing medical images, CoT can offer scalable and affordable computer resources. CoT can also make it possible to apply machine learning and AI methods to improve the precision and efficacy of medical picture analysis. [20].

The presence of Clinical and hospital information systems manages the administrative and operational aspects of healthcare facilities, such as patient registration, billing, inventory, scheduling, etc. The CoT can improve the efficiency and security of these systems by providing centralized and integrated data management, backup and recovery, access control, etc. The CoT can also enable real-time data sharing and collaboration among different departments and stakeholders [21]. Along with these, medical decision support systems helps medical practitioners, make clinical decisions that are supported by evidence-based standards and recommended practices. By giving users access to extensive and up-to-date databases of medical knowledge, including information on drug interactions, disease symptoms, and treatment alternatives, the CoT can improve the performance and functionality of these systems. CoT can also make it possible to use AI and big data analysis to produce individualized and foreseeable insights for medical diagnosis and therapy. [19].There are need of secondary use of health data for activities such as research, public health monitoring, quality improvement, etc. that are not directly related to patient care [22]. The CoT can simplify the gathering and combining of health data from many sources, including electronic health records (EHRs), IoT gadgets, wearable, etc. To ensure privacy and interoperability, CoT can also make it possible to standardize and anonymize health data [23].Finding new medications or altering

current ones to cure ailments is a process known as drug discovery. By enabling extensive data collecting, analysis, simulation, and modeling of potential drug candidates, IoT devices might hasten the process of drug discovery. For Internet of Things (IoT) devices, cloud computing can offer data storage, processing, analysis, and visualization capabilities as well as access to shared resources and tools[13].

Cloud-based digital libraries that are accessible and stored on the cloud are collections of digital resources. They can offer simple and convenient access to a wealth of current and pertinent material, including medical literature, journals, books, reports, etc., for researchers andhealthcare practitioners. By facilitating user cooperation and communication as well as data collection and transmission, IoT devices can support cloud-based digital libraries. For cloud- based digital libraries, cloud computing can offer features for data storage, security, privacy, accessibility, and interoperability [24].IoT-based applications in healthcare information systems, such as electronic health records (EHRs), clinical decision support systems (CDSSs), and personal health records (PHRs), manage and store health-related data. Through the collection and transmission of health data from diverse sources, including sensors, wearable, implants, and other IoT devices, healthcare information systems can perform more effectively and efficiently. Healthcare information systems can benefit from cloud computing's data storage, security, privacy, accessibility, and portability advantages [3, 9].

Utilizing data-driven insights, agile operations, and strategic collaborations on cloud platforms, it ensures the accessibility and affordability of necessary medications, vaccinations, and medical equipment. Big data analytics and cloud computing are useful for health analytics. It helps in gaining inputs and predictions about disease patterns, treatment, risk factors, etc. [25, 26, 27]. CoT can help healthcare organizations save on IT expenses, such as hardware, software, maintenance, and personnel. The CoT can also enable pay-as-you-go models, where healthcare organizations only pay for the resources; they use [28, 29].

CoT can help healthcare organizations increase their agility and innovation by providing access to the latest technologies and tools. The CoT can enable healthcare organizations to adopt new solutions and services faster and easier. The CoT can also enable healthcare organizations to leverage AI, machine learning, big data analysis, IoT, etc., to enhance their operations and outcomes [30]. Personal health trackers can help you manage not only your physical health but also your mental and emotional well-being. They can track your mood, stress level, sleep quality, etc., and provide you with feedback and suggestions to improve your overall health [31]. Regularly monitoring your biometric readings enables you to identify any small anomalies in your health and take preventative action before they worsen. This can reduce the need forhospitalization and save costs and time [25]. CoT can help healthcare organizations improve their collaboration and communication among different stakeholders, such as patients, doctors, nurses, pharmacists, etc. The CoT can enable real-time data sharing and synchronization across different devices and locations. The CoT can also facilitate telemedicine and e-health services. In addition to providing users with access to data, cloud computing also offers automated backups and data recovery tools in case data is ever lost for any reason [32].

5. Challenges of CoT in healthcare

While CoT offers numerous benefits, there are also challenges and considerations related to data security, privacy, regulatory compliance, and ethical implications. The successful adoption and implementation of CoT in healthcare depends on addressing these issues.

5.1. Security and privacy issues:

CoT involves the storage and transmission of sensitive and confidential data, such as patient records, medical images, lab reports, etc. This data is vulnerable to unauthorized access, theft, loss, or breach by hackers, malicious insiders, or third parties [33]. The interconnected nature of CoT devices and systems increases the vulnerability to cyber security threats, including data breaches and unauthorized access. CoT also needs to comply with various regulations and standards available in different countries and regions such as the Health Insurance Portability and Accountability Act (HIPAA) 1996 and General Data Protection Regulation (GDPR) 2016, etc., that protect the privacy and security of health data [34]. The interconnected nature of CoT devices and systems increases the vulnerability to cyber security threats, including data breaches and unauthorized access.

In addition, strong authentication, end-to-end encryption, keeping a clean machine, and implementing access controls bolsters healthcare data protection by restricting access to patient information and certain applications to only those users who require access to perform their jobs should be practiced to solve the issue of security and privacy. Access restrictions require user authentication, ensuring that only authorized users have access to protected data. Using efficient data management methods to store, process, and analyze healthcare data in the cloud. This can help reduce the time to market for IoT healthcare solutions, as well as enable insights backed by advanced analytics and AI.

5.2 Interoperability and compatibility issues:

CoT involves the integration and communication of various devices, platforms, applications, and services that may have different protocols, formats, standards, or architectures [35]. This may cause interoperability and compatibility issues that affect the functionality and performance of the CoT. CoT also needs to ensure the quality and reliability of data across different sources and systems [36].

There are different laws and regulations regarding data protection, privacy, and ownership in different countries and regions, which pose challenges for cloud computing and IoT services that operate across borders [37]. Interoperability standards and central regulations can help to harmonize the legal and technical aspects of cloud computing and IoT in health care [38].

5.3. Reliability and availability issues:

CoT depends on the availability and performance of cloud services and network connectivity. Any downtime, outage, or disruption of these services or networks may affect the accessibility

and delivery of CoT. It also needs to ensure the scalability and elasticity of cloud resources to meet the varying demands and needs of healthcare applications [38, 39]. Therefore, careful analysis and a customized design are needed to achieve the optimal balance between reliability and availability for each CoT application.

5.4. Regulatory and ethical issues:

CoT involves the use and reuse of health data for various purposes, such as research, public health surveillance, quality improvement, etc. This may raise regulatory and ethical issues regarding the consent, ownership, control, and accountability of health data. CoT also needs to ensure the transparency and trustworthiness of cloud services and providers [38, 39].

To address them effectively, CoT applications need to adopt a multidisciplinary approach that involves collaboration among various disciplines such as law, ethics, medicine, engineering, computer science, and social science. They also need to follow ethical principles such as respect for persons, beneficence, non-maleficence, justice, and accountability [40]. By doing so CoT applications can ensure that they are not only innovative and beneficial but also responsible and trustworthy for patients and society as a whole.

5.5. IoT devices will increase the attack surface:

The more devices are connected to the cloud, the more vulnerable they are to cyberattacks that can compromise the privacy and security of patients' data and health records [10].

Implementing strong security features and protocols for IoT devices and cloud services. This can help protect the data from unauthorized access, modification, or loss, as well as ensure compliance with privacy and regulatory standards such as HIPAA.

5.6. Legal and regulatory issues:

There are different laws and regulations regarding data protection, privacy, and ownership in different countries and regions, which pose challenges for cloud computing and IoT services that operate across borders [36].

Therefore, CoT applications need to establish clear legal frameworks and contracts that define the roles, rights, duties, obligations, and liabilities of each actor and stakeholder involved in CoT applications [40]). They also need to provide mechanisms for dispute resolution and redress for any affected parties.

6. Future of CoT in healthcare

The future of CoT in healthcare holds significant potential for transforming it into smart healthcare. Here are some key aspects that are expected to shape its future:

6.1. More innovation and digitization:

With the use of CoT the future of healthcare will be more innovative and digitalized. This means using CoT to enable new use cases, such as personalized medicine, precision medicine, digital therapeutics, and smart hospitals [41]

6.2. Advanced Data Analytics:

CoT will keep utilizing advanced data analytics techniques, such as machine learning and artificial intelligence, to extract useful insights from the enormous amounts of healthcare data created [42] .These analytics capabilities can support the early detection of diseases, personalized treatment recommendations, and predictive modeling for improved patient outcomes.

6.3. More accessibility and affordability:

CoT will improve the reach and quality of health care, especially for underserved and remote populations [43].

6.4. Precision Medicine and Personalized Healthcare:

CoT can contribute to the advancement of precision medicine by enabling the collection, integration, and analysis of diverse patient data, including genomics, clinical records, and environmental factors. This holistic approach can support personalized healthcare interventions and treatments tailored to individual patients.

6.5. More collaboration and integration:

CoT will facilitate data sharing and interoperability among different healthcare stakeholders, such as providers, payers, patients, researchers, and regulators [44].

6.6. More efficiency and quality:

CoT will optimize the performance and outcomes of healthcare processes, such as diagnosis, treatment, monitoring, and prevention [45].

6.7. More empowerment and engagement:

CoT enhances the participation and satisfaction of patients and healthcare workers in their healthcare [44].

7. Conclusions

Across the healthcare sector, CoT has a wide range of applications. CoT application in healthcare is only supporting human efforts rather than replacing human involvement and opening a new way of smart healthcare where an individual is capable enough to monitor and

analyze the symptoms and approach the healthcare provider while located remotely. On the other side, many challenges exist on the path of CoT applications, which requires a framework to overcome the situation. The present review discusses the application of CoT in healthcare, a solutiontowards smart healthcare, the challenges faced on the path of its application, and recommendations to solve the problem.

CoT-based transformation in healthcare has the potential to open a way of smart healthcare by improving the overall sector through cost reduction and better access to quality healthcare. This could be possible through a strong collaboration between the key stakeholders of the CoT healthcare ecosystem. With the application of CoT, many healthcare-related problems can be solved.

Even after continuous efforts in this regard, many challenges exist on the path of its widespread adoption and implementation. Issues related to security and privacy, interoperability and compatibility, reliability and availability, regulation and ethics, massive inputs of generated data, obsolete existing software infrastructure, high-power consumption, and legal and regulatory issues are the main ones in this regard. Exploring the unknown, leveraging the power of digitalization, building strong partnerships, embracing positive cultural change, and adopting interoperability standards and central regulations are some of the required measures to apply CoT in the healthcare sector for a new way of Smart healthcare.

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[Paper Id – 19] Smart Cities Development using Blockchain Technology in India:A Critical Analysis

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Abstract

Indian cities are facing enormous challenges due to population growth and rapid urbanisation. Every citizen's lifestyle is getting impacted. People move from rural areas to urban cities in search of employment, education, safety and security, better healthcare options. Blockchain technology mixed with the notion of a "smart city", could prove to be a boon in addressing these urban city problems, by providing a better living environment, and constructing a long-termsustainable solution [1]. The goal of this study is to consolidate existing knowledge on the topic, analyse current and continuing research developments, and show the way for future investigations using a rigorous and auditable systematic review technique. 146 papers published between 2018 and 2023 in 82 journals examined as part of bibliometric analysis. The study created and visualized the literature's bibliometric networks using citations and analysis of co-citation, co-occurrence network of keywords, journals, authors, and nations. The findings showed that there has been an exponential increase in recent years in the number of research articles explicitly focused on blockchain and smart cities. This paper also explores how blockchain technology might apply to smart cities.

Keywords

Environment, Smart City, Blockchain Technology, Urbanization, Infrastructure

1. Introduction

There has been a substantial increase in the urban population during the past few decades. The report titled "World Urbanization Prospects" predicts that by the year 2050, 65 percent of people will live in cities, which is an increase from the current percentage of 54 percent; however, only 46 percent of people currently live in communities. [2]. The number of people living in cities in developing countries in Asia and Africa grows faster than in other parts of the world. China's urbanization level went from 38% in 2001 to56% in 2015 [3]. In different areas, including wellness, education, mobility, economic improvement, living environment and employable conditions, urbanization has significantly improved the standard of living for people around the world. Moreover, the rapid urbanization of the globe also brings with it novel issues and challenges. Due to the high population density in urban areas, environmental resource constraints, trafficproblems, poor air quality, releases of greenhouse gases, and improper disposal have affected the life expectancy of urban residents.

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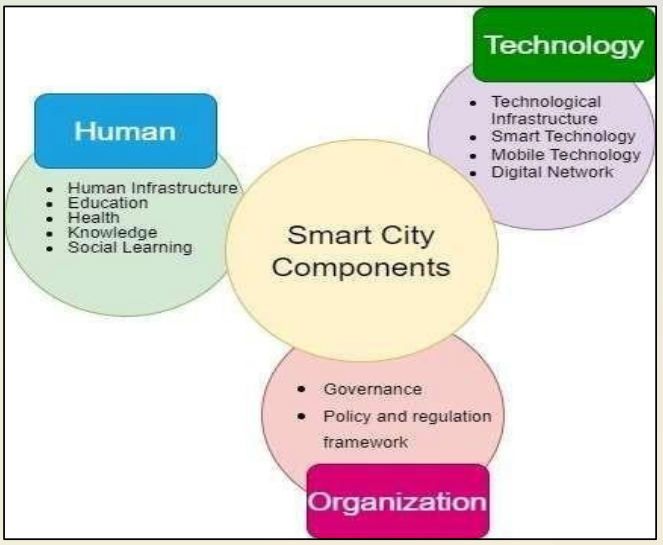
[4]. All these difficulties and issues compel city dwellers (such as officialsand residents) to focus on more intelligent strategies for the development of cities sustainably and the enhancement of the quality of life of their inhabitants. The concept of a "Smart City" is being introduced inthis context. [4] [5].

What does the term "smart City" refer to exactly? A "smart city" commonly defined as an urban area that leverages advanced communication and information technology to offer inventive solutions aimed at enhancing the overall quality of life and establishing an environmentally sustainable environment. This definition has gained widespread acceptance.[6]. Some of the features that define a "smart city" include efficient use of resources, an advanced transportation network [7], cutting-edge healthcare facilities[8], effective waste management systems [9], and top-notch educational facilities [10]. Smart cities represent urbanization's next stage. [11].

Figure 1: A conceptual framework of smart city



Source: Author's compilation

Smart cities largely depend on advanced technology and complex networks to operate properly, as stated by [12] and [13]. Government services such as health , safety and security, and the city's larger infrastructure (such as public transportation, emergency services, and energy grids) all work together seamlessly in a "smart city" [14]. Information Communication Technology is essential for implementing smart cities. Several strategies for developing innovative and environmentally conscious cities have been proposed in recent years. [15][16]. These techniques helped the governments and authorities take action, make judgements, and monitor urban expansion[17] but India has a long way to go.

Blockchain is very crucial to the success of smart and intelligent cities. Blockchain, as defined by[18], is"a digital, decentralised, and distributed ledger in which transactions are logged and added in chronological order with the goal of creating permanent and tamperproof records." Blockchain initially implemented by
S. Nakamoto (2008). It is distributed database and decentralised transaction technology [19]. Despite cryptocurrencies, blockchain technology presently recommended for use in a variety of application fieldsdue to its robustness and data security. Subsequently, there has been a surge in interest about the utilization of blockchain technology in diverse sectors. The security and decentralization of transactions initiated through blockchain arise from the distribution of transaction records across the network, enabling access, transmission, and verification by any participant within the system. Researchers and observers have suggested "blockchain cities" as the key to upgrading metropolitan cities to address urbanization concerns. Many believe

blockchain technology will boost the nation's economy and quality of life.[20].

The present study addresses the existing gap in knowledge by conducting a comprehensive bibliometric analysis of blockchain research with respect to smart city. The aim of the investigation is to identify areasof insufficient knowledge in this field and to assess the influence of literature in the scientific database of Scopus during the period from 2018 to 2023. The analysis encompasses co-citation analysis, as well as theexamination of keyword co-occurrence networks pertaining to publications, authors, journals, and nations. During the literature study, in addition to conducting a bibliometric analysis of the database, the author also endeavoured to address the below mentioned Research Questions (RQs).

Q1 In what manner Blockchain contribute to smart city development?

Q2 In what ways these major obstacles prevent Smart Cities from fully embracing Blockchain Technology?

Q3 How can we help communities use Blockchain Technology so that they can become more sustainable and technologically advanced??

The following is the outline for the paper:

The literature reviewed in Section 2, followed by a description of the research techniques used in thisstudy in Section 3, and finally, a thorough discussion of the results in Section 4. The bibliometric analysissummarized in Section 5, and the comments and potential future research discussed in Section 6. The conclusion discussed in Section 7, and future scope of research discussed in Section 8.

2. Literature Study

2.1 About Smart City

Since the terms "smart city" and "smart" have various meaning, academics, researchers, and businessexperts have shown a great deal of interest in this subject [21]. Examples include Digital City [22], Intelligent City [23], etc. (Pro et al., 2014) provides a comprehensive examination of the smart city, discussing its goals, research problems, and potential project area. According to [24] The primary objectiveof a smart city is to enhance the quality of life for its residents by the strategic use of innovative technologies that address many challenges, such as minimizing carbon emissions, alleviating traffic congestion, improving waste management, and tackling other pertinent concerns [25]. However, the rapid growth of population and globalisation make it difficult for the Indian government to find solutions that are both efficient and affordable to address the issues [26]. The functional prerequisites have been reviewed by [27]. The importance of information security in smart cities, as well as the related problems and solutions, are discussed in [28]. [29] found that although a city cannot be "smart" with few resources or modest sectoral shifts, it can be "smart" in every respect that matters administration, transportation, housing, lifestyle, environmental sustainability, and economic vitality. Contribution of every single part is essential, even though various approaches to creating an efficient smart city have been discussed in prior research, one of the most important

characteristics is sharing [30]. Smart card utilization and a dynamic ID based verification technique is proposed as a means to authenticate distant users in a multi-server environment, with a specific focus on applications related to financial security, was proposed by [31]. They concentrated mostly on eliminating the server spoofing and forgery attacks that were present in the earlier systems. After logging in, they dynamically changed the user ID to prevent tracking and to give the user anonymity.Similar to this, [32] suggested a different authentication method for a remote user utilizing smart cards and biometric verification. Achieve efficiency, they substitute nonces for clock synchronization and employ the one-way hash function. Real-time applications, like Smart City, do not work with the above authenticationmethods. The Smart City needs to process data in real time, which means it needs a good security systemthat does not slow down the system.

Technology is key to the smart city framework. because it makes it easier to collect and analyse real-time data, resulting in smarter decisions and improved city management. Using big data in smart communities and other settings was investigated [33] to determine its potential, challenges, and actual advantages. The analysis of traffic-related concerns in smart cities has been extensively examined by [34]
, and there have been discussions on innovative strategies for addressing these challenges. Machine learning, among other disruptive technologies, is widely employed inside contemporary traffic management systems, mostly in the stages of data collection and service delivery.

2.2 Blockchain Technology

The built environment industry is undergoing a complete transformation because of new disruptivetechnologies. In the future, blockchain technology may use to solve urban problems. and make a significant contribution towards the attainment of the United Nations Sustainable Development Goal at the municipal level. The advent of blockchain technology and its myriad potential applications have facilitated the development of intelligent urban centres and the resolution of associated challenges. Extensive researchand investigations have been carried out pertaining to the field of blockchain technology. [35] provided acomprehensive presentation on the overview of blockchain technology, encompassing its architecture, applications, consensus algorithm, and forthcoming research problems and directions. According to a survey conducted by [36], blockchain technology has security concerns and challenges. The characteristics of the well-known cryptocurrency Bitcoin, its fundamental structure, and related applications were described in [37].

The author [38] conducted research on blockchain and showed how the technology can be useful forgovernment-related tasks like citizen digital ID maintenance and data security. In their study, [39] examined the application of smart contracts in ensuring the security of real estate transactions conductedby buyers and sellers. Author outlined both the advantages and disadvantages of using smart contracts. In [2], the possible applications of blockchain technology to building information modelling (a subset of the construction management process) were investigated. The author draws the conclusion that constructioninformation can manage more safely with a blockchain system. Hence, it is evident based on prior scholarly investigations that blockchain technology possesses the potential to provide diverse

resolutions to the persistent challenges encountered in smart cities. The purpose of this article is to elucidate the significance of blockchain technology in the advancement of intelligent and environmentally conscious urban areas.

