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Adaptive Traffic Light Management System for Urban Areas, Using Cameras, and Google Map Services

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***Abstract* - The research methodology involves the collection of data using CCTV cameras, and the Google Maps API to analyze traffic patterns and density at intersections. The system dynamically adjusts traffic light timings based on real-time traffic conditions, harnessing the power of the Google API for enhanced accuracy and efficiency. The ATLMS (Adaptive Traffic Light Management System) demonstrates significant improvements in traffic management by reducing waiting times, enhancing traffic flow, and minimizing delays at intersections. Notably, the system considers traffic density as a critical factor in traffic light timing adjustments, leading to optimized traffic movement. Additionally, the intelligent components facilitate efficient emergency vehicle prioritization and improve pedestrian safety through the implementation of smart crosswalk systems. The findings underscore the significance of ATLMS which integrate traffic density analysis, the Google API, emergency vehicle management, and pedestrian safety measures. The ATLMS offers a scalable solution for various intersection types and configurations, effectively addressing the unique traffic challenges of urban areas. By considering traffic density, incorporating accurate data from the Google API, prioritizing emergency vehicles, and enhancing pedestrian safety, the system provides a comprehensive solution for efficient traffic management. Future research endeavors may explore further enhancements and the integration of advanced technologies to meet the evolving traffic demands of urban areas.**

Keywords: Adaptive Traffic Light Management System, Urban Traffic Management, Google Map Data, Traffic Density, Google API, Emergency Vehicle Management, Pedestrian Safety, Microcontroller.

I. INTRODUCTION

The global vehicle population is expanding at an unprecedented rate, leading to a parallel increase in urban traffic congestion. Sri Lanka, like many other countries, experiences a skewed distribution of vehicle registration data, with a significant influx of approximately 30,000 new vehicles registered in July 2020 [1] [2].(Figure 1).

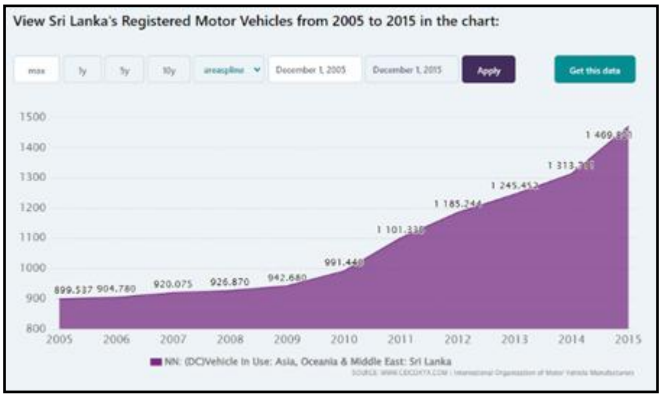

Figure 1 : Sri Lanka's Registered Motor Vehicles from 2005 to 2015

As a consequence, urban road traffic has surged, resulting in a multitude of problems such as traffic accidents, stress, and pollution. Cities worldwide are grappling with the impact of this rapid growth, with cities like Moscow witnessing an average of two and a half hours of daily traffic jams for city drivers [3]. Colombo, the capital city of Sri Lanka, faces its own traffic challenges, with average vehicle speeds restricted to around 10 km per hour [4].

The nature of city traffic is dynamic and exhibits significant variation throughout the day. Generally, traffic congestion increases during morning and evening rush hours, while weekends often witness a reduction in the number of vehicles within cities as people travel outside the urban areas. (Figure 2) provides a visual representation of the average annual daily traffic (AADT) distribution in a city over time [5].

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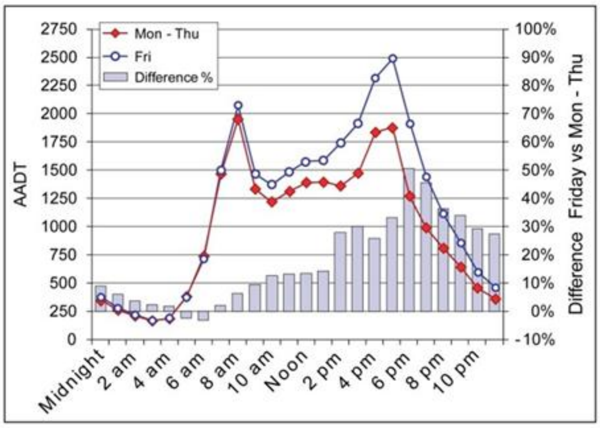