3 Research Methodology

3.1 Data gathering

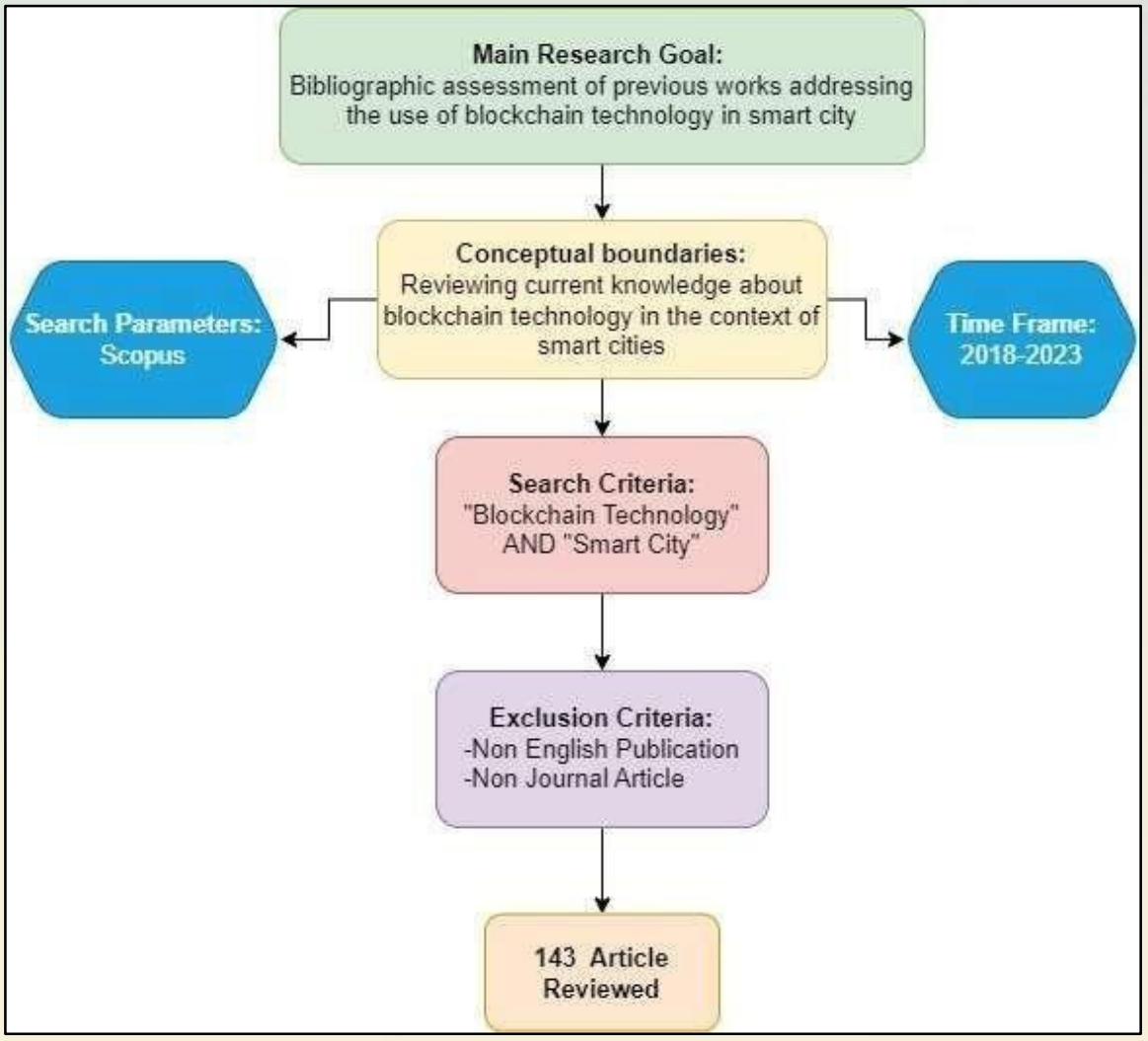
Using bibliometrics, Author examined smart city blockchain applications. This form of review helps researchers synthesise prior findings and inspire novel studies. According to [40], bibliometric reviews are useful since they are unbiased and can reveal previously unknown aspects of the literature. Bibliographictechniques allow researchers to visualize the mental terrain of a subject of study, which clarifies and simplifies their findings. In the similar way the strength of bibliometric reviews, according to [41], lies in their capacity to recognise and categorise a large range of documents within a certain field and to make iteasier to analyse data to highlight trends based on synthesized data.

Finding an appropriate database for the study is the first step in the bibliometric review process. We searched the Scopus database to determine the papers to include. Scopus is a popular research tool because of its capacity to organize citations and track references in a wide variety of fields. Web of science has around 70% less sources as compared to the Scopus Index and is widely considered to be one of the bestacademic databases in the world [42]. When searching for relevant articles, the author combined the Boolean AND operator with the terms "Blockchain Technology" and "smart city" in the title, abstract, andkeywords sections.

Using the framework of numerous studies as a starting point, the author analysed and constructed bibliometric indicators tailored to scholarly journal articles. This is because they provide a cross-sectionalview of scientific endeavour around the world. Enhance the scope of the study, the author examined articles that published in the English language. The inclusion criteria encompassed the consideration of articles published between the time limit of 2018 to 2023 in scholarly journals. By using the established criteria,the database successfully refined, resulting in a reduced set of 160 items. The author limited the scope of the study to specific disciplines, including management, accounting, computer science etc. to enhance the precision of the results. The disciplines received the highest level of focus. The quantity of articles decreased to 153. The title, abstract, and keywords of each article thoroughly examined to determine their relevance. A total of 143 journal papers identified for the ultimate evaluation and analysis.

3.1 Bibliometric Approaches

Figure 2:Review of Literature Framework



Source: Author's Compilation

Upon completion of the explanatory analysis, content of selected articles and article relationship reviewed in detail to obtain more insights. Network analysis also conducted to find the relationship network between blockchain and smart city by using one of the features of bibliometrics in RStudio.

A keyword co-occurrence analysis conducted using RStudio to ascertain the extent of research conducted on the topics of blockchain and smart cities within the specified temporal scope. This methodology aids in separating the realm of knowledge and revealing how many study directions interactwith one another [43].

In contrast to the methodology of co-citation analysis, wherein references grouped together based onthe strength of their connections, analysis of keyword co-occurrence network focuses on author-supplied keywords and investigates the frequency of their joint occurrence in published works.

[44] firstly developed Analysis of Co-citation. It was used to evaluate out and display some of thesmart city research potential of blockchain technology. Researchers can gain a better understanding of the connections between co-cited sources by analysing previously analysed articles. Article co-citation analysisis a frequently employed method in academic research due to its reliance on the assumption that a relationship exists between two papers if both cited in subsequent research. When attempting to determine the scope of a body of knowledge, higher co-citation rates between publications are indicative of closer ties, more consistent referencing, and more shared understanding [45]. This article's co-citation network builtin RStudio.

4 Findings

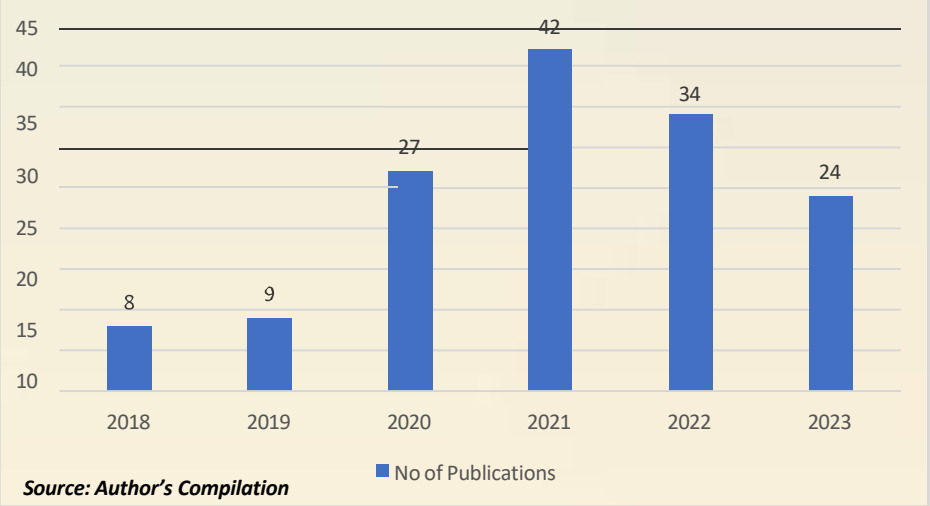
4.1 Yearly Publication Distribution

Table 1: ***Yearly Publication***

Year	Articles
2018	8
2019	`9
2020	27
2021	42
2022	34
2023	24

Source: Author's Compilation

Figure 3:Year wise publication



Source: Author's Compilation

The bar graph below shows the number of publications by year that derived from the Scopus database.It was found during the article search process that prior to 2018, not much research had done on blockchain and smart cities. The increase in the number of papers published each year was one of the reasons for starting in 2018. The number of papers released in 2020 increased considerably when compared to 2018and 2019, as seen in Figure 3.

The development of multiple decentralized applications with a smart city focus and an increase in thenumber of academics willing to understand how to use blockchain technology to

solve urban challenges are the two key factors driving this increase in interest [46]. It anticipates that there will be a substantial increase in the quantity of scholarly publications pertaining the use of blockchain technology in the futureof smart city. This surge in publications expected to follow an exponential growth pattern, signifying the progression of adoption maturation. Furthermore, it anticipated that these topics would continue to attract significant academic interest and attention.

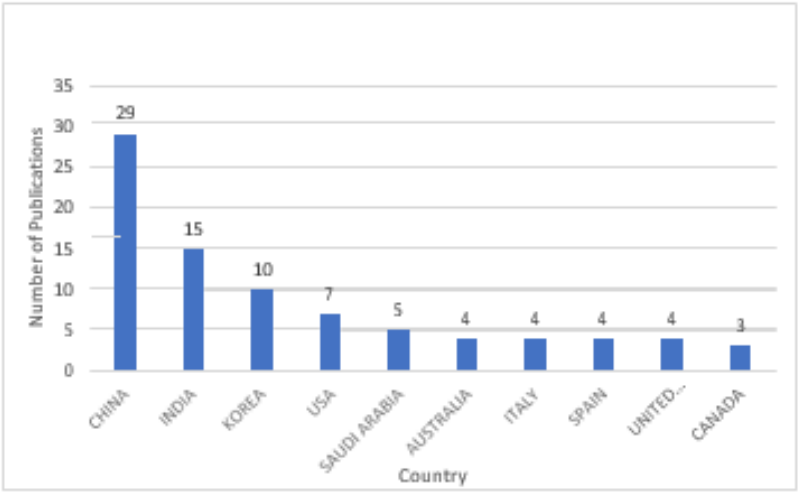
4.2 Country Specific Publishing Distribution

Table 2: Country Specific

Country	Articles
CHINA	29
INDIA	15
KOREA	10
USA	7
SAUDI ARABIA	5
AUSTRALIA	4
ITALY	4
SPAIN	4
UNITED KINGDOM	4
CANADA	3

Source: Author's Compilation

Figure 4: Publications by Country



Source: Author's Compilation

To extract the articles by country, the author affiliations have investigated. According to our literaturereview, China, India, and Korea have made considerable contributions to blockchain technology and smart cities research, with 29, 15, and 10, respectively. The fact that China has more than 300 smart city pilot programmes makes it evident [24]. Blockchain technology's contribution to many such projects can givecitizens smart solutions, a high standard of living, and the ability to make educated judgements. China is also the first country to adopt blockchain technology for data authentication [47]. The announcement made by Prime Minister Narendra Modi in India regarding the Smart City Mission initiative, which seeks to establish one hundred smart cities that are both citizen-friendly and sustainable, has garnered attention from researchers, governments, and various stakeholders who are keen on highlighting the incorporationof advanced technologies like blockchain in the developmental endeavours. The Indian government has commenced the implementation of blockchain technology for vehicle registration, land transactions, and land record administration in the port city of Vishakhapatnam [48].

Since 2018, South Korea has made substantial contributions to blockchain research and its applicationto revolutionize business operations. South Korea has emerged as an early adopter

of blockchain technology, employing it across sectors such as finance, logistic, intellectual property rights, trade, and healthcare. The South Korean government has made a number of measures, including implementing blockchain in tax law, educating people about the technology, planning to use it for military acquisitions,using it for administrative activities, and speeding up the loan application process. [49]

Over the course of the past decade, there has been a rapid surge in interest surrounding blockchain technology within the United States. Technology's use has expanded to include a vast array of fields, from finance and banking to government functions like auditing and tax collection [50]. A similar effort was launched in Chicago by the Cook County Recorder of Deeds to explore the feasibility of creating and managing digital property summaries via blockchain [46]. Improved public and private sector services, better citizen-government relations, and fundamentally secure and effective operation and commissioningof smart urban infrastructure are all goals of US state and local governments.

3.1 Journal Specific Publishing Distribution

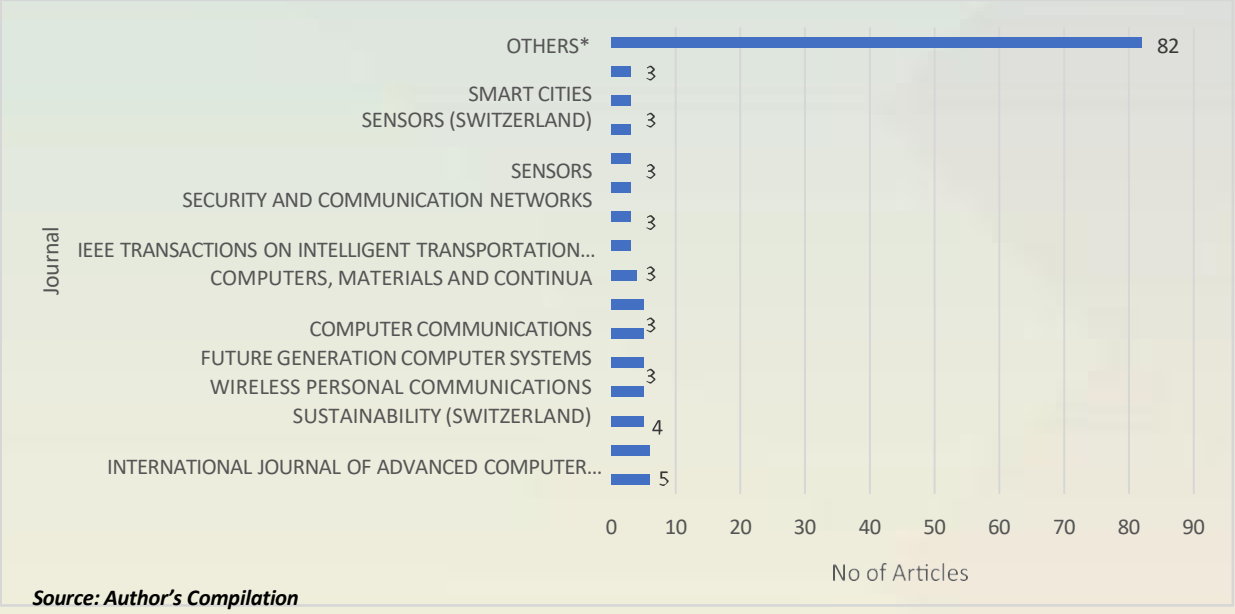
Journal publication counts displayed in figure 5. There is a total of 144 papers published across eighty-two journals (81), with IEEE and sustainable cities and society publishing the most (six each), followed byjournals publishing 5, 4, or 3 papers.

Table 3: Journal Specific publication

Journals	Articles
IEEE ACCESS	6
SUSTAINABLE CITIES AND SOCIETY	6
APPLIED SCIENCES (SWITZERLAND)	5
IEEE INTERNET OF THINGS JOURNAL	5
INTERNATIONAL JOURNAL OF ADVANCED COMPUTER SCIENCE AND APPLICATIONS	5
SUSTAINABILITY (SWITZERLAND)	5
WIRELESS PERSONAL COMMUNICATIONS	5
FUTURE GENERATION COMPUTER SYSTEMS	4
COMPUTER COMMUNICATIONS	3
COMPUTERS, MATERIALS AND CONTINUA	3
IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS	3
SECURITY AND COMMUNICATION NETWORKS	3
SENSORS	3
SENSORS (SWITZERLAND)	3
SMART CITIES	3
OTHERS*	82

Source: Author's Compilation

Figure 5:Publication by Journal



Source: Author's Compilation

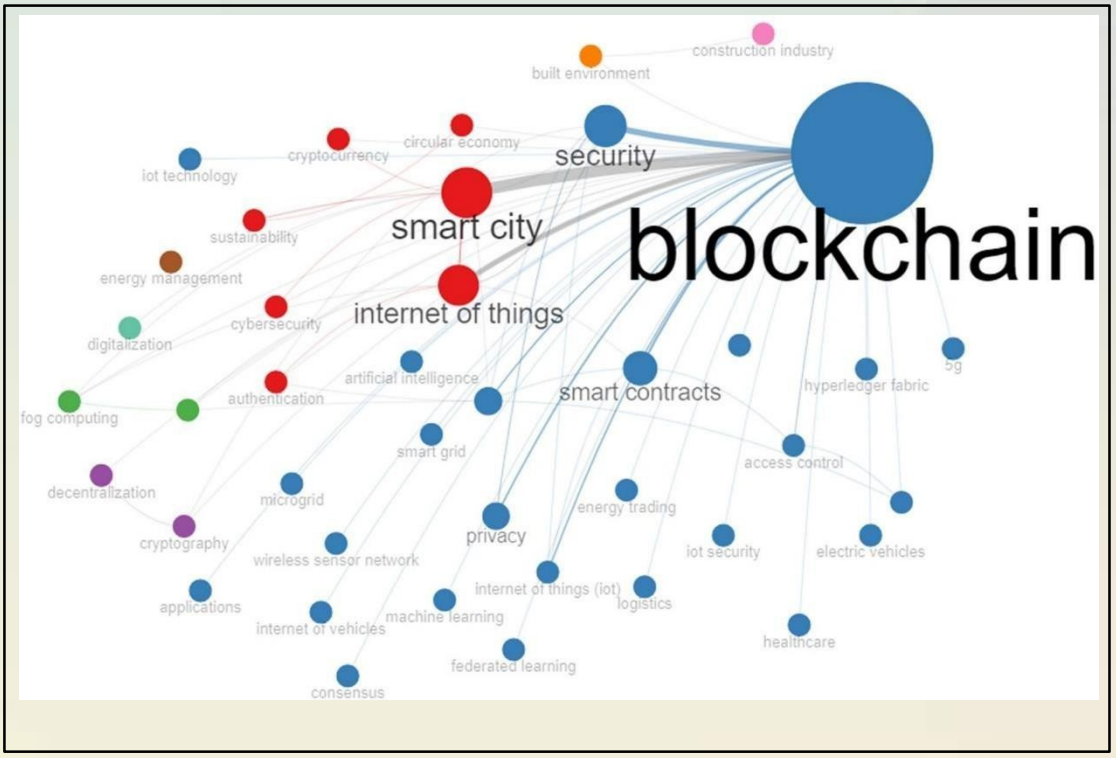
There are less than three publications in the "Others" category that discuss the intersection of blockchain technology and smart cities in seventy-one (71) journals. A detailed investigation from the journals revealed that blockchain technology and smart city have widely practiced by engineering and computer science professionals.These professions have published papers in highly repute journals having high \h index.

Fewer papers published in journals that focus on management, urban science, and the social sciences. We discovered that low output in such journals is typically the result of either a lack of submissions or a high rejection rate for papers that do not adhere to the journal's stated aims and objectives.

5 Bibliometric Analysis

5.1 Association network for keywords

Figure 6: Keyword Co-occurrence



Source: Author's Compilation

Scholars can benefit from an analysis of keyword co-occurrence by learning which topics have attracted the most interest. Keyword co-occurrence, according to [51], is a scientmetric technique that visualizes often co-occurring terms or subjects in the literature.

This strategy aids the researcher in comprehending the paper's content, the paper's overall scope, andother crucial details like the research's techniques and goals. Create the co-occurrence network, the author pre-adjusted the original keywords as needed. The terms "smart city" and "smart cities," "blockchain" and"blockchain technology," and "IoT" and "Internet of Things" are few examples of related terms that combined. As illustrated in fig 6 total forty (40) nodes appearing in the co-occurrence network and 6 keywords were combined which were common. There is a positive correlation between the size of a nodeand the frequency of the keyword's recurrence in the literature. Authors frequently utilize blockchain, smart city, security, and internet of things as keywords. Below table depicts the most frequently used keyword by the author in major 5 clusters.

Table 4: Top 5 keywords per cluster

Rank	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
1	Blockchain	Digital Storage	Data Privacy	Smart City	Smart Power Grids
2	Internet of Things	Network Architecture	Machine Learning	Information Management	Deep Learning
3	Network Security	Fog Computing	Privacy and Security	Sustainable Development	Data Analytics
4	Authentication	Software Defined Networking	Engineering Education	Decision Making	Smart Contract
5	Cryptography	Green Computing	Sensitive Information	Energy Utilization	Decentralised

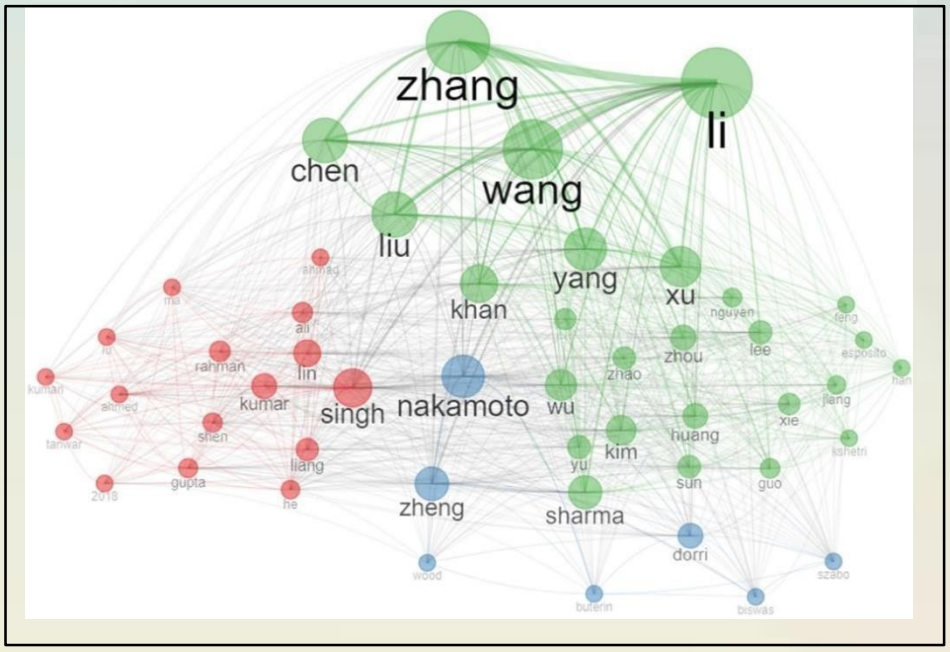
Source: Author's Compilation

5.2 Network of Article Co-Citations

The article co-citation network considered the most prominent form of co-citation analysis. The initialproposition of this methodology was put forth by [44], where the author suggests looking at the networkof sources that are cited together. The suggested approach utilizes articles as fundamental components of network analysis, while co-citation clusters serve as representations of the underlying conceptual structures underpinning the field. By applying co- citation methods, researchers can learn both about thecharacteristics of the referenced articles within a cluster and the relationships between clusters. The intention of this research was to undertake a co-citation analysis of blockchain and smart city-related articles to better understand the framework of the most significant contributions to this field of study. Article co- citation network results from RStudio bibliometric analysis presented in Figure 7. The pair of articles that exhibit a high degree of co-citation identified by the presence of thick arcs. The occurrence of co-citation refers to the situation in which two articles co-cited concurrently within a single article. The existence of dense arcs indicates a strong association between these articles, suggesting common attributes related to topics [44]&[51].

However, thin arcs indicate a poor correlation between publications which cited together and the absence of content similarity. A thick arc, such as the one between Zang and Li, indicates that the two publications are highly co-cited and discuss related topics. Both wang and Li follow a similar trend. The narrow line connecting Yang and Xu indicates a low co-citation strength and, by extension, a lack of content similarity between the two groups. Only 50 of the most frequently referenced (based on a minimum of two citations per article) are included in Fig. 6 of the co- citation network.

Figure 7: The co-citation network of articles



Source: Author's Compilation

6 Review and Future Research Implication

Based on our research, we can conclude that blockchain technology research has evolved significantly in the last few years. The rapid advancement of technology has led to the emergence of applications thatsignificantly impact the planning and management of "smart cities.". Scholars, professionals, and governments all over the world are putting a lot of effort into studying how blockchain can be used in smart cities. Several examples of the smart city uses of blockchain technology were presented. Since their inception, smart cities have benefited from the rapid evolution of IoT technologies and the widespread availability of big data. These advancements have transformed many industries, including healthcare, transportation, education, energy, and services, but they also pose security vulnerabilities [52], apprehensions regarding privacy [53], and technical inefficiencies [54].

6.1 Contribution of Blockchain Technology to the development of smart Cities

The development of "smart cities" could benefit from the use of blockchain technology. This has a wide range of potential uses, from public service monitoring and administration to supply chain tracking and voting system security. For example, blockchain can used to track and manage the distribution ofrenewable energy in a smart city, enabling the reduction of carbon impact and more effective use of resources. Furthermore, blockchain-based voting systems can offer transparent and safe election procedures. [55].

The utilization of blockchain technology in smart cities demonstrated by Dubai's "Blockchain Strategy," which aims to establish Dubai as the first-ever blockchain-driven government

globally by the year 2020.The proposed approach encompasses the utilization of blockchain technology in a diverse range of government functions, such as bill payments and visa applications [56].

Data exchange: Smart cities can securely and transparently manage and trade data using blockchain technology. Blockchain can track public services like energy and transportation. Blockchain provides a secure, transparent ledger of transactions, improving supply chain management [57].

Digital identity management: The implementation of blockchain technology enables the establishment of an immutable digital identity, which possesses the capability to be utilized across a diverse range of services such as banking, elections, and governmental functions [58].

Smart contracts: Using blockchain technology, procedures and transactions between parties can be automated, including lease agreements for real estate and energy trading. [59].

IoT integration: To enhance the efficiency of data collecting and management, the integration of blockchain technology with Internet of Things (IoT) devices, such as smart meters and sensors, can be employed [60].

Decentralized energy grid management: By eliminating the need for intermediaries and increasing market efficiency, a decentralised energy grid management system based on block chain technology willallow people and businesses to purchase and sell energy directly from one another.

6.2 Barriers in implementation of blockchain technology

India's smart cities confront several challenges when implementing blockchain technology, includingthe following.

Regulation: The absence of clear and comprehensive guidelines pertaining to the utilization of blockchain technology poses a significant barrier to its implementation within the smart cities of India.

[61]. The government and relevant organizations participating in blockchain technology should establishprecise guidelines and a comprehensive legal framework to facilitate the seamless integration of blockchain technology in smart cities.

Technical: Before blockchain technology can be used in smart cities, three technical issues—scalability, interoperability, and security—must be resolved. [34].

Scalability: To manage the enormous amounts of data that smart cities generate efficiently, blockchaintechnology must be able to scale. Scalability is a major problem for blockchain technology because the current technology cannot handle many operations per second.[62]. Scalability is improved by expandingnetwork capacity, which requires adding more nodes to the blockchain network. The network is said to bemore scalable if more nodes can fit within it.

Interoperability: Smart cities require technology that can interface with other systems and technologies for blockchain technology to be effective there. Interoperability is a challenge for

blockchain technology since multiple blockchain platforms use different protocols and technologies [63]. One potential approachto mitigating interoperability difficulties involves the establishment of shared standards and protocols, which can facilitate seamless communication between blockchain technology and other networks.

Privacy and security: Because blockchain technology is a decentralised system, it can be challenging to keep data confidential or secure. Sensitive data is used by smart cities, so it's crucial to make sure that thisdata is kept private [20] [64]. The government needs to develop cyber security standards and provide suitable guidelines on data protection and security. The government should also encourage enterprises to follow the rules when using blockchain technology.

Integration: Blockchain technology integration with the infrastructure and systems already present insmart cities can be a challenging and time-consuming procedure[60]. Choosing the appropriate blockchain platform might aid in mitigating the challenges associated with integration. Thoroughly evaluating the integrated system can also help mitigate this issue. The implementation of a change management plan canfacilitate the adoption of new technologies among employees through the provision of comprehensive training.

High implementation costs: For cities with limited resources, the high implementation costs ofblockchain technology can be a major roadblock to adoption[65]. It is imperative to perform a cost-benefitanalysis prior to implementing a technology to assess the prospective advantages in relation to the expected costs. The utilization of open source blockchain platforms can effectively mitigate development costs, resulting in a reduction of implementation expenses while maintaining the integrity of privacy andsecurity measures.

Lack of knowledge and comprehension: It can be challenging to adopt blockchain technology successfully since there is a lack of knowledge and comprehension about it among citizens and government officials. It is recommended that both governmental entities and private groups undertake workshops, awareness programs, and educational talks to emphasize the significance of blockchain technology and itspotential for efficient implementation in the development of smart cities.

6.3 Steps to adopt Blockchain Technology

Education and awareness: cities can offer training and education initiatives to assist businesses and residents in realizing the advantages and applications of blockchain technology.

Cities can conduct pilot projects and proof-of-concepts to show how blockchain can used in real-worldcontexts for things like energy management, supply chain traceability, and smart contract automation. Cities can work together to develop and execute solutions by forming partnerships and collaborationswith blockchain start-ups, businesses, and research organisations.

Policy and Framework: Cities can build a policy and legal framework that is favourable to blockchain innovation by, for example, setting up sandboxes for testing and experimentation[61].

Integration with current systems: To ensure a seamless integration and implementation, cities can combine blockchain solutions with current systems and infrastructure[60].

Promote citizen participation: Cities can work with residents, communities, and other stakeholders tojointly develop solutions that address their needs and priorities and promote citizen involvement in the adoption process.

Cities can experiment with various use cases, such as traceability solutions, decentralized markets, and smart-contract-based automation, to see how blockchain technology might applied to their requirements.

7 Conclusion

The transparent and readily accessible data management and sharing platform offered by blockchaintechnology has the potential to make substantial contributions to the intelligent and sustainable development of urban centres in India. Supply chain management, secure voting systems, and the monitoring and administration of public services are examples of applications for blockchain technology. The integration of blockchain technology in smart cities offers numerous advantages, such as optimized resource utilization, reduced environmental impact, implementation of smart contracts, integration withthe Internet of Things (IoT), management of decentralized energy grids, digital identity management, andvarious other benefits. However, Indian smart cities struggle to utilize blockchain technology due to a lackof regulation, technical issues, expertise and comprehension, high implementation costs, and system integration. Cybersecurity and privacy are also important.

It is necessary to find solutions to these problems for the blockchain technology successfully implemented in the smart communities of India. Governments, IT businesses, and researchers must worktogether to solve these problems and use blockchain technology to improve city life and reduce environmental impact. The government can begin blockchain deployment in smart cities by creating rulesand legislation. They might also participate in research and development activities to find solutions to the technical challenges that arise when putting blockchain technology into practise. Companies in the technology sector and researchers in this field can also contribute by developing blockchain-based solutions that are more scalable, private, and user-friendly.

To achieve sustainability and intelligence in Indian cities, it is imperative to gain a comprehensive understanding of the possibilities of blockchain technology and to address the barriers hindering its implementation. By implementing appropriate strategies and fostering collaboration, blockchain technology have the capacity to serve as a powerful tool for enhancing the efficiency and sustainability ofurban areas in India.

In this paper, the authors use bibliometric tools and methods to look at all the research on blockchainand smart cities that released between 2018 and 2023. We found some interesting trends in the way blockchain-based smart city research is growing, as well as the top countries and academic journals thatare adding to this new field. The networks built by keyword co- occurrence and article citations helped usidentify the main topics of the retrieved literature and the most important studies that expanded the field's conceptual understanding. For instance,

blockchain technology used with the Internet of Things improves sensor data security and integrity in smart city systems. Combining blockchain and smart city technologies is promising for future study. IoT data can analysed using machine learning and saved and shared securely using blockchain technology. Due to their automation, smart contracts, enabled by blockchain technology, used in many trade applications to share data, and ensure trust between service providers and networkparticipants. Finally, blockchain found to enable smart communities and improve smart city sustainability.

8 Future scope of research

The research limited to the examination of blockchain's effects on the smart city fields, thus not addressing the entirety of its potential uses. This study encourages scholars to examine the challenges ofblockchain technology in smart cities and urban initiatives in details. The findings of this research shouldspur additional research in this subject.

Future research might potentially prioritize the development of blockchain-based solutions that possess the ability to manage substantial volumes of data and transactions in a scalable and secure manner, whilealso ensuring privacy and interoperability. The proposed initiative holds significant potential for making asubstantial impact on the domain of efficient and sustainable urban development in India. Furthermore, it is imperative to conduct research aimed at ascertaining strategies for mitigating the financial burden associated with the integration of blockchain technology into pre-existing systems and technologies within smart urban environments. Research may also prioritize the exploration of smart contract development, enabling the automation of interactions and transactions between parties. Additionally, it may investigatethe integration of Internet of Things (IoT) devices to facilitate efficient data collecting and administration.Furthermore, research may aim to enhance data security and privacy in the context of smart city applications. Research can conduct to assess the utilization of blockchain technology in smart cities, examining its real-world applications, and identifying both potential challenges and chances for advancement.

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[Paper Id – 62] An efficient Multilingual Speaker Recognition system using fusion technique

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Abstract

The robustness and performance of speech signal based framework depends on the quality of features. In the today's era of research, working of single feature might not be enough to cover both robustness and performance simultaneously. In order to resolve this problem, researchers use multiple sources by applying various fusion techniques. These fusion techniques are categorized into few categories: Model level, Feature level and Score level combination scheme. The documents available in previous research shows the features available from different sources are used to enhance the strengths and recognition rate of the system. Even though these fusion techniques enhance the strengths and recognition rate of the system, but they found some demerits in the system. This will helps us to investigate further. The aim of the work is to introduce a system for multilingual speaker system with the help of SVM using fusion technique. The objective is to explore the advantage of various fusion techniques and how these techniques are useful to build efficient system for multilingual speaker system. The results from our proposed system indicate goodness of our work.

Keywords
Multilingual speaker recognition, SVM, fusion techniques, model level

1. Introduction

The speech recognition can be classified into two categories: speech recognition and speaker recognition. These systems consist of extracting important information form speech signals and identifying the required results by machine. In the case of speaker recognition, the machine tries to retrieve information based on any specific criteria from given speech signals and in speech recognition, only textual information is extracted from speech signals. They are similar to the pattern recognition systems. The accuracy of the system is depending on the discriminating power of the features used in the process. The feature extraction generally depends on the type of tasks. In case of speaker recognition, the machine calculates linear prediction cepstral coefficients (LPCC) or mel-frequency cepstral coefficients (MFCC) characteristics which represents speaker based vocal information in precise form [1, 2, 3].

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The researchers also explore speaker based information as alternative proof using various fusion methods. These methods provide better performance as compared to the independent vocal based systems. Moreover, these systems are comparably robust against various conditions [4]. The MFCC characteristics retrieved from phoneme samples are used as main characteristics for speech recognition systems. These MFCC characteristics shows the spectral envelope design of various phonemes, which are used for speech recognition system. The speech recognition systems is a speaker independent procedure, therefore need huge amount of information to efficiently represent the phoneme based information. To remove those complications people use much information. Tripathi et al. proposed different kinds of source information and then incorporated with MFCC characteristics by using given fusion methods [5]. They have also showed that combination of source information and MFCC characteristics not only enhance accuracy rate but also improves the robustness of phoneme recognition process.

The information consists of source excitation is generally used as additional proof with tract information to get enhanced information in various speech recognition systems [5, 6, 7]. The purpose for using source based excitation information as additional proof has two reasons: people use excitation features like duration, intonation and pitch to identify speakers as well as the matter of the speech data [8, 9, 10, 11]. People have proven themselves powerful even in decadent conditions, representing the capability of the excitation source data [12]. The other reason is the approbative description of source and vocal information. This approbative description gives additional proof that is use to enhance the performance and robustness of the baseline framework. The researchers also observe that combination of source excitation information and vocal tract enhance the robustness and performance of the speaker and speech recognition framework [13,14,15].

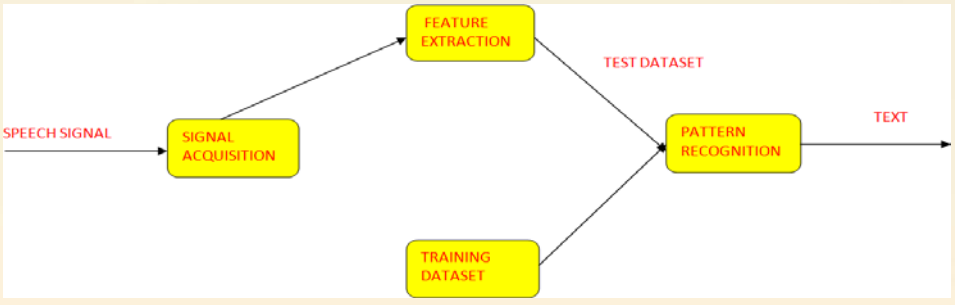

Figure 1: Block diagram of a generic speech based recognition system [16]

The performance of combined given system depends on importance of the features as well as on the suitable fusion methods. The optimized advantage can be found with the help of suitable

fusion and effective features. Since excitation source and MFCC information are paramount for various speeches processing frameworks [17, 18, 19], getting optimized performance mostly based on the applied fusion technique. The fusion of features can be processed at the comparison, model or feature level. This could be better explained from the diagram of speech recognition shown in figure 1. The speech sample is processed to make them input for feature extraction step in pre-processing steps. The purpose of the feature extraction step is to calculate the required features by applying various signal processing techniques. In feature level fusion, various features are calculated and fused for creating models. A similar technique is followed to calculate the test characteristics and used for matching. In case of Model based fusion, various models are created using individual feature sets. Further, the different models parameters are combined to create composite models. Finally, the comparison is created with test speech specimen and composite model. In score level fusion, different characteristics are obtained from given voice signal and used to create the corresponding models. During matching, the given features are matched with corresponding models, and calculate individual score. These score are combined to give final score.

In the speech recognition system, features represent the corresponding information about the job in a precise form. These given features are then used for creating blocks for various classes/pattern. For example, phonemes design in automatic speech recognition and speakers design for automatic speaker recognition. The existing work shows that instead of using single features, fusion of given multiple features gives optimized classes for speech based pattern identification tasks. Moreover, fusion of various features not only enhances the robustness but also performance of the systems. For example, recent researchers have shown the benefits of different features speech recognition systems, for automated speech recognition, and replay identification systems. In these researches, the fusion based techniques are limited to combination of features at every level. These techniques have their own advantages and disadvantages. A combined fusion technique could be created by utilizing the advantages of individual combination scheme which can be effective, efficient and useful for different speech processing systems. The target is to elaborate the advantages of different speaker recognition systems and apply them for the improvement of the effective recognition scheme. The main findings of the research work are as follows:

(1) The paper introduces a literature review of various types of speaker identification systems with its historical background.

(2) The paper summarizes the feature extrication, datasets, accuracy and demerits of existing work.

(3) The paper introduces the SVM based multilingual speaker recognition using MPDSS, RMFCC, and MFCC features.

(4) The paper introduces the combination of MPDSS, RMFCC, and MFCC in TIMIT, NIST 2003 SRE datasets.

(5) The performance of our paper is best when compare with other existing work.

The remaining part of paper is sketched as follows. In section II, we explain the related works. Section III presents the research methodology used in multilingual speaker recognition. The experiments and results are demonstrated in Section IV. Finally, Section V concludes the paper with future works.

2. Related works:

The speech recognition system refers to extrication of important information from speech signal by using different signal processing techniques for some applications. People's speech reflects effectively the textual content and speaker information recognition. The speech processing systems are generally categorized into two categories: speech recognition and speaker recognition. The extrication of textual data present in speech is called speech recognition system, and the speaker data is used to identify speaker is called as speech recognition system. We consider the systems related to above two fields as benchmark to represent the robustness of the proposed method. A detailed explanation about the speech and speaker recognition is given in present section.

The method of identifying people by machine using the data available in speech samples is called speech recognition systems (SRS). The SRS is broadly categorized in two categories: Automatic speaker verification system (SVS) and speaker identification system (SIS). In SIS, the objective of the machine is to detect the speaker from the given test samples, whereas, in SVS, the objective is to verify the particular identity with the help of given speech samples.

The entire SRS process consists of two parts: training and testing [20]. In training step, machine gathers the given speech sample from the speaker and register them by using SRS technique. The training step consists of feature extraction and creating models. The speaker based information is retrieved in feature extraction step from each and every sample by using various signal processing techniques and represent it in parametric form. These important features are then used in modeling stage to create model. In testing step, the machine calculates the speaker based features from test sample by using same feature extraction technique as used in training step, and used to compare with the existing model. Depend on the task, comparison processed in the comparison step. The comparison steps gives matching score that identify of the speaker for the speech samples.

The existing systems predominantly use cepstral computing technique for feature extrication and probabilistic technique like Gaussian Mixture Model (GMM) [21,22]. Based on the given speech samples the SRS are classified into two categories: Text independent and text dependent. In case of text dependent, the speakers kept for test are required to present same speech sample as given at enrollment process. There is no textual limitation on text independent model. They are used for real-time.

In the field of speaker recognition, additionally two research areas including limited data based speaker verification and replay attacks identification. In comparison with traditional

speaker verification system, limited data based speaker verification requires less amount of data for testing and training processes. As smaller amount of data is used, the limited data based speaker identification is very challenging task in the area of speaker recognition. The replay attack is a kind of spoofing attack to automated speaker verification task, where the decisions can be changed by prerecorded speaker samples by recording and playback devices. It doesn't require any technical knowledge, only a smart phone is needed for spoofing. The existing reviews shows that replay attack is highly efficient and effective and easily accessible constitute a critical threat to automated speaker verification.

Speaker identification is a method to identifying the speakers by using speech samples. A set of well known speakers are enrolled by the machine and used as reference patterns for recognizing the unknown speaker. The speaker identification system is performed in two steps: testing and training steps. In training step, individual speaker based features are retrieved from the set of speakers and used to create respective reference models. In common excitation source based information and vocal tract are used for creating reference models. In testing step, the same speaker based features are extricated from the test based speaker samples, and used for matching with the entire stored speaker design for recognition.

The speaker verification is the method of identifying the unknown applicant to a reference design by given speech samples. It is very clear that the applicant should be registered by the machine before placing the application. So, firstly applicant is asked to give speech samples for registration. Further, during verification, the voice samples are compared by matching with the corresponding samples. The decision is purely based on the threshold. The matching score is greater than threshold, it is accepted otherwise rejected.

The limited data based speaker verification refers to an identification task where the availability of testing and training data is very less say less than 10 sec. The forensic based investigation where data is less, performance is mostly affected. This is also affected due to inadequate coverage of the speech samples. So, effective and efficient technique is required for these conditions.

The automated speaker verification is generally applied without human directions. In that particular circumstance, it is possible that a fraud may fool the system by fake speech samples of any speaker. In the field of speaker recognition, fraud in automated speaker verification system by giving fake speech samples is called as spoofing. In case of speaker verification, spoofing can be processed with the help of four techniques: voice conversion, speech synthesis, replay attack, and impersonation. The impersonation is the method where a fraud try to generate the speech by voice mimicry [23,24]. The replay attack is the method of changing the decision of automated speaker verification with the help of pre-recorded speech samples through playback and recording devices [25,26]. The speech synthesis and voice conversion techniques requires deep speech processing and signal processing knowledge and also large amount of data to produce synthesized voice. On comparison, spoofing through replay and record do not need speech processing information. The replay attack could be easily obtained by using good quality playback and recording devices. An existing research

reports on spoofing to automated speaker verification says that replay attack is highly effective and easily accessible.

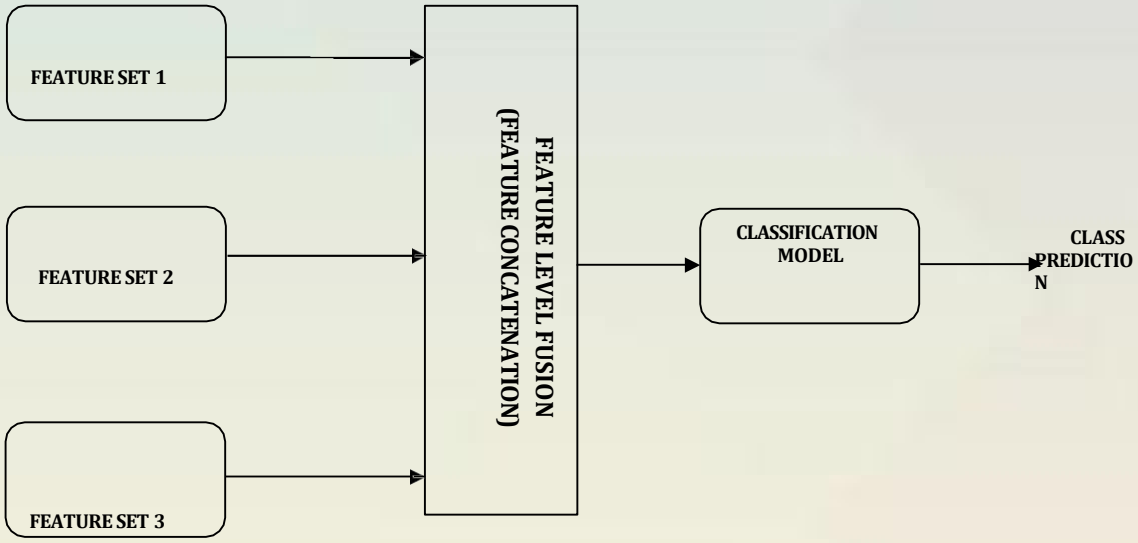

Figure 2: Block diagram of proposed speaker recognition system

3. Proposed Methodology: In speech processing systems, fusion of different features for the making of efficient and effective models is called as feature based fusion technique. The motive behind the feature based fusion technique is that every individual feature contains few important features that may be missed by different models. In feature based model technique, different features are merged and then used for creating models [27]. The general block diagram of speech oriented speech recognition system by applying feature based scheme is shown in figure 2. In training step, the input voice signal is proceed across the pre-processing step and then various features are calculated by using various signal processing techniques. These individual features are merged to build a combined feature, which is further used for creating reference models. The point to be noted that on concatenating the fusion of different features not required to be of same dimensions. At the time of simulation a same method is followed to create composite features for matching.