Figure 2 : Average annual daily traffic distribution in a city over time

Conventional traffic light systems, typically operated on predefined timers or logic, are ill-equipped to effectively control or minimize traffic flow considering these variations in real-time. In many instances, traffic lights are manually adjusted by police officers, a practice that is increasingly inadequate as city traffic continues to surge [6]. Developed countries have addressed this challenge through the implementation of automated lane changing systems [7]. These advanced systems open additional lanes in the direction with heavier traffic to alleviate congestion. However, the development and deployment of such sophisticated systems incur exorbitant costs, making them impractical for implementation in Sri Lankan cities. Therefore, this research proposes an alternative solution to dynamically control traffic lights based on real-time traffic density using a combination of CCTV cameras, Google Maps-based platforms, computer vision technologies, and Internet of Things (IoT) components.

The proposed system aims to analyze traffic conditions, improve travel times, efficiently handle emergency vehicles, and ensure pedestrian safety on the roads. By leveraging Google Maps API, computer vision technologies, and insights from CCTV cameras, the traffic light system can dynamically adjust its operation according to the identified traffic density. This adaptive approach offers a cost-effective and practical solution to the escalating traffic problems faced by cities in Developing countries like Sri Lanka.

II. LITERATURE REVIEW

A) Dynamic Counter Time Adjustment Based on Intersection Traffic Density Monitoring

The growth of the world's vehicle population has posed significant challenges in traffic management, particularly at intersections. Expensive infrastructure projects are often not feasible for developing countries to handle the increasing traffic. As a solution, adaptive traffic light control systems have emerged, which adjust the timing of traffic lights in real-time based on traffic flow. [8] These systems aim to improve traffic efficiency and reduce congestion. Traffic light controllers, managed by electronic devices, optimize traffic flow, enhance road safety, and minimize congestion by following pre-defined rules and signal timings. They receive inputs from sensors such as pressure sensors, cameras, and loop detectors to detect vehicles, bicycles, or pedestrians. Different intersection structures exist, including T-intersections, Y-intersections, cross intersections, five or more lane intersections, and roundabouts.

Traffic density, measured through manual or automated methods, is crucial for assessing traffic flow and determining necessary control measures.[8] While fixed-time traffic light controllers are commonly used, they lack adaptability to changing traffic patterns. Synchronizing traffic light controllers based on real-time data can lead to more efficient traffic flow. Data collection for dynamic adjustment includes vision-based (CCTV cameras) and sensor-based (ultrasonic, infrared, inductive loop) methods. Inductive loop sensors provide highly accurate data but can be costly, while infrared sensors count vehicles but may require multiple installations. [9] By addressing these aspects, this research aims to contribute to the development of efficient and adaptable traffic light control systems.

B) Enhancing adaptive traffic control efficiency with intelligent traffic density analysis using Google Maps

The quantification of gasoline consumption and time wasted due to traffic congestion remains a formidable challenge. Consequently, governments allocate significant resources to address this issue[2]. Developed nations have implemented adaptable road systems, capable of adjusting lane numbers based on traffic volume[3]. However, the implementation of such systems can be financially burdensome. Moreover, conventional traffic control systems have contributed to the escalating traffic problem.

To tackle these challenges, K.T.Y. Mahima and their team conducted a research project focused on a dynamic traffic light control system using Google Maps API and IoT. Their approach involved obtaining colour-coded traffic information 300 meters from traffic lights using a colour picker and calculating dynamic travel times for each direction[8]. Although their method proved time-consuming, our proposed system directly retrieves data from the Google Maps Matrix API. By storing this data at regular intervals and training a machine learning model on the resulting dataset, we achieve real-time prediction of travel times. This approach significantly enhances the accuracy and efficiency of the traffic control system while reducing the time-consuming for prediction.

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C) Prioritize emergency vehicles by synchronized dynamic traffic light systems

Traffic congestion not only affects regular road users but also hampers the timely response of emergency vehicles, such as ambulances and fire trucks, which are crucial in life-threatening situations. Studies have shown that traffic congestion can lead to delays in emergency vehicle response, resulting in potential loss of life and property damage [10]. In some cases, more than 20% of cardiac patients trapped in ambulances in traffic may die[10].