The first research was done by applying the feature based fusion scheme by Fururi et al. [28]. The author has proposed the concatenation of well-known features with the first and second order polynomials having form of DeltaDelta and Delta coefficients and then applied for speaker recognition systems. On comparison with cepstral features, the concatenation of various features reduces the error rate by 30% [29,30]. Further, fusion of different techniques reduces the speaker identification and verification process by 1.43% and 37.5% respectively [31,32,33]. The aforementioned research shows that fusion of different features helps in enhancing the robustness and performance of the different speaker recognition systems. So,

due to this reason we have applied this technique in our proposed framework [34,35].

In this proposed technique, different feature sets are computed separately and corresponding models are created with the help of particular modeling method. The feature based model is defined by their corresponding modeling variables. The introduced combination technique produces composite model by padding variables of corresponding feature based models. The padding technique is used to reduce the dimensions of the features and also reduces the computational complexity of the model. Additionally, the difficulty arises due to mapping of different modeling parameters can be avoided by same modeling technique. During testing, feature vectors of different parameters are set in same manner and put before for evaluation. The proposed fusion scheme based method is different by the fact that they are based on combined opinions. The scores produced by introduced technique are exactly used for matching without using any weights. Further, the proposed technique is more appropriate for real time systems.

3. Experiments and results:

The three MFCC, RMFCC, and MPDSS features are broadly used as features to show excitation source data. We are able to give experimental recognition report in this section to pick the suitable source excitation feature, particularly in the situation of using it as additionally demonstrate the speaker recognition system. On the basis of performance and robustness, the specific feature that is used to give optimized performance is further chosen.

We carry out speaker recognition process by using GMM technique with TIMIT dataset, and the speaker verification process by using GMM-UBM with NIST-2003 SRE dataset. In speaker recognition system, processing of signals takes place at 7500 samples per sec and unvoiced and voiced identification are done by thresholding based on energy. The features are calculated from 25 msec overlapping speech frames at the rate of 90 frames per sec with the help of most recent literatures. We have consider the suggestions of prasanna et al. to derive the residual signal LP to calculate the MPDSS from 25 LP residual power spectrum and 25 dimensional features are used as MPDSS features[30]. In the same way, the 13 mel- cepstral coefficients combine with 13 Delta and DeltaDelta is calculated from LP signals and speech to get RMFCC and MFCC features.

Table 1: GMM based speaker identification performance of MFCC, RMFCC, MPDSS features and their combined methods with TIMIT database.

Feature	Identification Accuracy (%) Proposed Method	Identification Accuracy (%)[29]
MPDSS	74.35	73.65
RMFCC	83.74	82.14
MFCC	96.19	95.39

MPDSS+ RMFCC	84.56	-
MPDSS+ MFCC	96.13	95.55
RMFCC+ MFCC	97.14	96.91

The speaker recognition performance of MFCC, MPDSS, and RMFCC features with TIMIT dataset are reported in table 1. The individual accuracy of these features is assessed using GMM modeling techniques. The MFCC feature produces the recognition rate of 96.14%, whereas an RMFCC and MPDSS feature gives the recognition rate of 83.74% and 74.35% respectively. It is observed that among these features, MFCC performs the best accuracy. The feature based fusion technique between all these features are given in the table 1, it is observed that fusion of RMFCC and MFCC produces the best recognition rate of 97.14%.

Table 2: Performance of MFCC, RMFCC, MPDSS features and their combined representation using GMM-UBM based speaker verification system using NIST-2003 SRE dataset.

Feature	**EER (%) Proposed Method**	**EER(%)[29]**
MPDSS	20.24	21.38
RMFCC	18.10	18.89
MFCC	6.94	7.54
MPDSS+ RMFCC	17.24	-
MPDSS+ MFCC	6.12	7.54
RMFCC+ MFCC	5.94	7.30

The speaker verification process (EER) result is calculated for all three MFCC, RMFCC, and MPDSS features are depicted in table 2. The same trend is observed for speaker verification system as observed in speaker recognition system. The error rate for the MFCC gives the beat error rate of 6.94% as compared to MPDSS and RMFCC having 20.24 and 18.10 respectively. The feature based fusion technique is used for all the three features and found that combination of RMFCC and MFCC produces best error rate of 5.94% as compared to MPDSS+ RMFCC and MPDSS+ MFCC of 17.24% and 6.12% respectively.

4. Conclusion and future works:

The robustness and performance of speech signal based framework depends on the quality of features. In the today's era of research, working of single feature might not be enough to cover both robustness and performance simultaneously. In order to resolve this problem, researchers use multiple sources by applying various fusion techniques. These fusion techniques are categorized into three categories: Model level, Feature level and Score level combination scheme. We have used feature based fusion technique in our research. The SVM

is used as a classification technique after combining different features. We have also proved that our speaker recognition and speaker verification framework works well with MFCC with TIMIT and NIST-2003 SRE dataset. Further, the fusion technique gives better results as compared to existing work. In future, more features will be added to enhance the recognition rate of speaker recognition and speaker verification system and try to incorporate some more deep learning methods.

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Revisiting the literature on smart education: Abibliometric and content analysis

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Abstract
Smart education is growing rapidly globally, thrusting on improved education and learning. The disruption caused by COVID in physical classes further highlighted the importance of digitally enabled education. Governments globally have also launched initiatives to promote ICT-enabled learning. However, this transition has not been without challenges, as evidenced by the digital divide highlighted during the pandemic, emphasizing the importance of inclusive smart education policies. This study aimsto shed light on the conceptual framework of smart education through bibliometric and content analysis and highlights the problems pertaining to adopting in the learning environment. The findings of the study indicate the prominent authors, journals, countries, and documents. The study delves into the subject through content analysis. Moreover, the study also provides future directions for upcoming scholars.

Keywords
Smart education, E-learning, Artificial intelligence, Internet of things, Literature review

1. Introduction

Smart education is the adoption of new-age technology in various dimensions of education, like teaching, training, and research [1]. The benefits of smart education were most visible duringthe COVID lockdown period across the globe, where academic classes were taken by instructors on online platforms like Zoom, MS Teams, and Google Meet, to name a few. Further, academic research collaborations have increased post-COVID, and researchers have become more comfortable discussing online with their global counterparts.

Education is an essential pillar for human development and economic growth for a country, and many governments across the world are also focusing on and promoting technological advancements for better education and learning. The Republic of Korea introduced the SMART initiative to adopt and effectively learn from ICT (Information Communication Technology) tools [2]. The Indian government launched the “Samagra Shiksha Scheme,” which aims for ICT-enabledlearning via smart classrooms, ICT labs, digital books, virtual labs, and e-content to all government schools for classes 6th to 12th[3].

The COVID pandemic disruption also exposed the large-scale inequality in the education access with almost 33% of the students not having access to digital tools to get an education in distance mode, prompting the United Nations Educational, Scientific and Cultural Organization (UNESCO) to come out with a book titled "Guidelines for ICT in education policies and masterplans (2022)"[4]. These guidelines can help policymakers and educational institutions impart education using smart tech tools in a better manner and increase adoptions amongst learners.

A study by [5] established that there is a significant increase in the adoption of the Internet of Things (IoT) in digital learning across various educational institutions worldwide. In a studyon education in the engineering field, evidence was found suggesting that technological adoption plays an important role in preparing smart and skilled engineers [6]. Along similar lines, a positive impact on education due to smart tech was found in Vietnamese schools [7]. Ina review study by[8], the five major attributes influencing the adoption of smart education were “technological aspects, data aspects, H.R. aspects, organizational aspects, and cost aspects”.

The upcoming decade is expected to see explosive growth in the smart education sector, with industry size growing from $260 billion to around $1.4 trillion in 2022 and 2032, respectively, clocking an average growth of 18.4% per annum [9]. This study aims to provide acomprehensive bibliographic literature review to identify the latest trends and intellectual structure of smart education themes. In particular, this study addresses the following researchquestions (RQs):

RQ 1 What is the general description (trend, countries, institutions, journals, and influential articles) of the scholarly landscape of smart education?

RQ 2 What is the knowledge structure of smart education research field?

The rest of this article is organized as follows: Section 2 outlines the methodology and data collection approach. Section 3 presents the bibliometric results and discussion, followed by the content analysis in the same section. The study concludes in Section 4.

2. Methodology and data collection

This section outlines the methodology used in this study. Literature reviews are increasingly used to synthesize existing knowledge, define current themes, and provide evidence-based insights (10,11,12). Researchers have employed various qualitative and quantitative methods, with systematic and bibliometric reviews widely popular (13, 14). Systematic reviews use qualitative approaches to analyze existing knowledge and advance the field, while bibliometric analysis is a quantitative and objective approach to reviewing the literature(15). In this study focusing on smart education, both qualitative and quantitative techniques are applied. Bibliometric analysis objectively assesses knowledge performance and mapping,while content analysis delves deep into the field of smart education. These approaches have been used in previous studies by various researchers (16,17). In review studies, researcherscommonly rely on Scopus and Web of Science databases for data collection. In the present study, the Scopus database is chosen for its extensive coverage of peer-reviewed scholarly

literature adhering to stringent indexing standards (18,19). Employing a comprehensive search query, "Smart Education," restricted to article titles, abstracts, and keywords, the authors retrieved a dataset of 303 documents. Figure 1 presents the structure ofthe current study

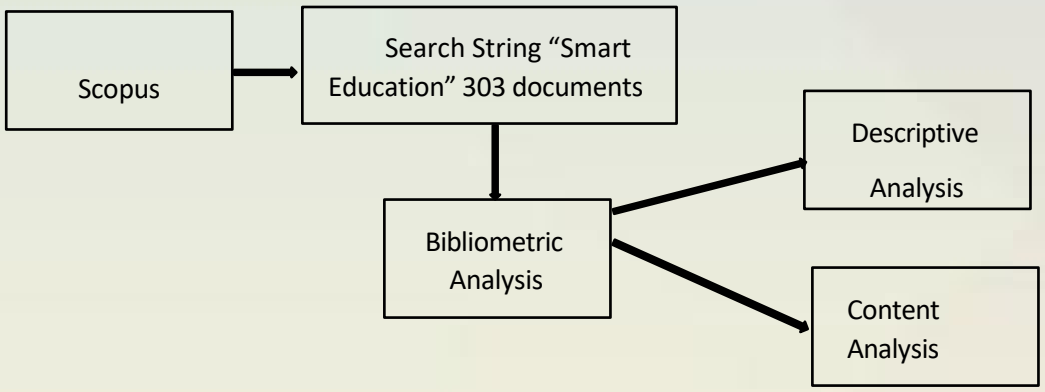

Figure 1: Structure of the study

3. Bibliometric results and discussion

3.1. General description

3.1.1. Annual publication pattern

Figure 2 displays the yearly publication pattern on smart education from 2003 to 2023. It indicates that initially, the subject has very slow growth. There are no publications even in someyears. The subject has gained momentum since 2011, possibly due to the advancement of internetfacilities and technology developments. The highest number of articles was published in 2023. Itsuggests that this topic has greater potential in the near future.

3.1.2. Leading institutions

Figure 3 demonstrates the most prolific institutions on the basis of the total number of publications in the smart education domain. It shows that the "Beijing Normal University" and "Hassan II University" are the most prominent institutions with equal publications. This is followed by the "Higher College of Technology" and "Gifu College" with 7 and 6 articles, respectively. These ten affiliations have contributed 17.82 % of sample articles in the studied domain.

Figure 2: Yearly publication growth

3.1.3. Leading countries and their collaboration network

This section discusses the leading countries in the smart education research area. The complete set of documents was produced by 60 varied nations. It indicates that these countries have a keen interest in this realm. Table 1 depicts the top contributed countries in terms of producing the articles. It reflects that China has the highest number of publications (88 articles) on this subject. The Russian Federation is ranked second with 28 articles, followed by India on position third with 26 articles. When we look around the number of citations in Table 1, it reflects that the United States, having 11 articles, is on the top list with 249 total citations. The numbers indicate that this country's authors might focus on impactful work rather than quantity work. While the United Arab Emirates and Indonesia, listed in the top ten, must do more quality work in this research field.

Figure 4 demonstrates a collaboration map within the nations. The collaboration work is necessary for advancing the specific field [18]. The nodes' color and density of the interrelation between nodes highlighted the strength of the research relationship between these countries. Figure 4 illustrates that China has the highest research connection with other nations (8 links) followed by the United States and the United Kingdom, having seven links with other countries.

However, countries such as Greece and the United Arab Emirates have limited research links withother countries, requiring more collaboration from these nations.

3.1.4. Prominent Journals

It is crucial to be aware of the prestigious journals in order to understand the current state and possible future scope of the specific subject [20, 21]. Table 2 shows the top productive journals in the smart education search. The Smart Innovation, Systems, and Technologies is ranked at one published 29 articles. This is followed by Lecture Notes in Educational Technologyand ACM International Conference Proceeding Series with 15 and 11 published

articles, respectively. It also indicates that the most influential articles are published in Sustainability (Switzerland) Journals, having the highest number of total citations (124).

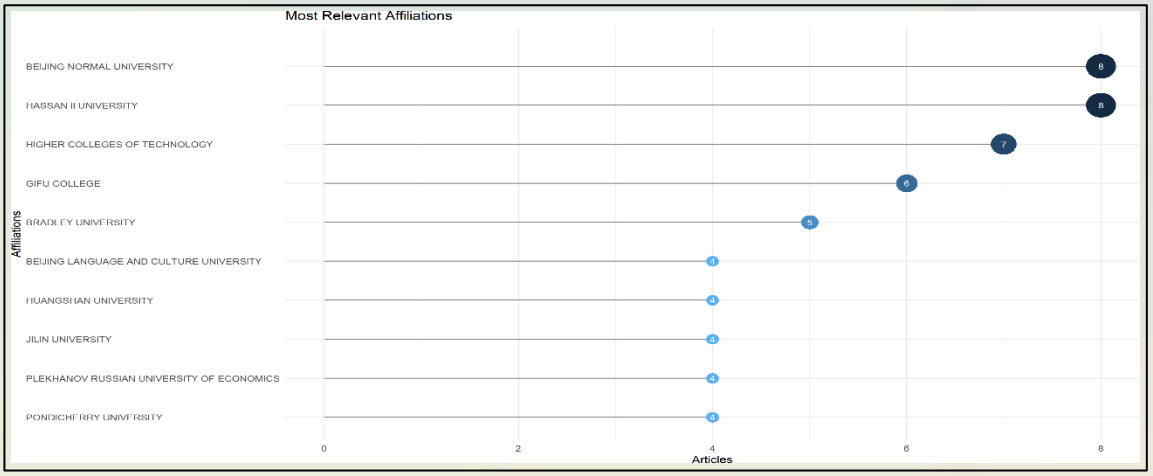

Figure 3: Top most organisations

Table 1
Top most countries

Country	Articles	Citations
China	88	653
Russian Federation	28	208
India	26	159
South Korea	25	197
United States	16	249
Japan	11	47
United Arab Emirates	11	32
Indonesia	10	21
Ukraine	8	50
Australia	6	98

3.1.5. Most influential articles

Table 3 shows the most impactful studies on the basis of the total number of citations. Citation analysis counts the number of times a study is cited by other works to determine its academic impact within a scientific field [22]. Table 3 indicates that an article titled "A research framework of smart education" is the most influential article, having 324 total citations. Other studies, such as "Internet of Things in smart education environment: Supportive framework in the decision- making process" and "Smart Education with artificial intelligence-based determination of learning styles also have significant impacts in the smart education literature, having 182 and 106 total citations, respectively. Interestingly, a recent study by [28] in 2020 was also listed in the top ten influential articles, which indicates the significant

impact of this study in the smart education literature. [23] highlighted the four-tiered structure of smart pedagogies and essentialelements of smart educational environments for nurturing small learners. [24] stated the role ofthe Internet of Things in education and how it affects the students' learning.

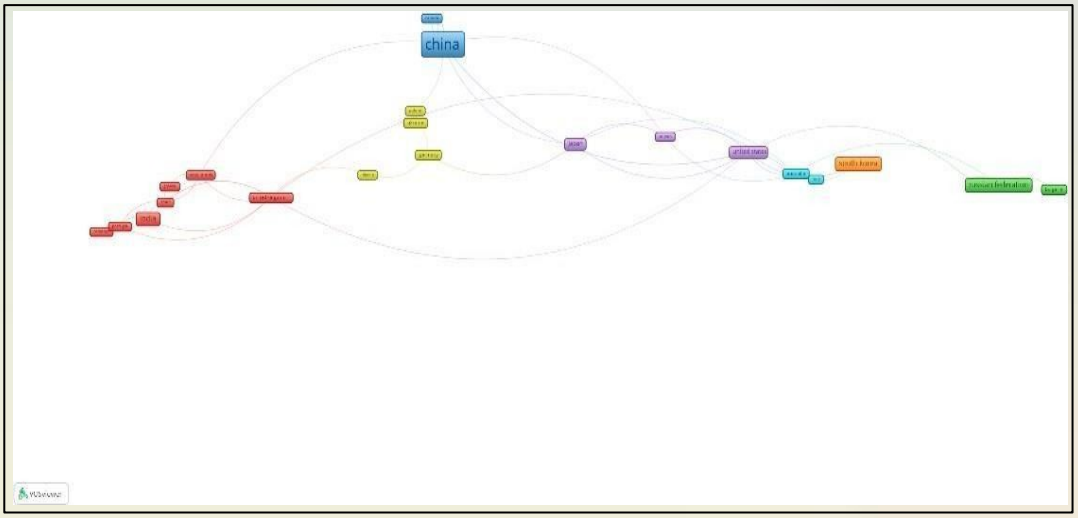

Figure 4: Country collaboration map

Table 2
Top most journals

Source	Articles	Citations
Smart Innovation, Systems and Technologies	29	106
Lecture Notes in Educational Technology	15	2
ACM International Conference Proceeding Series	11	8
Lecture Notes in Networks and Systems	9	21
Advances in Intelligent Systems and Computing	8	19
Sustainability (Switzerland)	7	124
Journal of Physics: Conference Series	5	17
Communications in Computer and Information Science	4	8
Education and Information Technologies	4	63
International Journal of Emerging Technologies in Learning	4	2

3.2 Content analysis

A lot of attention has been paid to the concept of a "smart education environment," or a learning environment that makes use of information and communication technology (ICT). To further develop this environment and lessen the significant burden on educators, we need a systemthat can efficiently set up the learning environment [33]. In this context, literature heavily emphasizes cloud computing in the smart education system [34,32]. Cloud computing

grabbed the attention for use in the education system due to its potential to provide affordable, safe, credible, and transferable educational services. [32] documented a content-focused smart education platform that combines a number of features necessary for setting up a cloud-based educational media service environment. [33] proposed a smart education system framework using mobile technology and cloud computing systems. Because of cloud computing, real education practices are unaffected by the use of smart educational technology. Similarly, [35] discussed a mobile Software-as-a-Service style Smart Education Support System enabling teaching staff to use the original digital learning materials and ICT environment without interfering. The smart education system significantly changes the education system. [36] provided evidence of how university students and educators support this system. Furthermore,

[37] demonstrated smart educational methods are adaptable and allow the instructional strategyto be changed to better meet the demands of specific learners.

Table 3
Top cited articles

Authors	Title	Year	TC
[23]	A research framework of smart education	2016	324
[24]	Internet of things in smart education environment: Supportive framework in the decision-making process	2019	182
[25]	Smart Education with artificial intelligence based determination of learning styles	2018	106
[26]	Social Networks Research for Sustainable Smart Education	2018	61
[27]	Intelligent Recommendation System for Course Selection in Smart Education	2018	56
[28]	Smart education literature: A theoretical analysis	2020	54
[29]	Teachers' beliefs and technology acceptance concerning smart mobile devices for SMART education in South Korea	2019	54
[30]	The potential of Augmented Reality to Transform Education into Smart Education	2018	51
[31]	Three Dimensions of Smart Education	2015	48
[32]	A Content Oriented Smart Education System based on Cloud Computing	2013	46

Note: TC is total citation

The goal of modern culture is to make a smart world. The objective of education is to meet thedemands of an ever-changing globe and prepare students to become totally integrated members of society [30]. Smart education system based on digital technology is used to enhance the standard of the education system for the better quality of education [38]. It aids in developing competencies for critical thinking and assessing decision-making choices. Multiple

tools, such asthe Internet of Things, artificial intelligence, and wearable technology, drive this smart education system [30]. In line with this, [39] discussed the 5-G technology beneficial for developing the educational sector. Moreover, [40] documented the algorithm for smart learning. Modern trendsfor advancing smart education in Europe and Asia are also explored by [41].

The pandemic era and cities' transition to smart status necessitated e-learning, remote learning systems, and hybrid models. Personalized education is imperative to overcome distancelearning challenges and maintain high achievement levels. While education systems have progressed, personalization to meet students' cognitive needs during non-face-to-face instruction remains a frontier. Various technologies are revolutionizing education in smart cities, enabling personalized learning and customized content based on individual preferences [42,43].Leveraging technologies such as the Internet of Things in educational settings not only accelerates students' learning but also significantly enhances instructors' effectiveness (3,9066).Utilizing advanced technologies, smart education streamlines the processes of teaching, learning, communication, and collaboration, leading to increased efficiency due to timely notifications [44]. [42, 43] proposes a transformative paradigm for smart education based on the integration of XAI(Explainable Artificial Intelligence) and IoB (Internet of Behavior) technologies (IoT and IoB) to collect and analyze student behavior data. XAI further refines aspects for students to monitor their performance, ensuring tailored aid from the educational system [43]. [45] usedneutrosophic sets to highlight critical aspects of IoT, showcasing its potential for informed decision-making and enhancing smart education. [46] emphasizes the need for robust IoT security in the IoB and sustainable IoT ecosystems in smart education, stressing the importance of IoT security and ethical considerations for staff well-being and equipment use.

Advancements in AI and IoT technologies are reshaping education, transitioning from traditional to digital learning methods [5]. [47] found evidence that smart education effectively met distance learning objectives during the COVID-19 pandemic and military events in Ukraine. At the same time, the widespread adoption of IoT in education presents unique opportunities and challenges. Leveraging big data from IoT applications can address challenges, as seen in aliterature survey identifying diverse IoT applications in education [5].
[23] outlined a comprehensive smart education framework, including a four-tier smart pedagogy approach, incorporating class-based differentiated instruction, collaborative learning, personalized learning, and mass-based generative learning. In addition, ten key features of smart learning environments are identified to nurture 21st-century skills. The paper also presents a technological architecture emphasizing smart computing and discusses associated challenges in smart education implantation. [48] introduces a Smart Education Framework, including New or improved teaching methods at the core layer. He categorizes technologies into essential, enriching, and supportive layers. The research provides a systematic approach, validating the framework through literature analysis. Additionally, [28] proposed a new innovative solution framework called SCAS Students Career Assistance System, aiding students in managing their learning and career development for a better future. Furthermore, rooted in ecological theory, integrating various information technologies leads to developing a Metaverse-based smart education ecosystem. This dynamic ecosystem

emphasizes students-centered integrated learningexperiences. However, the journey is not without its challenges; meticulous navigation is essential to address issues such as data security, privacy concerns, and potential social implications in virtual environments [49].

Utilizing technology and innovative teaching tools, contemporary smart education aims to improve skills and learning outcomes, generating Educational Big Data (EBD) from student interactions [50,51]. EBD holds potential for educational institutions and governments, yet challenges like data security persist. While EBD offers valuable insights and teaching enhancements, overcoming these challenges requires tailored, innovative approaches [50]. [52] proposes leveraging management systems and big data analytics to enhance teaching methods. They explore the implementation of Data Mining and Data Analytics to enhance learning and teaching experiences. Their research further employs an exploratory approach to uncover the intricacies and necessities of big data in the realm of education.

4. Conclusion

The development of new technologies has revolutionized learning, making it more effective, efficient, flexible, and comfortable. Learners utilize smart devices to access digital resources through wireless networks and immerse in personalized and seamless learning. Smart education,a concept that describes learning in the digital age, has gained increased attention. This is further accelerated by the urgent need for online education during the COVID-19 pandemic. Governments globally have also launched initiatives to promote ICT enabled learning. However, this transition has not been without challenges, as evidenced by the digital divide highlighted during the pandemic, emphasizing the importance of inclusive smart education policies.

The present study provides a comprehensive overview of the scholarly landscape of smart education. The growth in publications post-2011 reflects the increasing interest and research efforts in this field. Collaborative networks among countries, especially between research powerhouses like China and the United States, signify global cooperation in advancing smart education. While the proliferation of cloud computing has revolutionized smart education environments, challenges such as data security and privacy, as well as ethical considerations, underscore the need for continuous innovation and regulations. Smart education's evolution intopersonalized and student-centric learning experiences, fueled by technologies like XAI and the IoB, showcases its potential to revolutionize teaching and learning approaches. EBD has emergedas a valuable resource, offering insights into student interactions, although challenges related todata security and privacy persist.

Based on the content analysis, future research endeavors could advance features or explore cutting-edge artificial intelligence algorithms or neurotechnology to better understand and caterto individual student's cognitive needs during remote learning. In addition, researchers could focus on developing frameworks and guidelines that ensure the ethical use of technologies in educational settings. Thus, the journey toward smart education is marked by immense potentialand challenges. Embracing innovation, fostering global collaboration, and prioritizing ethics are important in navigating these challenges and unlocking the full transformative power of smart education for the benefit of learners worldwide.

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[Paper Id – 72] CNN-KPCA: A hybrid Convolutional Neural Network with Kernel Principal Component Analysis for Intrusion Detection System for the Internet of Things Environments

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Abstract

The combination of several Machine Learning and Deep Learning techniques has been spurred by the need to address security breaches inside an Internet of Things (IoT) focused environment. This research presents a novel way to solve the challenge of classifying normal and abnormal attacks on the Domain Name System (DNS) protocol. The proposed method involves the use of a hybrid model that combines Convolutional Neural Networks (CNN) with Principal Component Analysis (PCA). The methodology begins by transforming nominal features into numerical data as part of the preprocessing stage. The quantitative data is subsequently subjected to PCA in order to identify features, reducing the dimensions of the dataset by separating the most important properties. Following this, the data is inputted into theCNN with the objective of detecting and categorizing anomalous behaviors inside the IoT ecosystem. The effectiveness of the hybrid model was assessed by employing the IoTID20 dataset. The model exhibited exceptional performance in terms of accuracy, recall, F-Score, precision, and ROC metrics, surpassing those of existing detection methods. Significantly, the suggested framework not only improves security measures but also tackles privacy concerns and strengthens the maintainability of IoT-based systems.

Keywords

Machine learning, Deep learning, Principal component analysis, Convolutional neural network,Intrusion detection [1]

1. Introduction

The eventual convergence of cutting-edge sensor technology and the Internet of Things (IoT), quickly infiltrating human existence, is unavoidable. The number of linked things on the Internetwill have surpassed 50 billion by 2020 [1], [2]. Data Streams are usually dynamic, such as in time- series format, and their memory consumption and processing time are constrained by hardwareand database server limits [3]. Because they use centralized and broadened operating systems, IT infrastructure, and applications, IoT-based systems are defenceless against traditional threats.

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On the other hand, traditional cloud computing risks face new security concerns due to several technological advancements that could lead to new types of misuse [4]. Network Intrusion Detection Systems (IDSs) are now essential for restoring network security, especially for IoT- based systems [4]–[6]. Because of the complexity and heterogeneity of these systems, it isn't easyto find a haven for them from cyber-attacks [7]. Furthermore, having different types of operatorsnecessitates varying levels of protection.

The loss of control over the infrastructure used by Cloud customers is one of the most serious issues they face [8]. High missing and noisy perceptual data contribute to the imbalance trait in IoT-based systems. Because the calculation capabilities of IoT capture devices and sensors are limited, any categorization for such data should be updated in on-the-fly response time. The IoT security issues are not hidden from any organization, and their importance has been taken seriously in various organizations [8]. In recent years, Artificial Intelligence (AI) has been used toprofessionally and accurately handling security in IoT- based systems. The AI techniques help fillthe gaps of fighting against intruders that attack information in IoT-based systems for their gains, thus significantly increasing the stakeholders' trust in IoT systems. IoT-based devices and sensors operate in hostile environments, where physical layer fraud is a real possibility.

A distributed denial of service (DDoS) attack, which sends enormous amounts of data by consuming bandwidth access, is the most serious breach [9], [10]. Over a thousand botnets are causing havoc on legitimate websites such as Amazon, eBay, Netflix, and even governmentagencies. AI is a data-driven technique in which the first step is to grasp the data. Unique attack behaviours are represented by several types of data, such as host activities and network activity. Network traffic indicates network behaviour, whereas server logs describe host behaviour, and numerous types of attacks exist, each with its own setup. As a result, selecting appropriate data sources to detect various risks based on the threat's characteristics is crucial. The DoS attack hasthe ability of sending multiple packets within a shortest time, and this is one of their keycharacteristics, thus the flow data is suitable for identifying DoS attacks [11], [12].

A secret channel is ideal for session data detection since it contains a data-leaking transactionbetween two IP addresses. Hence, advancements in deep learning algorithms can aid in the detection of specific network patterns [13], [14]. Therefore, this study proposes a CNN model with PSO to optimize a flexible and secure architecture for safeguarding large-scale IoT networks.The model was greatly enhanced by adding a deep learning algorithm to identify emerging vulnerabilities to the IoT network to detect anomalies. This paper has the following contributions:

- To detect intruders in an IoT environment, the team developed an advanced Deep Learning model termed the hybrid CCN-KPCA[15] technique.
- The effectiveness of the system underwent evaluation using an IoT-based network dataset generated in 2020, presenting a significant challenge in establishing a strong framework.
- A thorough performance comparison was executed with a recent research study utilizingthe same dataset, considering various performance metrics.

2. Related Works

With the exponential growth of IoT devices protecting critical resources and associated servicesis becoming a challenging task for the service providers [16]. Malware and related attacks are themost common threats in IoT networks. Hackers utilise a range of tactics to detect and control thebehaviour of vulnerable resources, including the entire computing environment. Traditional cyber-threat approaches such as security protocols, cryptography [17], access controls were shown to be ineffectual and no longer appropriate for delivering effective critical infrastructure protection [8], [18]. Therefore, efforts has been given to design stat of the art Intrusion Detection Systems (IDS) in a variety of computing environments [19]–[25]. The IoT has become a vital partof today's data and information transmission machinery, necessitating global network security [26]. The traditional Machine Learning (ML) and Deep Learning (DL) models are critical in the development of an intelligent system in cybersecurity based on IoT. As a result of IoT devices, most businesses and organisations have undergone digital revolutions. However, this has generated new problems and vulnerabilities that can be exploited quickly once hackers become aware of them. Qaddoura et. al [27] proposed an IDS using multistage classification approach forIoT framework. During the training procedure, the network data has been oversampled with the use of Synthetic Minority Oversampling Technique and Support Vector Machine. The main technique of this method is the use of Single Hidden Layer Feed-Forward Neural Network (SLFN)for network detection. Multistage IDS has also been explored by Anthi et al [28]. The IDS consists of three layers a stage to classify the malicious and benign instances and the last layer designed to detect attack types. The layered approach successfully detects DoS and man in the middle attacks. In a similar node a two layers classification approach using Naïve Bayes and k-Nearest Neighbour has been used to keep track of User to Root (U2R) and Remote to Local (R2L) attacks[29]. Similarly, to choose the aspects of malicious attack behaviours, a feature selection strategy

[30] was presented, and the system provided an appropriate means of defending enterprises from cybercrime. For the detection of botnet attack at the host and network levels, ML algorithmshave been proved effective in the IoT-based environment [30]. Similarly, host level attacks are also detected marvellously using deep leaning models [31]. To detect intrusion and improve theprior model, reference [32] proposed an intelligent mechanism model based on a decision- making process; they constructed a recurrent neural network (RNN). Reference [32] used autoencoder for feature extraction to select revenant features before using CNN for classificationthe dataset for any possible attacks.

Recently, an intelligent IDS has been proposed for IoT based environment, where the detectoris able to protect all the devices connected directly to its interface[33]. The Passban detector successfully detect SSH brute force, HTTP, port scanning and SYN flood attacks. To boost featureextraction across layers, a CNN was employed to identify infiltration [34], and feature fusion techniques were applied to acquire the whole attack characteristics. Reference [35] developed asolution to protect IoT in healthcare by managing traffic and brightening the environment. Security measures for IoT systems have also been devised, as mentioned in [36] and [37]. In a similar node, Ullah et al [38] proposed a new botnet based IoT dataset

to test various flow basedintrusion detection systems. The logistic regression on the new botnet dataset shows 96% detection accuracy on 20 attack features in the training model.

The reviewed works have shown that deep learning models can significantly improve the accuracy and efficiency of IDSs in an IoT-based environment, thus retaining a low false alarm rate. Hence, the study proposes a hybrid CNN-enabled PCA feature extraction and classification of anomaly trends detection in IoT-based systems. The PCA methods reduce the feature to minimizeand useful one, thereby increasing the accuracy of the proposed model for detecting an intruder on an IoT-based system.

3. The Method

The approaches that are employed in accordance with the KPCA-CNN [15] framework consist ofthree primary stages: (i) preprocessing, (ii) feature selection, and (iii) classification. During the preprocessing phase, nominal qualities are initially transformed into numeric features in order to streamline later processing steps. The process of feature selection entails employing Kernel Principal Component Analysis (KPCA) to discover significant attributes within each class, hence lowering the dimensionality of the vector. The CNN model is utilized for the purpose of classifyingevents inside the IoTID20 dataset, with a specific focus on identifying potential attacks.

The data preparation stage primarily covers two main ways. First and foremost, the process of data conversion entails the translation of nominal properties into numerical features in order tofacilitate subsequent processing. Additionally, the objective of data normalization is to address the significant variability of attributes by constraining values to a rational range. The normalizingprocess can be theoretically defined by equation (1) through the utilization of the minimum- maximum scaling method.

$$Y = \frac{Y - mmmn(Y)}{max(Y) - mmmn(Y)} \quad (1)$$

where dataset feature value is indicated by Y, and it is in the range of [0, 1].

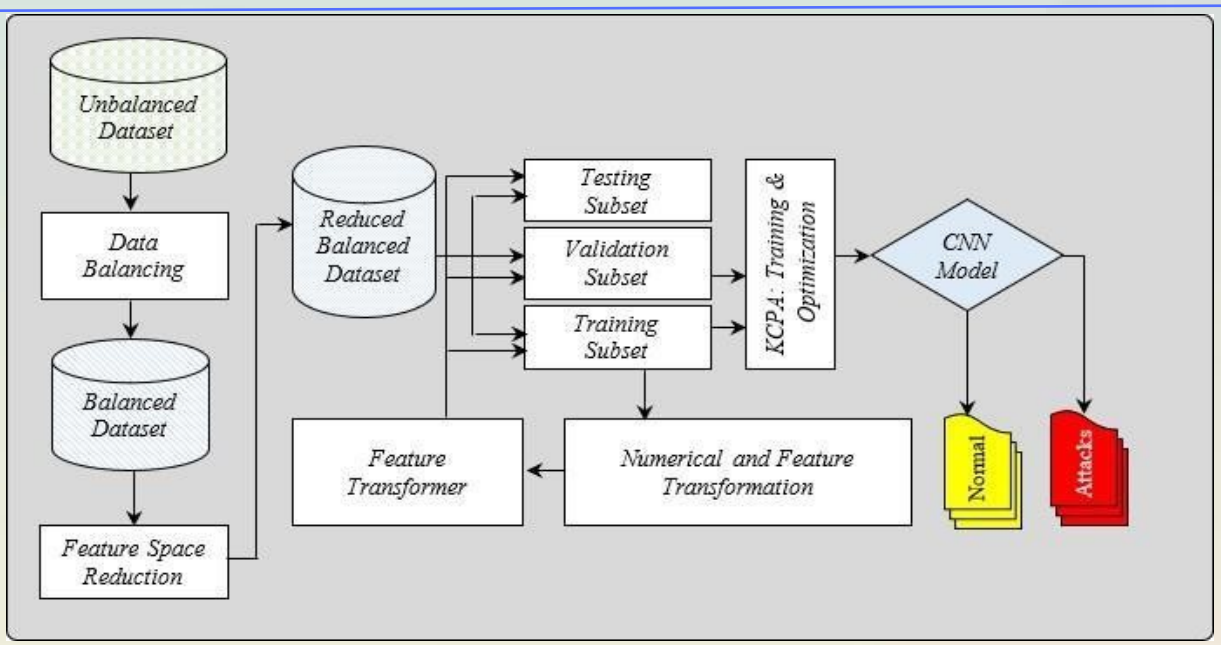

Figure 1: The CNN-KPCA IoT-based Intrusion Detection Framework

Before the data are exposed to feature extraction, they are put through preprocessing, duringwhich PCA (Principal Component Analysis) is utilized the majority of the time to reduce the size of the dataset. However, due to the fact that PCA is unable to accommodate non-linear data features, particularly in complex structures, an alternate method such as KPCA is required in order to successfully overcome this constraint.

A convolution kernel is applied within the convolution layer in order to progress the learningand classification process. This results in the generation of a new feature graph that is comprised of numerous interconnected feature graphs. These interconnected feature graphs are utilized asan input signal for distinct convolution cores. Convolving many feature graphs together produces each output feature graph, which in turn contributes to the formation of another output layer [39]. The computation is carried out as follows within the convolution layer:

$$XX_{jj}^{l} = ff_{\blacklozenge}\left(\sum_{iigM_{jj}} XX_{ii}^{l-1} \mathrm{x} K_{iijj}^{l} + b_{jj}^{l}\right) \quad (2)$$

where XX_{jj}^{l} represents the jj feature and the layer map l, K_{iijj}^{l} represents the convolutional kernel function, ff represents the activation function, and both b_{j}^{l} and M_{jj} represents bias parameter and the input feature graph respectively.

4. The dataset

The newly developed IoTID20 attack dataset was generated in the year 2020 [40]. The dataset included 80 features from PCAP files, with two basic class label attacks and normal.

Table 1 lists all of the IoTID20 dataset assaults, whereas Table 2 lists the number of characteristics for each class label.

Table 1
Varieties of Attacks in the IoTID20 Dataset

Scan	Mitm	Mirai	DOS
Host Port	ARP Spoofing Services	Brute Force (Host) Flooding (HTTP) Flooding (UDP)	Syn Flooding

Table 2
The number of attack occurrences in the IoTID20 dataset for each class

Class	Number of Instances
Attack Flooding (Mirai)	55124
UDP Flooding (Mirai)	183554
DoS	59391
HTTP Flooding (Mirai)	55818
Port DoS (Scan)	53073
Brute Force (Mirai)	121181
Host Port (Scan)	22192
MITM	35377
Normal	40073

5. Results and Discussion

The research employed actual data obtained from an Internet of Things (IoT) cybersecurity network. The CNN-KPCA model was utilized to categorize different types of threats present in thenetwork dataset. The utilization of the KCPA model yielded notable enhancements in feature extraction, leading to substantial gains in both classification performance and model correctness.Significantly, the procedure of feature selection successfully decreased the total number offeatures from 81 to 19, identifying these specific features as the most essential components for detecting intrusions inside the dataset.

The dataset consisted of a total of 625,783 instances. To provide a comprehensive analysis, the data was divided into two partitions: 80 percent (500,627 instances) were allocated for trainingpurposes, while the remaining 20 percent (125,155 instances) were reserved for testing. This division was necessary due to the large number of examples in the dataset. Table 3 presents a wide array of measures utilized to assess the performance of the suggested model.

Table 3
The number of attack occurrences in the IoTID20 dataset for each class

Models	Acc (%)	Sen (%)	Spe (%)	Pre (%)	F1-Score	Time (Sec)
CNN	97.49	99.32	91.05	98.52	98.73	79
CNN-KPCA	99.35	99.71	91.26	98.57	99.21	79

The suggested model produced the best outcomes when tested against the IoT-based dataset utilized for performance data from the network to detect infiltration. The overall effectiveness of the suggested CNN-KPCA model is shown in Figure 2. The IDS model performance is evaluated inTable 3 using two classes of attacks and the baseline condition; the CNN-KPCA model performs better, with 99.35% accuracy, 99.71% sensitivity, 91.26% specificity, 98.57 precision, and
99.21% F1-score, respectively.

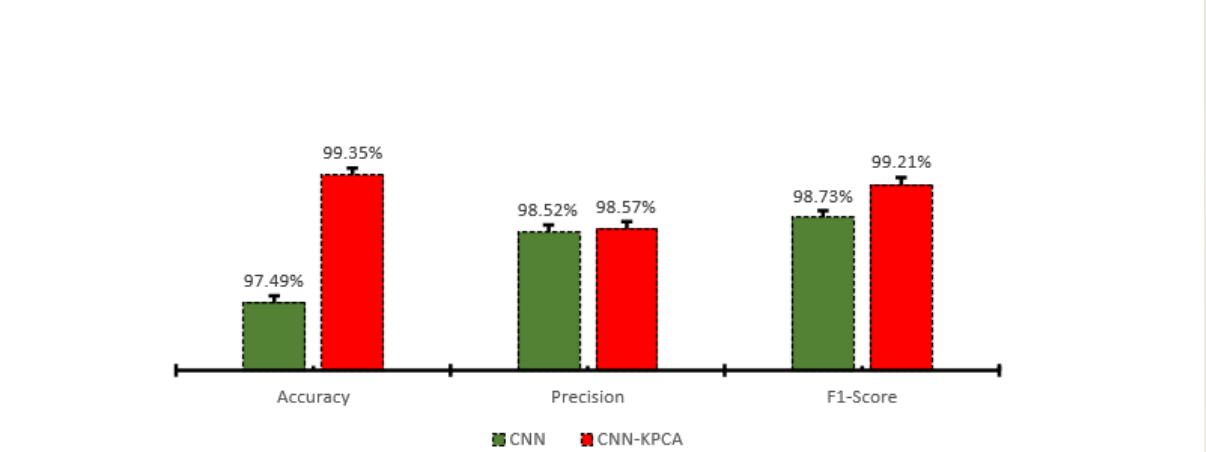

Figure 2: Performance evaluation of CNN-KPCA model

Recent research investigations that used the same dataset as the CNN-KPCA model were compared with it, particularly the research that produced the dataset used for evaluation. Several ML-based models, including Linear Discriminant Analysis (LDA), Decision with Random Forest, Support Vector Machine (SVM), and Gaussian Nave Bays (NB) from the IoT-based platform, wereutilized in the baseline analysis on the dataset for the identification of intrusions [39]. Another important study by authors in [12] used CNN, LSTM, and CNN-LSTM on the same dataset and minimized the features from the network dataset from 81 to 21 revenant features using the particle swarm optimization approach (PSO). In order to further increase the accuracy of intrusion detection on the dataset, this study suggested CNN-KPCA. In order to handle theunbalanced data and minimize the number of characteristics from 81 to 19, the KCPA model wasemployed. This helped the suggested model accurately identify attackers on the IoT-based platform.