To tackle the complexities associated with emergency vehicle detection and prioritization, advanced technologies are necessary. Deep learning architectures, particularly deep convolutional neural networks (CNNs), have demonstrated remarkable capabilities in computer vision tasks, encompassing object detection and classification [11]. Among these architectures, the YOLO-V5 model has shown promise in real-time emergency vehicle detection using video footage [12]. By leveraging the capabilities of YOLO-V5, it becomes possible to enhance the detection and prioritization of emergency vehicles in traffic scenarios. The integration of advanced technologies like YOLO-V5 plays a crucial role in improving the efficiency and effectiveness of emergency vehicle management systems [13].

D) Developing a Computer Vision System for Detecting Visually Impaired Pedestrians and Hazard Identification

The implementation of a Smart Crosswalk System, particularly addressing the safety and priority of differently abled individuals, has gained significant attention in recent research. This literature review examines existing studies and findings related to smart crosswalk systems and their impact on pedestrian safety and accessibility, with a specific focus on accommodating the needs of differently abled individuals.

Several researchers have emphasized the importance of inclusive urban design for pedestrian safety and accessibility [1]. They highlight the potential benefits of smart technologies, such as intelligent sensors and adaptive signal control, in enhancing crosswalk safety for people with disabilities. Additionally, studies have discussed various technological approaches used in smart crosswalk systems, including the use of sensors, cameras, and advanced signal control mechanisms [2]. While these studies acknowledge the potential for smart crosswalk systems to improve pedestrian safety, they also emphasize the importance of inclusive design principles to ensure that the needs of differently abled individuals are met.

In terms of specific research studies, [3] proposed a pedestrian crossing assistance system that utilized computer vision techniques to identify and prioritize differently abled individuals. Their system utilized cameras to detect individuals with disabilities and adjusted signal timings accordingly to provide them with sufficient time to cross the road safely. Similarly, [4] conducted a study on the design and evaluation of an adaptive crosswalk system for individuals with visual impairments. They emphasized the use of intelligent sensors and communication technologies to facilitate safe and independent crossing for visually impaired pedestrians.

While the literature review reveals a growing interest in smart crosswalk systems and their potential to enhance pedestrian safety and accessibility, including for differently abled individuals, there is a need for further research in this area. Future studies should focus on developing and evaluating inclusive design solutions and technologies that cater to the specific needs of differently abled pedestrians in smart crosswalk systems.

The literature review demonstrates that smart crosswalk systems have the potential to significantly improve pedestrian safety and accessibility. By incorporating inclusive design principles and leveraging advanced technologies, such as computer vision and intelligent sensors, future smart crosswalk systems can provide personalized assistance and priority to ensure the safety of all pedestrians, including those with disabilities.

III. METHODOLOGY

The proposed traffic control system integrates four essential components to effectively manage traffic and enhance road safety. Firstly, it includes the analysis of vehicle density using CCTV camera video footage to optimize traffic flow. Secondly, it incorporates intelligent analysis of traffic density by integrating with Google Maps API Services, enabling real-time adjustments of traffic light timings based on live traffic information. The system also features a real-time emergency vehicle detection module that employs computer vision techniques to identify emergency vehicles in the traffic flow using CCTV video footage. Also dynamically changes traffic signals and synchronizes multiple traffic lights to prioritize emergency vehicles. Finally, the system focuses on enhancing pedestrian safety by utilizing computer vision technology to detect visually impaired pedestrians and potential hazards, thereby reducing the risk of accidents. Together, these components form a comprehensive traffic control system that improves traffic management efficiency, enhances pedestrian safety, and optimizes the handling of emergency vehicles.

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A) Dynamic Counter Time Adjustment Based on Intersection Traffic Density Monitoring

The system utilizes YOLOv5 object detection to identify traffic density at the intersection. CCTV cameras placed at the intersection capture video footage, with each lane having a dedicated camera. The captured footage is then broadcast to a cloud server via the HTTP protocol. The YOLO model was trained using a labeled dataset from Kaggle, which includes various vehicle classes from different regions. The dataset underwent preprocessing, and model training involved multiple YOLO architectures to improve accuracy in detecting vehicle count and density details.