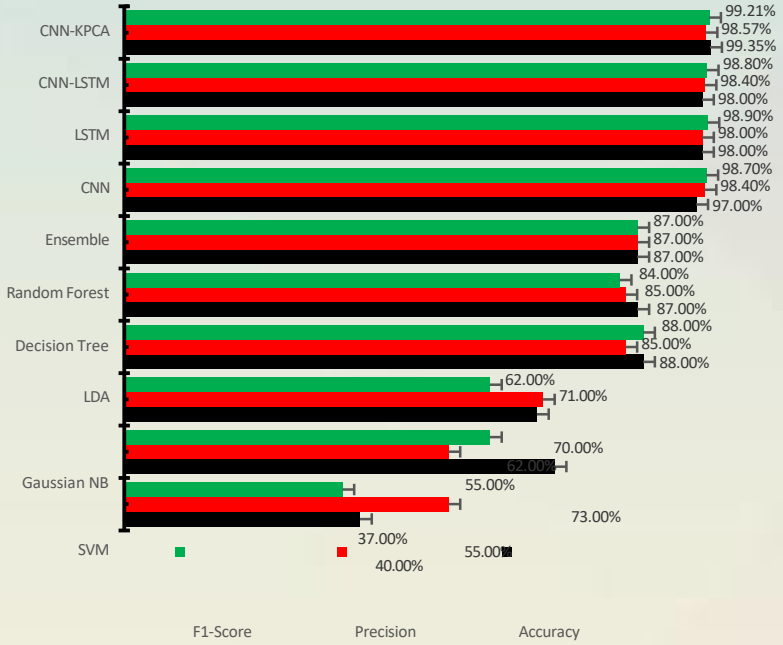

Figure 3: Comparison of the CNN-KPCA model and the existing models

From Figure 3, the results show that the CNN-KPCA framework performed better and yieldeda better detection accuracy using various metrics with other ML models.

Table 4
Comparison of the CNN-KPCA model and the existing models

Models	Acc (%)	Sen (%)	Spe (%)	Pre (%)	F1-Score
SVM [40]	40.00	-	-	55.00	37.00
Gaussian NB [40]	73.00	-	-	55.00	62.00
LDA [40]	70.00	-	-	71.00	62.00
Decision Tree [40]	88.00	-	-	85.00	88.00
Random Forest [40]	87.00	-	-	85.00	84.00
Ensemble [40]	87.00	-	-	87.00	87.00
CNN [12]	97.00	99.01	77.20	98.40	98.70
LSTM [12]	98.00	99.67	71.60	98.00	98.90
CNN-LSTM [12]	98.00	99.23	77.40	98.40	98.80
CNN-KPCA	99.35	99.71	91.26	98.57	99.21

Table 4 presents a comprehensive comparison of various machine learning and deep learningmodels that have been implemented with the intention of achieving the particular goal of detecting intrusions in IoT environments. The models under discussion encompass a range of techniques, spanning from conventional machine learning approaches like SVM, Gaussian Naive Bayes (NB), LDA, Decision Trees, Random Forest, and Ensemble methods, to more intricate deeplearning architectures such as CNN, Long Short-Term Memory (LSTM), CNN-LSTM, and the suggested CNN-KPCA hybrid model.

The traditional machine learning models displayed a level of performance that is commendable or at least respectable. An accuracy rate of 40% was demonstrated by the SVM

technique. On the other hand, the accuracy reached by Decision Trees was the greatest at 88%. Having said that, it is important to highlight the fact that their accuracy and F1-scores were significantly lower than average. Based on this discovery, Decision Trees may have specific limitations when it comes to efficiently handling the complexities connected with intrusion detection in IoT systems. Despite this, the Gaussian NB, LDA, Random Forest, and Ensemble approaches all demonstrated equal levels of accuracy, with ratings ranging from around 70% to 87%. Although these models offer a satisfactory comprehension of the data, their capacity to identify complex patterns within the IoT data may be constrained. In contrast, deep learning models, specifically CNN, LSTM, and CNN-LSTM, have exhibited superior performance comparedto standard models, achieving accuracies ranging from 97% to 98%. It has been proved that thesemodels are successful in managing the complexities of IoT data and extracting sophisticated features for the purpose of conducting intrusion detection.

The CNN-KPCA model, which had outstanding performance, made use of a hybrid approach that synergistically merged the capabilities of CNN and KPCA. This allowed the model to more effectively analyze complex data. The model that was given shown outstanding performance, obtaining an accuracy rate of 99.35 percent, a precision value of 98.57%, and an incredible F1- Score of 99.21%. The CNN-KPCA model demonstrated a noteworthy specificity of 91.26%, indicating a strong capability to accurately detect non-intrusive occurrences in IoT data. The outstanding performance of this hybrid model suggests that it has the ability to effectively identify intrusions in IoT environments while producing only a limited number of false positives. As a consequence of this, it exhibits promise as an option that might potentially be used for the development of reliable intrusion detection systems in these complex environments.

In a nutshell, traditional machine learning methods have made important contributions toward a more fundamental understanding of intrusion detection. However, the application of more complex models, such as the hybrid model comprised of CNN and KPCA, has shown significant progress in performance enhancements. In the context of intrusion detection, this underlines how important it is to incorporate deep learning and hybrid approaches in order to successfully address the unique aspects of IoT data.

6. Conclusion

The proliferation of ransomware and malicious botnets in the realm of IoT systems poses a substantial risk to the privacy of users. These threats have the ability to intentionally focus on IoT systems in various industries, potentially resulting in significant harm that could affect the assets of several clients, particularly in vital domains such as healthcare, banking, smart cities, and others. The mitigation of these hazards requires the implementation of strong network intrusion detection systems (NIDSs) that are capable of efficiently detecting and mitigating online attacks. These systems play a crucial role in ensuring the security of networks. This study presents a novel approach that combines DL techniques to develop a model capable of detecting intrusions in networks based on the IoT. The research use the KPCA model as a means to identify key components that are vital for the detection of unauthorized individuals within IoT network platforms. Following this, a CNN is utilized to categorize the dataset based on the IoT, so

assessingthe effectiveness of the model proposed. The results of the performance evaluations demonstratethat the proposed model exhibits superior performance compared to currently employed approaches, with a remarkable accuracy rate of 99.35%. This demonstrates a significant improvement of 1.35% in accuracy when compared to the nearest CCN-LSTM models that utilizedthe identical dataset.

Future study should aim to investigate contemporary classification approaches and design concepts in order to evaluate the robustness of IDS against a wide range of threats. The exploitation of conventional deep learning methods by intruders frequently results in notable instances of false alarms. This emphasizes the necessity for adaptive strategies to effectively address these difficulties.

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[Paper Id – 61] Web Performance analysis of Ecommerce using GTmetrix

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Abstract

Optimizing web performance is a crucial aspect for building success-full and user-friendly websites. In today's world with fast growing digital pace, user wants a quick loading website as they result in low conversion and frustrated users. Users expect websites to load quickly and provide fast and smooth browsing experience. Web performance optimization is basically increasing the performance of a website. This work presents an overview of key strategies and techniques to enhance web performance. Strategies like optimizing codes and scripts, compressing images etc. Website loading, minification, web caching and con-tent delivery networks are techniques to improve web page performance. Using web diagnostics tools like Google Page speed Insight and GTmatrix, developers can analyze the performance of websites. The analysis of website performance offers valuable insights and actionable recommendations to enhance its overall user experience. In current work considering certain aspects that includes: Is it happening? Is it useful? Is it usable? Is it delightful? authors compared two websites (Flip-kart.com and meesho.com), the performance score is calculated by considering metrices which include the speed index, total blocking time, cumulative layout shift etc. the performance score and the time index help us know which is a better website. The LCP for Flipkart is 1.5ms and is better than meesho.com. Out of all the parameters for Flipkart.com TBT (Total Blocking Time) is very high 680 ms,which indicates that for so long a user cannot interact with the website. Comparing two websites usingdifferent diagnostic tools it is being analyzed that user experience for www.flipkart is found better than www.meesho.com..

Keywords

Web Optimization, Diagnostic tool, Google Page speed Insights, GTmetrix

1. Introduction

Optimizing web performance involves a range of techniques and strategies aimed at improving the speed, efficiency, and overall user experience of a website. By reducing pageload times, enhancing responsiveness, and minimizing network latency, web performance optimization aims to create fast and reliable web experiences. Web page optimization is used for several reasons like improving user experience, increasing conversation rates, accessibility, and competitive advantage [1].

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1.1. Strategies for Improving Page Load Times

Improving page load times is key for providing a positive user experience. There are various strategies to achieve faster page load times:

- Compress image- large images files can significantly slow down page load times. We can optimize images by reducing file sizes without even giving up its quality.
- Optimize Code and scripts - Writing efficient and optimized codes can enhance page loadtimes. Remove unnecessary code, place scripts at bottom of your web pages to prevent them from delaying page rendering.
- Minimize HTTP requests- Reduce number of hypertext transfer protocol requests by combining CSS files into single file.

1.2. Techniques to Improve Web Page Performance.

i. Website loading speed- This refers to the time taken by a web page to fully load and displayits content in web browser, it is a critical factor that significantly impacts a website performance. Fast loading speeds are essential because users expect quick access to information. Factors that influence website loading speed include Server Performance, Network and connection speed, File size and compression [2].

ii. Minification- Minification is the process of reducing the size of computer programs source code without changing its functionality. The minification process typically involves removing unnecessary characters from the source code [2].

iii. Responsive Designs- The goal of the responsive design approach to web development is to build websites that can adjust and respond to various screen sizes and devices. Responsivedesign, which primarily strives to enhance user exprience and make websites aestheticallyappealing across devices. Less versions are required thanks to responsive design, which does away with the necessity for separate mobile-specific websites or several iterations ofthe same website. As opposed to this, a single responsive website may modify its design and content to accommodate different screen sizes and devices. Consolidation streamlinesdevelopment and boosts speed by reducing the complexity and maintenance work required to maintain numerous versions of the website [5][6].

iv. Image Optimization- Enhancing site performance through image optimization is essential.Frequently, photographs make up the bulk of the file size of a webpage, and poorly optimized graphics can dramatically slow down the page. To optimize image techniques like Compression, Resizing, Format selection, Image sprites can be used [3][4].

Performing performance tests on different devices and network conditions is crucial to ensure a seamless user experience for a wide range of users. Testing on numerous devices: Test your website on desktops, laptops, smartphones, tablets. Think about devices with various operating systems, browsers, screen sizes, and resolutions. To emulate the user experience on various devices, employ real hardware or emulators or simulators. Conduct load tests to determine how well your website operates when there is a lot of visitor traffic.

Tools for load testing like Apache JMeter, LoadRunner, or Gatling may mimic thousands of simultaneous visitors visiting your website. To guarantee that your web page can manage theanticipated traffic without experiencing performance degradation, test it on various devices and networks. Conduct usertesting sessions with actual people, various devices, and networksetups. Examine your website's effectiveness in actual situations and solicit user feedback [7][8].

2. Literature Survey

Web performance can be improved by improving server speed, file size and using compression techniques for videos and images. Performance optimization techniques include reducing the HTTP requests a page makes to the server, reduce page size and use caching Gardner [11]. Different compression techniques are used for reducing the size of files and data sent over the Internet [10]. Queries to databases can also cause slow web performance. Performance in querying large databases using index structures can improve the Web performance. Slow page load time can be frustrating and annoying to users and should be kept below a threshold range

[9] [10]. Content Prioritization can be used so that pages are shown to users sooner with the important content is another approach to improve web performance. The approach of dynamically re-prioritizing web content shows positive impact on user experience [11]. Measuring performance of a web application has been a big challenge to developers due to how the performance of different browsers varies when processing Javascript [12]. Web Workers API is a mechanism that allows executing JavaScript applications on multiple threads [13]. It is intended to be used for keeping pages responsive on web browsers and improving user experience [14]. A framework is suggested with performance metrics framed around fourquestions: (1) measuring if there is any response after a user starts the navigation to the page (isit happening?). (2) measure if the content rendered is actually useful or meaningful to a user (is it useful?). (3) measuring if a user can interact with the content that has been rendered. (is it usable?) (4) measures the experience of the interactions and how enjoyable and pleasant the website is to use (is it delightful?) [15][18].

3. Practices by which we can maintain and optimize web performance

Use tools like Google PageSpeed Insights, Lighthouse, or WebPageTest to continuously check the performance of your website. Check performance indicators like rendering speed, time to first byte (TTFB), and page load time often. You may spot performance bottlenecks and potential improvement areas with the use of monitoring.

Regular testing and improvement Check out your website on various platforms, browsers, and networks. Through user testing and analytics, pinpoint performance and usability concerns. Based on the comments and new information, continually improve and tweak your website.

Remove unnecessary Plugins and Scripts:

Evaluate and remove any unnecessary plugins, scripts, or tracking codes that can introduce additional overhead and negatively impact performance. Keep in mind that improving web performance is a continuous endeavor. To maintain a quick and easy user experience, regularly examine and optimize your website based on performance indica-tors, user feedback, and developing technologies [16][17].

4. Analysis of a website using tools like Google PageSpeed Insights and GTmetrix.

These tools help us give valuable insights into the performance of a web-site, by using the resultsyou can enhance your website

4.1. Analyzing weblink using Google PageSpeed insights.

Below are the steps to use Google PageSpeed insights for analysing the performance of any weblink. In this case just for study we are evaluating performance of a web platform [19]**.** Figure1 Represents the metrices used to check website performance.

Steps-

i. go to Google Page Speed insights website.

ii. enter the URL of website you want to test.click “analyze” and wait for the analysis

Figure 1: The performance metrix score of websites

LCP – This reports the time of the largest image or text block visible when the page starts to load.LCP count less than 2.5 s is good.
FID- (First input delay) – this measures the time when the user first interacts with the page.
FCP-(First contentful paint) - this measures the time when page starts loading till the time anypart of page's content is rendered on screen.
INP- (Interaction to Next Paint) – this assesses a page's overall response to user interactions byobserving the latency of all clicks as shown in figure.1.
TTFB- (4Time to First Byte)- TTFB is a measure duration of HTTP request to the first byte of thepage being received by the client's browser [18].

4.2. Several ways to enhance the performance of website-

Reduce initial server response- The first step towards better server response times is to define the fundamental conceptual activities that your server must execute in order to provide page content, and then time each of these processes. Once you've discovered the time-consuming tasks,look formethods to shorten them. There are several causes of sluggish serveranswers, and hencenumerous approaches to improve:

i. Optimize the application logic on the server to prepare pages quicker. If you utilize a server framework, the framework may provide suggestions on how to accomplish this.
ii. Optimize your server's database queries, or switch to speedier database solutions.
iii. Increase the RAM or CPU on your server hardware. To decrease network latency, use a CDN (content delivery network). This works especially well if the page can be cached at the CDN edge node.
iv. Avoid enormous network payloads. Avoid an excessive DOM size -A huge DOM tree frequently has numerous nodes that are not visible when the user first opens the website,increasing data costs for your users and slowing download time. The browser must continually recompute the location and style of nodes when users and scripts interact with your website. A big DOM tree combined with complex style rules can

significantly slow down rendering. If your JavaScript employs generic query selectors like document.querySelectorAll('li'), you may be accidentally keeping references to a huge number of nodes, which can overflow the memory capabilities of your users' devices.

5. Comparing the performance of two websites using Google Pagespeed Insights.

Comparing the performance and accessibility of two shopping websites using Google Page speed Insights. First, we will test performance and accessibility of a shopping website https://www.meesho.com/.The results are as follows Figure 2-

Figure 2: The metrices of www.meesho.com website

Out of all the parameter's Total Blocking Time is very high in Figure 2. TBT is 680 ms which indicates that for so long a user cannot interact with the website. The main thread of the page weremain block for such duration. Cumulative layout shift that measures the user experience on website needs improvement. The cumulative layout shift for the site is (>.1), and it needsimprovement.

Figure 3: The performance score and the first page which is seen when the meesho.com website is completely loaded.

The overall performance of site come out to be 68, as in Figure 3. The Performance is calculated using Lighthouse scoring calculator. Lighthouse performance scoring works by combining 6 different web performance metrics. Figure 4 show the weightage of each metric in calculation ofperformance. Total Blocking Time and Largest Contentful Paint account for almost half of the performance score.

Metric	Acronym	% of Performance score
First Contentful Paint	FCP	10%
Speed Index	SI	10%
Largest Contentful Paint	LCP	25%
Total Blocking Time	TBT	30%
Cumulative Layout Shift	CLS	25%

Figure 4: The metrices of www.meesho.com website

The overall composition has changed over time, but the table below shows the breakdown as of Lighthouse 9.6 (Jan 2023). Total Blocking Time and Largest Contentful Paint account for almost half of the performance score.
Now we will test the performance and accessibility of the second shopping website https://www.flipkart.com/. The results are in Figure. 5-

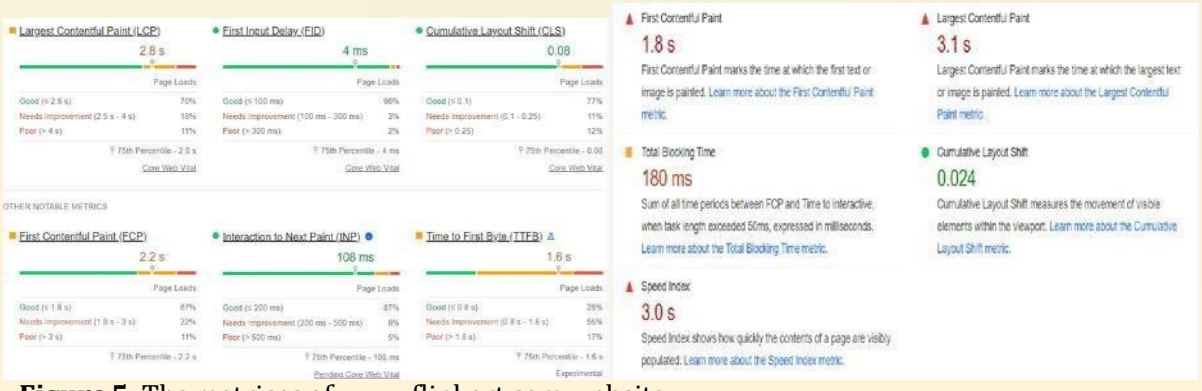

Figure 5: The metrices of www.flipkart.com website.

As shown in Figure 5, Total Blocking time is 180ms for www.flipkart.com, breakdown of the score can be analyzed to check the area where performance can be improved. The overall performance of site come out to be 64, as in Figure 6. The Performance is calculated using Lighthouse scoring calculator.

Figure 6: The performance score and the first page which is seen when the www.flipkart.com iscompletely loaded

Hence using the tool Google Page speed Insights, we can easily compare two websites. Figure 6, show performance score and the first page which is seen when the www.flipkart.com is completely loaded tree map of site

Table 1.
Comparative Analysis of Flipkart.com and Meesho.com.

Parameters	Flipkart.com	Meesho.com
LCP	1.5ms	2.8ms
FID	2ms	4ms
FCP	1.4ms	2.2ms
INP	152	108
TTFB	.6	1.6
Total Blocking Time	680ms	180ms
Cumulative Layout shift	72	0.024

By the following analysis of two websites we can say that the performance score of the website flipkart is better than meesho Table 1. By comparing the first contentful paint or the time at whichfirst image or text is painted of both websites we observe that the time taken by the first websiteis less than that of second one. Similarly, there is a difference in speed index of both the websites.These aspects help us know about the performance of a website.

6. Comparing the performance of two websites using GTmatrix

GTmetrix is a tool to check the performance of web sites. It will analyze a site's load time, size, and requests happening, and suggest corrective measures to improve the web performance.

This tool can be used by businesses and developers to measure site's performance and look for room for improvement. Comparing two performance score for both sites www.flipkart.com and www. meesho.com it is being analyzed that user experience for www. Flipkart.com is better thanfor www.meesho.com. Figure, 7 and 8

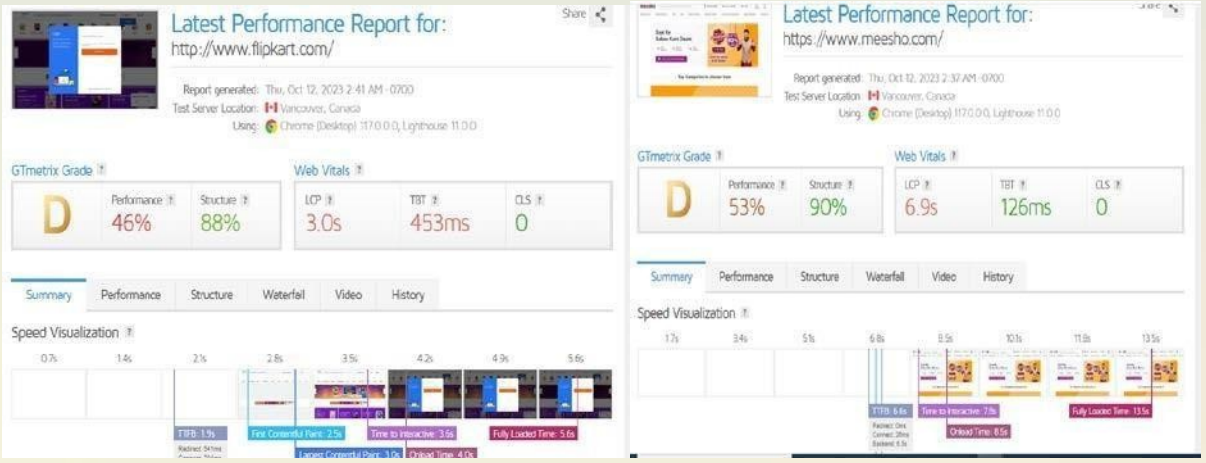

Figure 7: Performance report generated by GTmatrix for two ecommerce websites a) www.flipkart.com b) www.GTmatrix.com

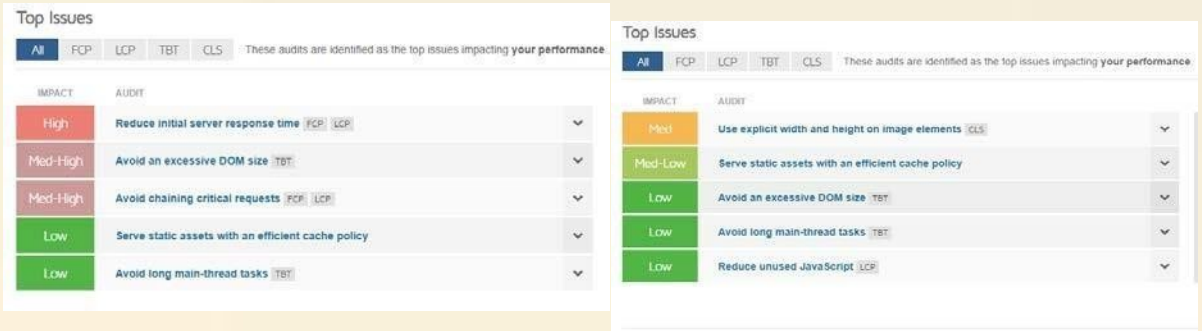

Figure 8: issues reported by GTmatrix and corrective measures as suggested, for two ecommercewebsites a) www.GTmatrix.com b) www.flipkart.com

7. Limitations to consider while trying to optimize web performance.

Server-side constraints: Your server infrastructure's capabilities and constraints may have

animpact on the performance of your website. The entire page load times can be affected by elements including server response times, server processing power, and database performance. In such circumstances, performance may need to be improved by server-side optimizations or anincrease of resources.

Network and latency: External variables, such as the user's network connection, location, andnetwork congestion, can have an impact on how well a web page performs. Even if your website is optimized, slow or unstable network connections can cause greater latency and longer load times. Your web page has to be designed to smoothly manage changing network circumstances. Constraints on time and resources: Web development projects frequently face these limitations, and performance optimization may not always be the first priority. Within these limitations, it may be difficult to strike a balance between performance, design, and utility.When enhancing thespeed of a web page, it's critical to recognize these constraints and make wise choices. Consider the particular environment and project restrictions when deciding which optimizations to prioritize based on their influence on your target audience. Maintaining and improving web pagespeed over time requires regular testing, monitoring, and iterative changes

8. Conclusion

In conclusion, optimizing web performance requires a holistic approach that encompasses including caching, compression, image optimization, code minification and etc. Developers may construct high performing websites that provide amazing user experience by adopting such techniques and tactics. It is critical for academics, developers, and webmasters to keep current on the newest trends and developing technologies in online performance optimization. Continuous research and implementation of best practices will help the continued development of web performance and user happiness in the digital world. By considering different aspects of website optimization, work compared two websites (Flipkart.com and meesho.com), the performance score is calculated by considering metrices which include the speed index, total blocking time, cumulative layout shift etc. the performance score and the time index help us knowwhich is a better website. The LCP for Flipkart is 1.5ms and is better than meesho.com. Out of allthe parameters for Flipkart.com TBT (Total Blocking Time) is very high 680 ms, which indicates that for so long a user cannot interact with the website.

Optimizing web performance is a crucial aspect for building success-full and user-friendly websites. In today's world with fast growing digital pace, user wants a quick loading website as they result in low conversion and frustrated users. Users expect websites to load quickly and provide fast and smooth browsing experience. Web performance optimization is basically increasing the performance of a website. This work presents an overview of key strategies and techniques to enhance web performance. Strategies like optimizing codes and scripts, compressing images etc. Website loading, minification, web caching and con-tent delivery networks are techniques to improve web page performance. Using web diagnostics tools like Google Page speed Insight and GTmatrix, developers can analyze the performance of websites. The analysis of website performance offers valuable insights and actionable recommendations

to enhance its overall user experience. In current work considering certain aspects that includes: Isit happening? Is it useful? Is it usable? Is it delightful? authors compared two websites (Flip- kart.com and meesho.com), the performance score is calculated by considering metrices which include the speed index, total blocking time, cumulative layout shift etc. the performance score and the time index help us know which is a better website. The LCP for Flipkart is 1.5ms and is better than meesho.com. Out of all the parameters for Flipkart.com TBT (Total Blocking Time) isvery high 680 ms, which indicates that for so long a user cannot interact with the website. Comparing two websites using different diagnostic tools it is being analyzed that user experiencefor www.flipkart is found better than www.meesho.com.

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[Paper Id – 38] Artificial Intelligence Based Autonomous Traffic Regulator

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Abstract - Artificial intelligence (AI)-based autonomous traffic regulation refers to the management and control of traffic flow. In order to collect real-time data on traffic conditions, sensors, cameras, and communication networks are used. This data is then evaluated and processed by AI algorithms to produce insights and make judgement. AI- powered autonomous traffic regulation aims to increase system efficiency by reducing congestion, increasing safety, and all of the above. The advantage of using autonomous traffic regulation utilizing AI is the ability to process and collect large real time data and conclusions are drawn. This enables the system to adjust the traffic flow fast in response to shifting traffic circumstances. Algorithms based on AI can also be used learn from previous traffic patterns and situations to create future forecasts and conclusions that are more accurate. For autonomous traffic regulation, a variety of AI algorithms, which includes reinforcement learning machine learning, deep learning, can be applied. Algorithms based on Deep learning can be used to interpret photos, video data from cameras, spotting patterns and trends in traffic data can be achieved through machine learning algorithms. Algorithms for reinforcement learning can be used to learn from the past and make choices based on reward signals. To guarantee their dependability and safety, it is crucial to make sure that these systems are designed and deployed with the proper protections. This AI-powered system can also adjust in real-time to shifting traffic patterns and road conditions, making the traffic regulating process more responsive and dynamic. As a result, there may be an improvement in traffic-related emissions reductions and fuel efficiency. Overall, the AI is used for the development of intelligent transportation systems which has advanced significant, which has the potential to revolutionize traffic management and assure a more effective, safe, and sustainable transportation system.

1. INTRODUCTION

The automation of traffic management and control is accomplished here by development of an autonomous traffic regulator. It enhances the safety and effectiveness of roadways by using a variety of technologies such as cameras, signal controllers and artificial intelligence algorithms to detect and

adapt to traffic patterns in real- time. Reduced traffic congestion, lower accident risk, andimproved vehicle flow are the objectives of an autonomous traffic regulator. Image detection, image processing, density calculation, communication networks, an efficient signal switching algorithm and a centralized control system are essential parts of an autonomous traffic regulation system. Autonomous Traffic Regulators use a combination of such technologies and algorithms to collect and analyze data about the flow of traffic. This information is then used to control the traffic lights, which in turn help us in regulating the flow of traffic, time spent by each vehicle on the road and lesser time delays. This further helps in reducing congestion and hence reducing the carbon emissions on the road.

The ATR system's ability to reduce travel time and fuel consumption is one of its main advantages. The ATR represents a significant advance in the future of traffic management given the rising demand for smart cities and the creation of intelligent transportation systems. It has the ability to fundamentally alter how we control traffic and guarantee a more effective, secure, and sustainable transportation system. Increased road safety is a benefit of the ATR system as well. The system can make decisions that reduce the danger of crashes and other traffic-related occurrences by assessing real-time data on traffic patterns and road conditions. This can aid in lowering the amount of collisions and fatalities on the roads, hence enhancing the safety of the roadways for all users. But there are enormous potential advantages, and technology is developing quickly. The ATR system offers a viable answer to one of the most critical issues facing modern cities as they continue to grow and traffic congestion worsens.

The necessity to overcome the difficulties traditional traffic management systems confront is driving the development of autonomous traffic regulators. The increased needs of modern transportation and the growing complexity of urban traffic networks have shown the current traffic management methods to be insufficient.

One of the main problems that autonomous traffic regulators seek to address is traffic congestion. In addition to wasting time and fuel, it also causes air pollution and traffic collisions. Traditional traffic management systems rely on time-consuming, ineffective manual interventions to control traffic. Road safety is another problem that autonomous traffic regulators seek to solve.

As per the World Health Organization records, road accidents are the ninth main common cause of mortality worldwide and the main reason for the death among young people. Real-time detection and accident prevention are limitations of conventional traffic management systems. To improve traffic safety, autonomous traffic regulators make use of cutting-edge technologies including object identification, weighted assignments to objects, and real-time traffic monitoring. Furthermore, conventional traffic management systems are frequently created for a particular site and are not adaptable enough to accommodate shifting traffic patterns. This may result in an ineffective utilization of the road system, especially during rush hour. By minimizing travel time, fuel use, and

emissions, autonomous traffic regulators can also increase the overall effectiveness of the transportation network. Autonomous traffic regulators can save travel times and use less fuel by enhancing traffic flow and minimizing congestion. Additionally, autonomous traffic regulators can lower car emissions by lowering the amount of traffic accidents.

2. LITERATURE SURVEY

Zaatouri et al. [1] introduces a traffic light control system which accepts the YOLO (You Only Look Once) algorithm for detecting the objects. The system dynamically adjusts traffic light timings by analyzing vehicle and pedestrian presence, aiming to enhance traffic flow and alleviate congestion. By utilizing YOLO's efficiency and accuracy, the proposed system helps to self-adaptive approach for optimizing traffic signal operations.

Liu et al. [2] presents an approach that combines the YOLO network with the anchor box mechanism to improve object detection accuracy and efficiency. Experimental results demonstrate the effectiveness of the proposed method in detecting objects in real-time scenarios. The research contributes to the advancement of object detection techniques by leveraging the capabilities of the YOLO network and introducing the anchor box mechanism.

The authors Pratama B et al. [3] present a system for traffic density calculation with a help of road pattern analysis using adaptive traffic light control. The model aims to optimize traffic flow by dynamically adjusting signal timings according to the current traffic density. Experimental results from a case study in Manado, Indonesia, demonstrate the effectiveness of the proposed approach in reducing traffic congestion and improving overall traffic management.

Bhave N et al. [4] proposes a smart traffic signal control system that combines reinforcement learning and object detection. The system dynamically adjusts signal timings based on real-time traffic conditions and vehicle detection. By applying reinforcement learning algorithms, the system learns optimal traffic signal policies for different traffic scenarios. Experimental results from Palladam, India, demonstrate the effectiveness of the proposed approach in reducing traffic congestion and improving overall traffic management by adapting to changing traffic patterns.

Garg et al. [5] the authors explored the multi-agent deep reinforcement learning approach for optimizing traffic flow at multiple road intersections. By utilizing live camera feeds, the system learns optimal traffic signal control policies, resulting in improved traffic efficiency and reduced congestion.

Kwon J et al. [6] focuses on traffic data classification using machine learning algorithms in Software-Defined Networking (SDN) networks. The study proposes a classification framework to classify network traffic based on machine learning techniques. By analyzing traffic patterns, the proposed approach enables efficient traffic management and improves network performance in SDN environments.

Lee et al. [7] designs intelligent traffic control techniques for autonomous vehicle systems using machine learning. The paper discusses the application of machine learning algorithms to predict traffic conditions and optimize traffic signal timings for improved traffic flow. The proposed approach aims to enhance the performance and efficiency of autonomous vehicle systems by leveraging machine learning capabilities in traffic control.

Tiwari et al. [8] focuses on real-time traffic management utilizing machine learning techniques. The study proposes a system that employs machine learning algorithms to analyze traffic data and make intelligent decisions for traffic control and management. The goal is to enhance the efficiency of traffic flow and reduce congestion by dynamically adjusting signal timings based on real-time traffic conditions.

Lorencik D et al. [9] discusses the object recognition techniques in traffic monitoring systems. The study explores the use of computer vision algorithms and machine learning methods for accurately detecting and classifying objects in traffic scenarios. The proposed approach aims to enhance the effectiveness of traffic monitoring systems by enabling automated object recognition, which can contribute to improved traffic analysis, management, and safety.

Asha C S et al. [10] presents a vehicle counting system for traffic management. The system combines the YOLO (You Only Look Once) algorithm and correlation filter techniques to detect and count vehicles in real-time. The proposed approach aims to provide accurate and efficient vehicle counting for traffic analysis and management systems, which can assist in making informed decisions and improving overall traffic flow.

De Oliveira L F P et al. [11] presents the development of a smart traffic light control system with real- time monitoring capabilities. The system utilizes Internet of Things (IoT) technologies to monitor traffic conditions and dynamically adjust signal timings based on traffic flow. The paper discusses the design and implementation of the system, highlighting its ability to improve traffic efficiency, reduce congestion, and enhance overall traffic management through real-time monitoring and control.

Peiyuan Jiang et al.[12] provides a comprehensive review of the developments in the YOLO (You Only Look Once) algorithm. The paper discusses the evolution and improvements of the YOLO algorithm over time, including different versions and variations. It covers various aspects such as network architecture, training techniques, object detection performance, and applications. The review aims to provide an understanding of the advancements in the YOLO algorithm and its relevance in the field of computer vision and object detection.

Maqbool S et al.[13] presents an approach that combines computer vision techniques with image processing algorithms to detect vehicles, track their movement, and accurately count the number of vehicles in a given area. The proposed system has potential applications in traffic monitoring, congestion management, and urban planning. The research contributes to the field of intelligent transportation systems by providing an effective solution for vehicle detection and tracking.

Kumari R et al.[14,15] The first paper focuses on analyzing the PyGameGUI modules and their functionalities, while the second paper demonstrates the use of Pygame for implementing a trained model for autonomous driving using deep reinforcement learning. Together, they contribute to the understanding and utilization of Pygame in different contexts such as user interface development and autonomous driving simulations.

3. STUDY OF SUCCESSIVE TECHNOLOGIES

1) The flow of Self Adaptive Traffic Light Control by Adapting YOLO Algorithm

This research suggests a real-time method of traffic signal control which is based on traffic movement. They have the features of the opposing traffic flows at the signalized road crossing thanks to computer vision and machine learning. You Only Look Once, a cutting-edge real-time item detection system, does this. It is built on deep conventional neural networks (YOLO). Then, traffic signal phases are optimized based on data that has been gathered, namely line length and waiting time per vehicle, to allow the greatest number of vehicles to pass safely with the shortest amount of waiting time. YOLO's accuracy and real-time efficiency made it possible to substitute the policeman in traffic control optimization.

Deep learning is used to create a novel adaptive traffic light control algorithm that complies with safety standards. Real- time detection and vehicle monitoring with duration before exiting the intersection are made feasible by YOLO v2. In fact, the controller uses the YOLO model to determine how many vehicles are in each lane and how long they will wait when the light turns yellow. The

duration of the following phase is determined to reduce waiting time based on the maximum and average waiting times for each lane and the length of the queue.

Without disrupting the cycle order, our approach gives preference to those who have waited the longest. See Fig. 1 for a discussion of this algorithm.

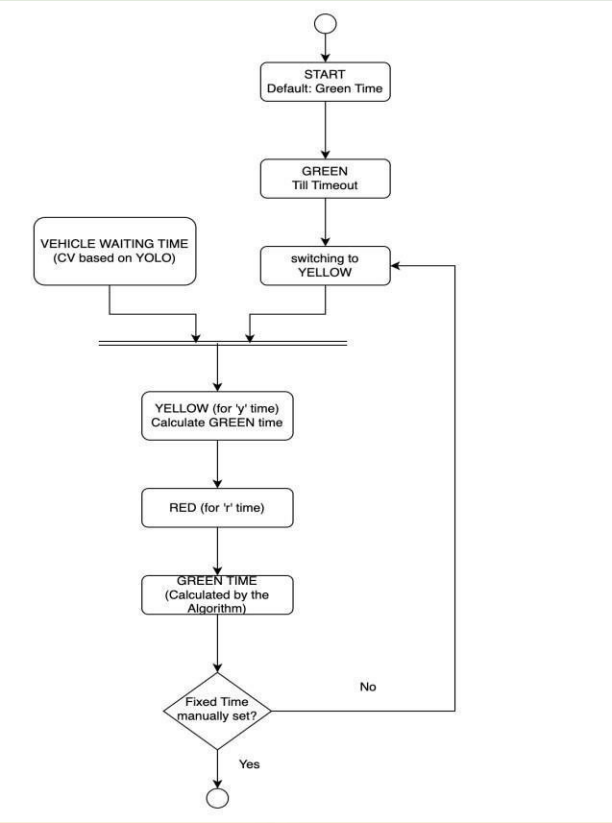


Figure 1: Activity Diagram of the proposed ATR

1) Use of YOLO algorithm to detect the Objects

We explored and simulated several visual degenerative processes. The excellent results have been produced by Deep learning-based object detection. As there are many numerous problems with issues like photographs when shooting happens in the real world, which includes issues such as noise, blurring, rotational jitter, etc. The advantages of these issues on object detection is important.. In the beginning, they developed the models for degraded photos mostly by applying mathematical models to produce degraded images based on common data sets. They then trained the network to adapt to the challenging real-world environment using these models. Based on the YOLO network developed image degradation model and incorporated conventional image processing techniques to emulate the issues present in real-world shooting, using traffic signs as an example. We examined the impacts of various degradation models on object detection after developing the various degradation models.

In order to increase the average precision (AP) of traffic sign detection in real scenarios, we trained a strong model using the YOLO network. In addition to improving the accuracy of object detection, our work has also shown that it is possible to train models that are robust to a variety of visual degradations. This is important for applications such as self- driving cars, where the ability to detect objects in degraded conditions is essential for safety.

Finally, we enhanced the model's capacity for generalizing complex images. We used the YOLO neural network to assess the traffic signs as our study object. A new picture degradation model was created as a result, using various deteriorated photographs as test sets. After that, they altered the source network and used several degradation techniques to the training set. Then, they used more intricate degradation processes to the training sets to produce an improved and broadly applicable detection network. In conclusion, the model's capacity for generalization had been strengthened, and object detection had become more precise.

2) The Traffic Density Calculation done for Road Patterns

Through estimations of traffic density on road layouts, we suggest adaptive traffic signals to regulate their timing. Several different road designs are subjected to image processing to determine the traffic density. Later, the traffic density is used to determine when the traffic signal will turn on. To assess the performance of their suggested method and compare it to a fixed-time traffic light system, the authors created a simulation model. The simulation's findings demonstrated that, in comparison to the fixed-time system, the adaptive traffic signal system was able to decrease the average vehicle waiting time and increase traffic flow. A server that collects data and manages traffic light operations at crossroads is also present. Real-world road conditions are used to validate the whole set of algorithms, including those for calculating traffic density and timing of traffic lights. The results obtained demonstrate the accuracy with which the traffic density sensing system can accurately determine the time of a traffic light. By ensuring that the green light is on for a longer period of time when there is a high volume of traffic on the road and a shorter period of time when there is less traffic, the system was able to lessen congestion.

A. *Canny Edge Detector*

Canny edge detection algorithm is one of the important used techniques in image processing. using the Contrast Limited Adaptive Histogram Equalization (CLAHE) equation The image is processed before the edge of the image is determined. By adaptively adjusting the contrast difference, this technique can be utilized to lessen the noise that results from using a camera with low performance or from taking photos at night.

B. *Bilateral Filtering*

A method of image screening known as bilateral filtering provides a smoothing operation while preserving the image's edge structure. In other words, the image is edge-preserving smoothing via bilateral filtering .The two processes that make up bilateral filtering are

selection and filtering. Here, Bilateral filtering is employed in this study to eliminate noise on coloring that was created in the first step. The goal of the selection procedure is to take the surrounding pixels into account. A delimiter function based on the difference in pixel values is the criteria function that is utilized. The filtering procedure itself then applies linear (using kernel box or Gaussian) or nonlinear (median filter) filtering techniques. The range of pixels included in the selection process and the maximum distance that passes the selection process are two parameters for the bilateral filtering algorithm that must be manually defined.

C. *Binary Threshold*

The last method to identify traffic congestion is the binary threshold. This procedure's major goal is to separate the automobiles from the background (road). In order to clearly identify the region that includes the object and backdrop of the image, the binary threshold converts the image to a binary or black-and-white image. The Region of Interest (ROI) of the path, which serves as the observation's focal point, is where the segmentation process is restricted.

By counting the black and white pixels in the ROI, one can determine the traffic density. The following formula is used to determine the traffic density formula:

$$Traffic\ density(\%) = \frac{black\ pixels}{black\ pixels + white\ pixels} x100\%$$

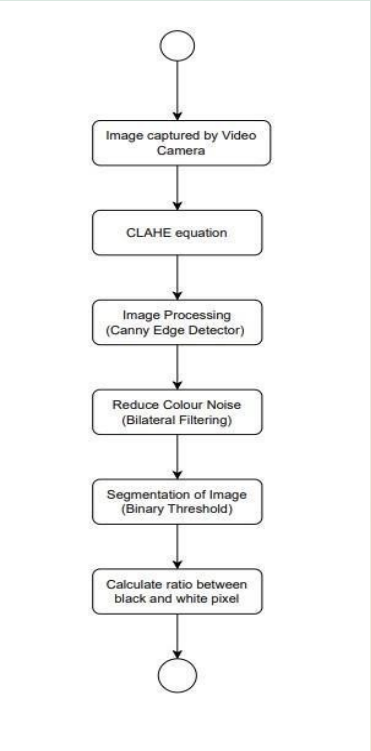


Figure 2: Traffic Density Calculation Algorithm

3) Self-Adaptive Traffic Signal Control incorporating Reinforcement Learning

The use of Reinforcement Learning (RL) and Object Detection to improve traffic flow and reduce congestion is explored. The system uses object detection algorithms to detect and count vehicles at intersections and RL algorithms to determine the optimal signal timings. The signal timings are then adjusted in real-time based on the traffic conditions to reduce wait times and improve traffic flow.Our suggested system is a fully functional model that includes hardware, software, algorithms for object identification and reinforcement learning. Following is a description of how each component like Actions and State-Action Pair work. The agent's Actions are determined by how the agent perceives the environment. The potential green phase timings of the traffic signal are the activities of our RL agent. These show how many seconds have passed since the green phase began whereas the State-Action pair is a mapping which is associated with Q-values, known as the state space representation. The State space is represented by a Matrix in our implementation. Each cell displays a Q- value for a possible State and action pair.The authors evaluated the performance of the proposed system using simulations and compared it to a traditional fixed-time signal control system.

The results showed that the proposed system was able to significantly reduce average wait times and improve traffic flow compared to the fixed-time system. In conclusion, the study demonstrates the potential benefits of using RL and object detection in traffic signal control systems to improve traffic flow and reduce congestion. The authors suggest that their proposed system could be implemented in real-world scenarios and further research is needed to validate the results and refine the algorithms.