The recorded video footage is analyzed using a trained YOLO model on a server, capable of analyzing live traffic videos. The specific area required to calculate vehicle details in each lane is defined. Simultaneously monitoring all lanes at the intersection allows for capturing information such as vehicle count, density, traffic length, and speed. (Figure 03) These data are then stored in a database. A developed algorithm utilizing scheduling techniques can be used to suggest traffic light counter times based on traffic density. The system defines a maximum counter time for each lane and repeatedly analyzes the density data stored in the database. This analysis helps determine the suggested counter time by considering the traffic density.

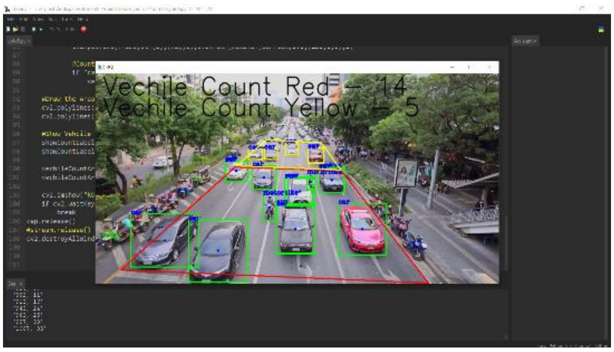

Figure 3 : Calculate vehicle details at the intersection

The traffic light synchronization algorithm coordinates light timings to create a smooth "green wave" for vehicles. A centralized control mechanism analyzes real-time traffic data from CCTV cameras, considering factors like density and lane occupancy to calculate optimal timings and reduce delays and congestion.

B) Enhancing adaptive traffic control efficiency with intelligent traffic density analysis using Google Maps

The methodology commences with the development of a traffic monitoring system using the Google Maps Matrix API. This system gathers traffic congestion information by specifying a point 400 meters away from the traffic light. (Figure 4) The collected data includes traffic duration, ratios, speeds, and vehicle counts, which are continuously stored at regular intervals. A comprehensive dataset is created, encompassing various time intervals, days, and traffic conditions to capture the diverse patterns accurately.

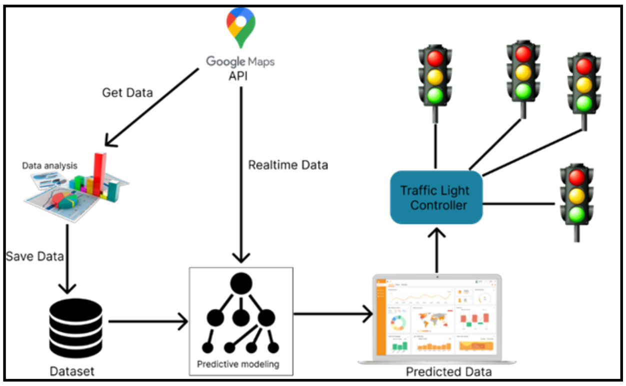

Figure 4 : Flow of the solution using Google Map

Next, machine learning algorithms, such as linear regression, decision tree, random forest, and support vector machine, are employed to develop a traffic count prediction model. These algorithms analyze the dataset, establishing relationships between input variables (traffic duration, ratios, speeds) and the target variable (traffic count). The model's performance is evaluated using training and testing sets, identifying the most suitable algorithm for real-time traffic count prediction. (Figure 4) shows the flow of the solution.

Figure 5 : Traffic condition monitor interface

Finally, the validated traffic count prediction model is integrated with the dynamic traffic light system. This integration incorporates IoT components, including sensors and communication devices, into the traffic light infrastructure. By considering real-time traffic count predictions, the system optimizes signal timings to improve traffic flow and reduce congestion. The integration enhances the accuracy and effectiveness of the dynamic traffic light system, leading to improved traffic management.

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C) Prioritize emergency vehicles by synchronized dynamic traffic light systems

Computer vision technologies, specifically the YOLOv5 object detection framework, accurately identify emergency vehicles in real time. Using that framework, yolov5l selects a specific model, runs it with a high number of epochs, and trains the emergency vehicle data more accurately to create a model that can accurately identify emergency vehicles. Data Labeling It contains vehicle object class e.g.-"Ambulance, fire truck, and police vehicle" and it contains text object data like "ambulance word", fire truck word". Both vehicle and special text labels of vehicles. Identifying emergency vehicles more accurately.