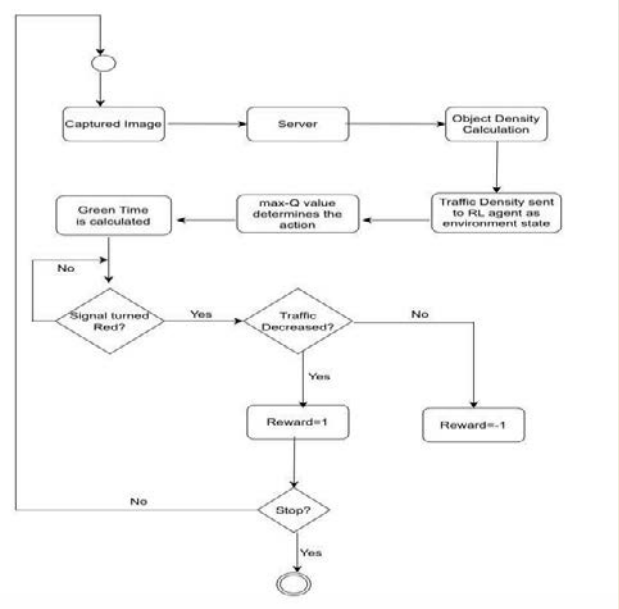
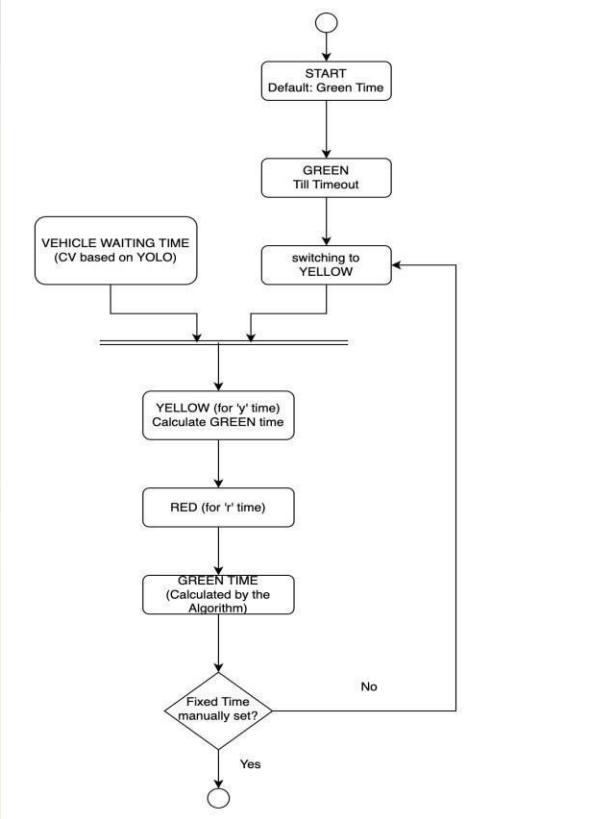


Figure 3: Flowchart for the reinforcement based system

4) Traffic optimization can be done through Multiple Road Intersections adapting Multi-Agent Deep Reinforcement Learning using Live Camera

A system of numerous, coordinated traffic signal control systems is suggested to be used. It presents a study on a traffic optimization system that uses multi-agent deep reinforcement learning (RL) to control the traffic lights at multiple road intersections. The system uses live camera feeds to detect and count vehicles at each intersection and adjust the signal timings in real-time to optimize traffic flow. The authors used a multi-agent deep RL algorithm to train the system, where each intersection was treated as an independent agent. In this study, multi-agent deep reinforcement learning (DRL) is applied for the first time to real-time traffic optimization over several road crossings using just the raw pixel input from CCTV cameras. By enhancing traffic flow and decreasing the average amount of time a vehicle spends at an intersection, it is demonstrated that this set of traffic control agents significantly outperforms independently running adaptive signal control systems. In a scenario where each agent only has access to the partial state of the traffic environment, they have shown that a centralized controller is capable of fostering a principled learning strategy between the signal control agents, leading to the positive emergence

of cooperative behavior among them. The performance of the proposed system was evaluated using simulations and compared to a traditional fixed-time signal control system. The results showed that the proposed system was able to significantly reduce average wait times and improve traffic flow compared to the fixed-time system.



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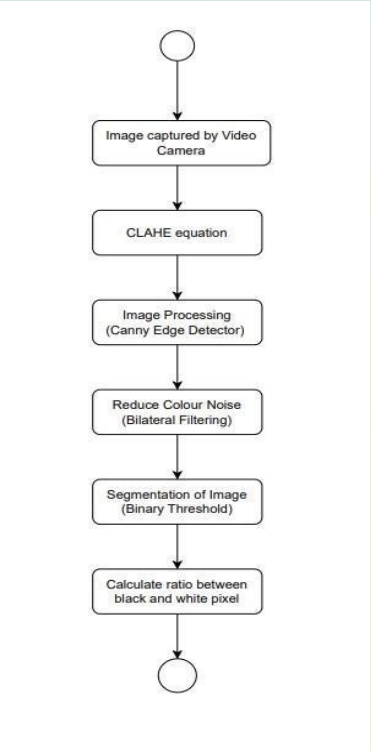

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The use of Reinforcement Learning (RL) and Object Detection to improve traffic flow and reduce congestion is explored. The system uses object detection algorithms to detect and count vehicles at intersections and RL algorithms to determine the optimal signal timings. The signal timings are then adjusted in real-time based on the traffic conditions to reduce wait times and improve traffic flow.Our suggested system is a fully functional model that includes hardware, software, algorithms for object identification and reinforcement learning. Following is a description of how each component like Actions and State-Action Pair work. The agent's Actions are determined by how the agent perceives the environment. The potential green phase timings of the traffic signal are the activities of our RL agent. These show how many seconds have passed since the green phase began whereas the State-Action pair is a mapping which is associated with Q-values, known as the state space representation. The State space is represented by a Matrix in our implementation. Each cell displays a Q- value for a possible State and action pair.The authors evaluated the performance of the proposed system using simulations and compared it to a traditional fixed-time signal control system.

The results showed that the proposed system was able to significantly reduce average wait times and improve traffic flow compared to the fixed-time system. In conclusion, the study demonstrates the potential benefits of using RL and object detection in traffic signal control systems to improve traffic flow and reduce congestion. The authors suggest that their proposed system could be implemented in real-world scenarios and further research is needed to validate the results and refine the algorithms.

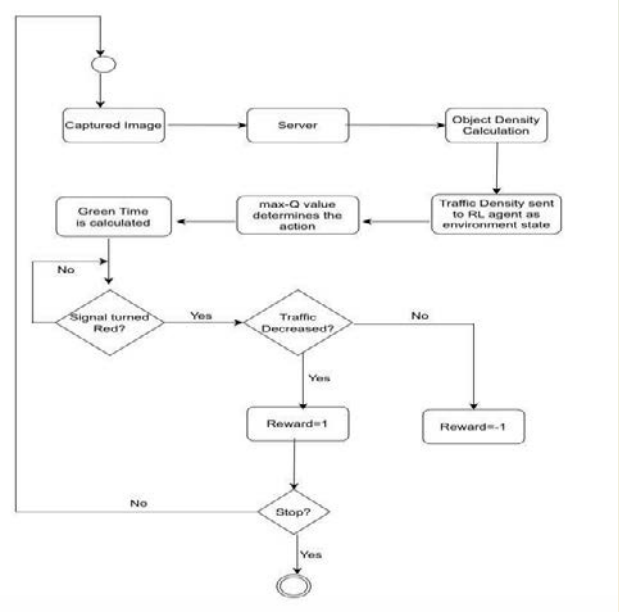

Figure 3: Flowchart for the reinforcement based system

7) Traffic optimization can be done through Multiple Road Intersections adapting Multi-Agent Deep Reinforcement Learning using Live Camera

A system of numerous, coordinated traffic signal control systems is suggested to be used. It presents a study on a traffic optimization system that uses multi-agent deep reinforcement learning (RL) to control the traffic lights at multiple road intersections. The system uses live camera feeds to detect and count vehicles at each intersection and adjust the signal timings in real-time to optimize traffic flow. The authors used a multi-agent deep RL algorithm to train the system, where each intersection was treated as an independent agent. In this study, multi-agent deep reinforcement learning (DRL) is applied for the first time to real-time traffic optimization over several road crossings using just the raw pixel input from CCTV cameras. By enhancing traffic flow and decreasing the average amount of time a vehicle spends at an intersection, it is demonstrated that this set of traffic control agents significantly outperforms independently running adaptive signal control systems. In a scenario where each agent only has access to the partial state of the

traffic environment, they have shown that a centralized controller is capable of fostering a principled learning strategy between the signal control agents, leading to the positive emergence of cooperative behavior among them.The performance of the proposed system was evaluated using simulations and compared to a traditional fixed-time signal control system. The results showed that the proposed system was able to significantly reduce average wait times and improve traffic flow compared to the fixed-time system.

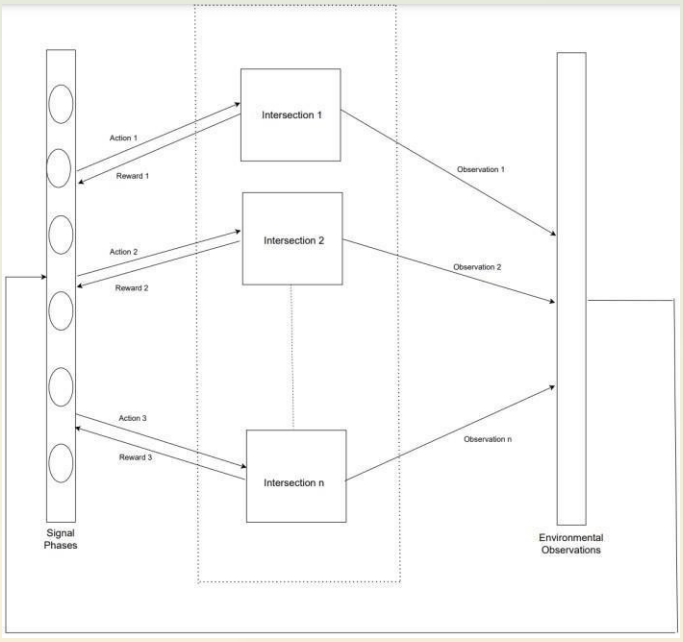

Figure 4: Flowchart for the reinforcement based system

1) Usage of YOLO and Correlation Filter for Vehicle Counting for Traffic Management System

In order to comprehend the flow of traffic and make judgments about traffic control, vehicle counting is a crucial component of traffic management. The current techniques for counting vehicles take a long time, require a lot of work, and are inaccurate. This method locates and recognises automobiles in real-time video footage by using the object detection algorithm YOLO, which is based on deep learning. Then, to precisely count the number of vehicles on the road, the Correlation Filter method is applied. It can be concluded that the YOLO and Correlation Filter algorithms can be used to automate vehicle counting in traffic control systems. The suggested approach works well for precisely counting automobiles and following their movements. Future research should concentrate on enhancing the algorithms' accuracy and integrating the approach with other traffic control systems.

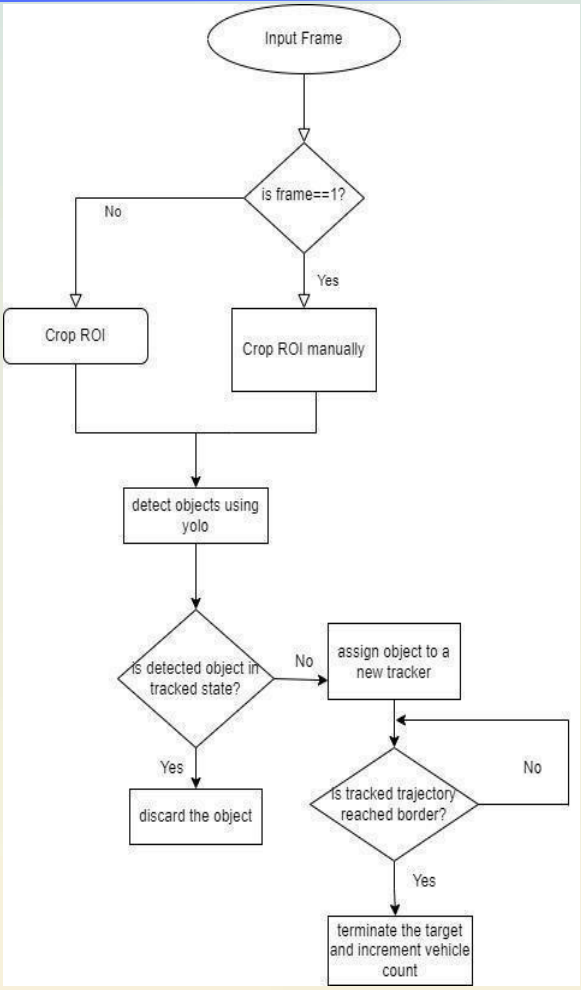

Figure 5: Flowchart of the proposed mechanism

Factors to be considered for developing the algorithm:

a. **Number of lanes**

b. Traffic density is calculated by using processing time of the algorithm similarly image need to be acquired which is decided by the green light duration.

c. For each class the total count of vehicles is maintained.

d. The above factors are used to calculate the traffic density.

e. Due to lag time added for each vehicle suffers during starting stage and the non-linear increase in lag is suffered by the vehicles which are at the back.

f. The average speed of each class of vehicle when the green light starts i.e. the average time required to cross the signal by each class of vehicle.

g. The minimum and maximum time limit for the green light duration -to prevent starvation.

4. WORKING OF THE ALGORITHM

When the algorithm is initially run, it sets the default time for the first signal of the first cycle and all following cycles' signals as well as the times for all other signals of the first cycle. The main thread manages the timer of the current signal, and a second thread is initiated to handle vehicle detection for each direction. The detecting threads take a snapshot of the next direction when the current signal's green light timer (or the subsequent green signal's red light timer) reaches zero seconds. The next green signal's timer is set when the result has been parsed. While the main thread is reducing the time remaining on the current green signal's timer, all of this is occurring in the background. As a result, there won't be any latency during the timer's assignment. The next signal turns green for the duration specified by the algorithm when the current signal's green timer reaches zero.

To improve traffic management, it is possible to specify the average amount of time it takes for each class of vehicle to cross an intersection based on the location, i.e., the region, the city, the locality, or even the intersection itself. For this, information from the relevant transportation authorities can be analyzed. The picture is taken when there are exactly zero seconds till the signal that will turn green next. This allows the system to process the image, count the number of vehicles in each class present in the image, and determine the green signal duration in a total of 5 seconds (equivalent to the value of the yellow signal timer). and set the red signal time for the following signal as well as the times for this signal appropriately. The average speeds of vehicles at startup and their acceleration times were utilized to determine the best green signal time based on the number of vehicles of each class at a signal, and from there, an estimate of the average time each class of vehicle takes to cross an intersection was found. The following formula is then used to get the green signal time.

where:

- NoOfVehicles of Class indicates the number of vehicles of each class of vehicle at the signal as detected by the vehicle detection module,
- Green Signal Time(GST)
- averageTimeOfClass is the average time the vehicles of that class take to cross an intersection,
- noOfLanes is the number of lanes at the intersection

Summary of the Algorithm

The vehicle detection module's traffic density data is used by the Signal Switching Algorithm to set the green signal timer and update other lights' red signal timers. Additionally, it cycles throughthe signals in accordance with the timers. The detection module's information on the vehicles that were picked up by the algorithm, as described in the preceding section, serves as its input. This data is presented in JSON format, with the confidence and coordinates serving as the valuesand the label of the object being detected as the key. To determine the total number of vehicles ineach class, this data is analyzed next. Following this, the signal's green signal time is determined and assigned, and the red signal times of other signals are calculated. To accommodate any number of signals at an intersection, the algorithm can be scaled up or down.

Simulation Module

To model actual traffic, Pygame was used to create a simulation from scratch. It helps with system visualization and comparison with the current static system. There are 4

$$GST = \frac{\sum_{vehicleClass} (NoOfVehicles_{vehicleClass} * AverageTime_{vehicleClass})}{(NoOfLanes + 1)}$$

traffic lights at a 4-way intersection there. Each signal has a timer on top that displays the amount of time until it changes from green to yellow, yellow to red, or red to green. The quantity of vehicles that have passed through the intersection is also shown next to each light. There are cars, bikes, buses, trucks, rickshaws, and other vehicles coming from all directions. Some of the vehicles in the rightmost lane turn to cross the intersection to increase the realism of the simulation. When avehicleis generated, random numbers are also used to determine whether or not it will turn. It also has a timer that shows how much time has passed since the simulation began.

5. RESULT: ATR VS EXISTING SYSTEM

In this study, we examined that Autonomous Traffic Regulator reduced travel times by up to 28%.

A study by the Indian Institute of Technology, Bombay examined that the traffic congestion in India cost the country an estimated $100 billion per year in lost productivity and fuel cost. So if our modelis implemented we can save the fuel cost by an estimated figure of $26 billion.

The below graphs help us in understanding the efficiency and effectiveness of our proposed systemvs. the traditional automatic traffic light control system that is already in use, by comparing the number of vehicles crossing the signal per second unit of time:

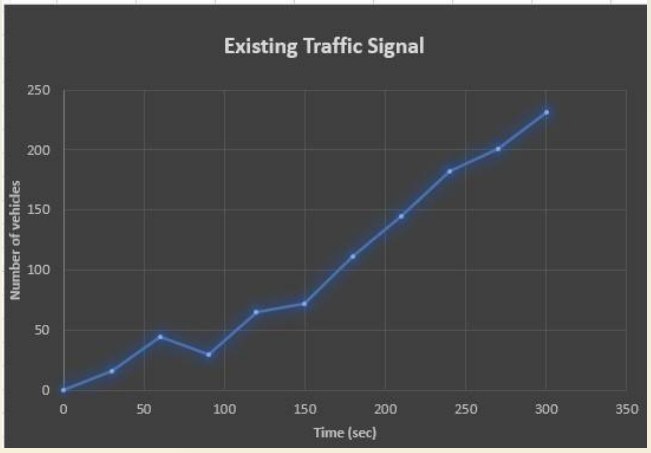

Figure-6: Indicating the vehicles crossing the signal per unit time inthe existing traffic system

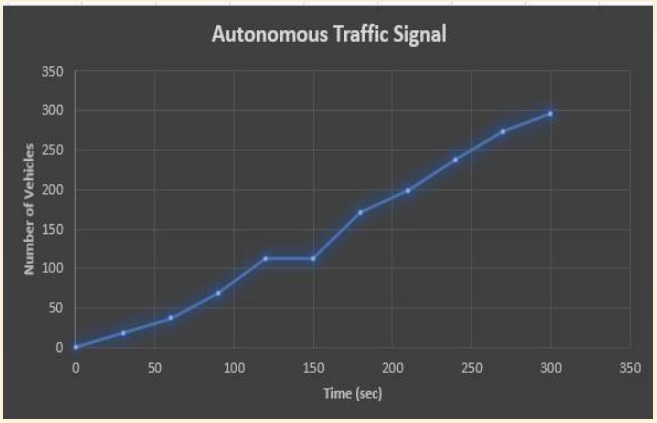

Figure-7: Indicating the vehicles crossing the signal per unit time in the propose

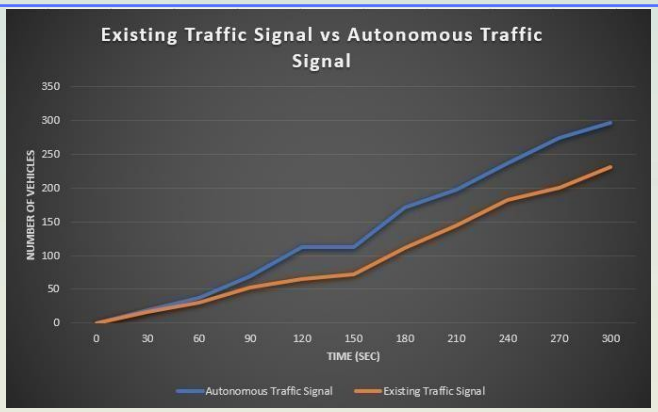

Figure-8: The efficiency Comparison of autonomous traffic control system v/s traffic control system which are traditional

6. APPLICATIONS

a. Traffic Control: Controlling traffic is one of the main uses for autonomous traffic regulators. Autonomous traffic regulators monitor and manage traffic flow using real-time data from sensors andalgorithms, which helps to ease congestion and improve traffic flow. As a result, the transportation system becomes more effective and less time and fuel are lost due to congestion.

b. Road Safety: By detecting and averting incidents on the road in real time, autonomous traffic regulators also improve road safety. For the purpose of preventing accidents, sensors and algorithmscan identify risky driving practices, poor road conditions, and seasonal patterns.

c. Environmental Sustainability: By lowering transportation-related pollutants, autonomous traffic controllers can help support environmental

sustainability. Autonomous traffic regulators can optimize traffic flow and ease congestionwhile cutting down on fuel consumption, which lowers emissions.

d. Emergency Response: Autonomous traffic controllers can help with emergency response initiatives. Autonomous traffic regulators can modify traffic lights and infrastructure in the case of a natural disaster, auto accident, or other emergency circumstance to enable a smooth flow of emergency vehicles and help the evacuation of impacted areas.

Autonomous traffic regulation using AI has the potential to greatly increase road safety and traffic flow. In order to improve traffic flow, AI algorithms can study traffic patterns, forecast congestion, and dynamically change signal timings. This may lead to shorter travel distances and less fuel use, as well as fewer pollution and accidents. Additionally, To improve road safety by detecting and responding to potential hazards, such as vehicles driving erratically or pedestrians crossing the street illegally AI-Powered Traffic management system can be implemented.. However, the implementation of AI-based traffic regulating systems also brings up significant ethical and privacy issues, in addition to technical difficulties such as ensuring the resilience, dependability, and explain ability of AI algorithms. In addition, thorough examination of a number of legal and regulatory issues, such as culpability in the event of accidents or system failures, is necessary for the implementation of autonomous traffic regulation using AI. A lot of money must be invested, and many parties, including communities, businesses, and governments, must work together to integrate AI-based systems with current infrastructure. Despite these difficulties, autonomous traffic management using AI offers a lot of potential for the future of mobility and transportation. Artificial intelligence (AI)- based technologies can offer real-time, data-driven solutions to enhance traffic flow and safety on our roads by utilizing the power of machine learning and computer vision. But it's crucial to make sure that the deployment of these technologies is carried out in a morally righteous, accountable, and open way, taking into account the potential risks and advantages for all stakeholders.

It is essential to make sure that autonomous traffic regulators are deployed in a way that is visible, accountable, and beneficial to society as a whole. Additionally, it's crucial to approach the deployment of autonomous traffic.

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(SCCTT-2023)

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