After correctly identifying the emergency vehicle, the next process is to set the system to work correctly based on the collected vehicle data such as speed, direction, and urgency. Calculates the speed of vehicles using the Deep short algorithm. The vehicle's direction defines using multiple ROI line draws for each lane in the junction. When an emergency vehicle is detected, the traffic light in its path is immediately changed to green using an algorithm to allow the vehicle to pass.

Furthermore, the system synchronizes several traffic lights along the route of the emergency vehicle, allowing it to bypass traffic lights without any delay. The system calculates the time it takes for the vehicle to reach the next traffic junction based on its speed and the distance between the two junctions.

Arrival Time to the next Traffic Light = (DBTL / EVS)

Where:

ATNTL - Arrival Time to the next Traffic Light (h)
DBTL - Distance between two Traffic Lights (km)
EVS - Emergency Vehicle Speed (km/h-1)

Before the arrival of the emergency vehicle, if the lane is already congested, the traffic lights are dynamically changed to ease the traffic and facilitate the passage of the emergency vehicle.

To support the visualization and management of real-time updates on the location and status of emergency vehicles, we are developing a web dashboard using MERN stack technology, so that traffic management officials can analyze real-time data and decide what is important to this system. Benefits If there are significant benefits, the system can be extended to other areas.

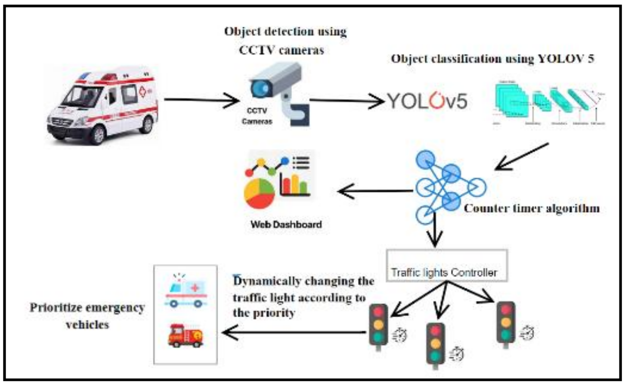

Figure 6 : Diagram of emergency vehicle detection

D) Developing a Computer Vision System for Detecting Visually Impaired Pedestrians and Hazard Identification

The methodology begins with the collection of data using high-resolution cameras installed at crosswalks. The cameras capture real-time video footage of pedestrian activity at the intersections. Special focus is given to capturing the movements and characteristics of differently abled pedestrians. A diverse dataset is created by extracting frames from video footage that specifically showcases differently abled individuals crossing the road. The dataset includes various types of disabilities, such as individuals using wheelchairs, crutches, or walking with assistive devices. Annotations are added to label the differently abled pedestrians in the dataset. Image Recognition Algorithms: State-of-the-art image recognition algorithms are employed to analyze the dataset and develop models that can accurately identify and track differently abled pedestrians. These algorithms utilize deep learning techniques, such as convolutional neural networks (CNNs), to learn and recognize patterns and features that distinguish differently abled individuals from others. The prepared dataset is divided into training and validation sets. The image recognition algorithms are trained on the training set using the labelled data. The models undergo multiple training iterations to optimize their performance and ensure accurate identification of differently abled pedestrians.

The validation set is used to evaluate the models' performance and make necessary adjustments. Real-Time Processing: The trained models are integrated into the Smart Crosswalk System, enabling real-time processing of video footage from high-resolution cameras. The system continuously analyses the live video stream to identify and track differently abled pedestrians at the crosswalks. Once a differently abled pedestrian is identified, the Smart Crosswalk System communicates with the Adaptive Traffic Light Management System (ATLMS). This communication ensures that the traffic lights provide extended crossing times or temporarily halt vehicular traffic to prioritize the safe passage

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of the identified individual. The performance of the Smart Crosswalk System is evaluated through field tests and simulations. Different scenarios and conditions are considered to assess the system's accuracy, reliability, and response time in identifying differently abled pedestrians and coordinating with the traffic lights.

IV. RESULTS AND DISCUSSION

The objective of the dynamic traffic light management system is to reduce traffic congestion and efficiently manage traffic flow in urban areas. The system comprises four interconnected components, which work together in a collaborative and interactive manner to achieve these goals.

In the initial stage of the research, a prototype of the dynamic traffic light management system is tested at a 4-way intersection. The testing process involves four main stages. The first stage focuses on monitoring traffic details, utilizing two methods: live traffic data monitoring through CCTV cameras and traffic data monitoring using the Google Maps API. These methods are employed to determine the most accurate data in various traffic situations.

The CCTV video footage is analyzed using the YOLOv5 model to extract vehicle details. In a 4-way intersection, four CCTV cameras are placed on each lane, and the model stores traffic data in real-time. The system interacts with the model through the Django Python server, allowing for seamless integration. Figure xxx illustrates a sample output of the vehicle object detection process.

In the second method, traffic data is obtained using the Google Map API service, including distance, duration, and duration in traffic. This data is filtered by specific areas, stored in the database, and utilized by a machine learning algorithm to make predictions on average speed and traffic ratio. These predictions provide insights into traffic queues and congestion levels.

Another component of the system is dedicated to identifying emergency vehicles and giving them priority at the intersection. CCTV cameras installed at the intersection detect emergency vehicles and relay this information to the control system. A YOLO model is employed to identify emergency vehicles, and a priority algorithm adjusts the traffic light status accordingly, providing a "green light" for the lane in which the emergency vehicle is approaching.

Another component focuses on identifying pedestrians and disabled pedestrians to adjust the counter time at pedestrian crossings based on pedestrian density. The system uses a YOLO model to detect pedestrians, especially disabled pedestrians, prioritizing their safe passage. By identifying pedestrians nearest to the crossing, the system can optimize the counter time. These data are then processed by the controlling system.

To test the system before integration with the actual traffic light system, desktop applications were utilized. Pre-recorded traffic video footage was employed to assess object detection using CCTV camera footage. The footage was uploaded to a cloud stream service, and live video footage was used to evaluate the YOLO models. Data collection through the Google Map API was conducted by obtaining a Google API subscription, following standard procedures.

The SUMO (Simulation of Urban Mobility) tool is employed to generate a virtual traffic environment with various parameters. This virtual environment allows for testing the counter time algorithm, emergency vehicle handling algorithm, pedestrian handling algorithm, and synchronization algorithm using the provided data.

A prototype was developed using physical components to showcase the connectivity of the traffic light controlling system to the internet. Arduino was utilized to interconnect various components, and the prototypes were connected to the controlling system through the HTTP connection method using models.

A web management system allows authorized users to monitor the traffic light system, analyze statistical information, and control certain functions manually. The authors aim to integrate the system with the actual traffic light system in the future, subject to permission from relevant authorities, to enable further advancements and operational processes.

Figure 7 : Monitor vehicles at the intersection

V. CONCLUSION AND FUTURE WORK

The research project aimed to enhance a traffic control management system through the utilization of CCTV cameras, intelligent analysis of traffic density using Google Maps matrix traffic API service, and computer vision technology. Our system successfully adjusted and synchronized traffic

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light systems based on the analysis of vehicle density data, resulting in reduced congestion and improved traffic control efficiency. Additionally, the utilization of Google Maps API data provided valuable insights into traffic patterns, enabling us to further analyze and optimize the flow of vehicles. The real-time analysis of traffic density has enabled optimized traffic flow and reduced travel times for road users. Furthermore, our study has emphasized the importance of accurately identifying and prioritizing emergency vehicles, such as ambulances, fire trucks, and police vehicles, through dynamic adjustments of traffic light patterns. This has improved emergency response times and facilitated the smooth navigation of emergency vehicles through congested areas. Furthermore, our implementation of computer vision algorithms has enhanced pedestrian safety by detecting blind pedestrians and potential hazards, thereby contributing to a safer road environment. Overall, our research lays a solid foundation for the integration of technology and data analysis in traffic control systems, leading to improved traffic flow, efficient emergency response, and enhanced safety for all road users.

In future work, several areas can be targeted for the improvement and expansion of the proposed traffic control system. Firstly, enhancements can be made to the accuracy and efficiency of vehicle detection algorithms through computer vision technologies. This will ensure more precise detection and tracking of vehicles, leading to improved traffic density analysis and adjustments of traffic light patterns. In addition, currently, this system is proposed as a pilot project for the frequent emergency vehicle traveling areas traffic light systems (E.g.- ambulances - near hospital areas). By evaluating the feasibility and cost-benefit of the project, this system can be improved for other areas in the future, and the system can be used for efficient traffic management, optimal handling of emergency vehicles, and enhanced overall transportation systems. For that, the currently used technologies can be improved to be more accurate and related to system efficiency.

REFERENCES

[1] CEIC, "Sri Lanka Motor Vehicle New Registration," 1 10 2020. [Online]. Available: https://www.ceicdata.com/en/sri-lanka/newregistration-of-motor-vehicles/motor-vehicle-newregistration#:~:text=Sri%20Lanka's%20Motor%20Vehicle%20New,29%2C176.000%20Unit%20for%20Jul%202020.

[2] S. Ismail, "Traffic Speed down to crawl not just in the city," 22 07 2018. [Online]. Available: https://www.pressreader.com/srilanka/sunday-times-sri-lanka/20180722/281767040010820.

[3] M. Ben Ahmed et al., "A Statistical Multiplexing Method for Traffic SignalTiming Optimization in Smart Cities," TELKOMNIKA Indonesian Journal of Electrical Engineering, pp. 107-113, 2015.

[4] Central Bank of Sri Lanka, "Sri Lanka Motor Vehicle New Registration," 5 9 2020. [Online]. Available: https://www.ceicdata.com/en/sri-lanka/new-registration-of-motorvehicles/motor-vehicle-new-registration.

[5] PLOS, "Mobile Phones in a Traffic Flow: A Geographical Perspective to Evening Rush Hour Traffic Analysis Using Call Detail Records," 5 9 2020. [Online]. Available: https://journals.plos.org/plosone/article/figure?id=10.1371/journal.pone.0049171.g004.

[6] Cristina Olaverri-Monreal, Javier Errea-Moreno, Alberto Díaz-Álvarez, "Implementation and Evaluation of a Traffic Light Assistance System Based on V2I Communication in a Simulation Framework", Journal of Advanced Transportation, vol. 2018, Article ID 3785957, 11 pages, 2018. https://doi.org/10.1155/2018/3785957.

[7] https://rno-its.piarc.org/en/planning-and-deployment-its-futures-intelligence-transport/vision-automated-highways

[8] K. T. Y. Mahima, R. A. B. Abeygunawardana and T. N. D. S. Ginige, "Dynamic Traffic Light Controlling System Using Google Maps and IoT," 2020 From Innovation to Impact (FITI), Colombo, Sri Lanka, 2020, pp. 1-5, doi: 10.1109/FITI52050.2020.9424870.

[9] L. Bhaskar, A. Sahai, D. Sinha, G. Varshney and T. Jain, "Intelligent traffic light controller using inductive loops for vehicle detection," 2015 1st International Conference on Next Generation Computing Technologies (NGCT), Dehradun, India, 2015, pp. 518-522, doi: 10.1109/NGCT.2015.7375173.

[10] S. Roy and M. S. Rahman, "Emergency Vehicle Detection on Heavy Traffic Road from CCTV Footage Using Deep Convolutional Neural Network," 2019 International Conference on Electrical, Computer and Communication Engineering (ECCE), Cox'sBazar, Bangladesh, 2019, pp. 1-6, doi: 10.1109/ECACE.2019.8679295.

[11] V. S. Raj, J. V. M. Sai, N. A. L. Yogesh, S. B. K. Preetha and L. R, "Smart Traffic Control for Emergency Vehicles Prioritization using Video and Audio Processing," 2022 6th International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2022, pp. 1588-1593, doi: 10.1109/ICICCS53718.2022.9788119.

[12] S. Nagarathinam, R. Dhivyapriya, C. Pavithra, M. Harshapradha and R. Saralesh Kumar, "Junction

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https://doi.org/10.47001/IRJIET/2023.710026

Monitoring System for Emergency Vehicles and Density control Using Image processing," 2021 International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA), Coimbatore, India, 2021, pp. 1-6, doi: 10.1109/ICAECA52838.2021.9675759.

[13] S. Sathruhan, O. K. Herath, T. Sivakumar and A. Thibbotuwawa, "Emergency Vehicle Detection using Vehicle Sound Classification: A Deep Learning Approach," 2022 6th SLAAI International Conference on Artificial Intelligence (SLAAI-ICAI), Colombo, Sri Lanka, 2022, pp. 1-6, doi: 10.1109/SLAAI-ICAI56923.2022.10002605.

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