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SMART TRAFFIC MANAGEMENT USING IOT

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Abstract: Smart Traffic Management is designed to overcome the limitations of traditional fixed-timing traffic control methods. By employing a dynamic approach based on real-time vehicle density, the system optimizes traffic flow and reduces congestion, particularly during peak hours. Integrating advanced sensors and cameras strategically allows for accurate monitoring and comprehensive data analysis, enabling dynamic adjustment of traffic light timings. This responsive system not only enhances efficiency but also prioritizes emergency vehicle passage by seamlessly altering signal timings. The integration of camera technology provides real-time monitoring for informed decision-making, promising a more seamless commuting experience and improved emergency response in urban areas.

Keywords - Smart Traffic Management, Congestion, Camera-based traffic monitoring.

I. INTRODUCTION

Contemporary urban landscapes grapple with the persistent challenge of traffic congestion, a critical concern that significantly impacts the efficiency of transportation systems and the overall quality of urban life. Traditional fixed-timing traffic control systems, although fundamental to traffic management, often fall short of addressing the dynamic and fluctuating nature of real-time traffic conditions. As cities continue to expand and urban populations grow, the need for innovative solutions to mitigate congestion and enhance commuting experiences becomes increasingly imperative.

In response to these challenges, this research proposes an intelligent traffic-controlling system that offers a transformative and dynamic approach based on real-time monitoring of vehicle density. This innovative system aims to revolutionize traffic management by dynamically adjusting traffic light timings in direct response to the actual density of vehicles on the road. Unlike static systems constrained by predetermined schedules, this adaptive approach holds the promise of optimizing traffic flow and alleviating congestion, particularly during peak hours of heavy traffic.

Furthermore, the integration of advanced sensor and camera technologies enhances the accuracy and responsiveness of the system, ensuring a comprehensive understanding of traffic conditions. By leveraging these cutting-edge technologies, our proposed intelligent traffic-controlling system seeks not only to address the inefficiencies of current traffic control methods but also to enhance the overall commuting experience, contributing to the development of more sustainable and resilient urban infrastructures.

II. OBJECTIVES

The Smart traffic management system aims to tackle persistent traffic congestion challenges at road junctions, prioritizing smooth and safe vehicular flow. Through dynamic control mechanisms, the system recognizes variations in traffic patterns, especially during peak hours, proactively addressing congestion issues. Integrating microcontroller technology and strategically placed IR sensors, the system intelligently adapts signal timings in real-time based on vehicle density, minimizing traffic jams and optimizing road clearance. Additionally, the incorporation of camera technology allows for continuous monitoring of traffic flow, providing a comprehensive understanding of dynamic conditions at road junctions. The system extends support to emergency services by facilitating the passage of emergency vehicles during congestion, ensuring swift response times, and enhancing overall emergency management. Beyond routine traffic control, the system takes a holistic approach to enhance overall traffic management efficiency, contributing to a smarter, safer, and more responsive urban transportation network. By addressing congestion and optimizing traffic flow, the system significantly improves the commuter experience, marking a substantial stride toward creating a more efficient and commuter-friendly urban transportation network.

III. METHODOLOGY

Part 1: YOLOv3 Vehicle Detection System

Initialization: Load the pre-trained YOLOv3 model with its corresponding weights and configuration files. The model classifies objects detected in the video feed. **Vehicle Detection:** Every frame captured from the video is processed by the YOLOv3 model to detect vehicles. For every 25 frames (adjustable based on camera FPS), the system counts the number of vehicles detected.

Data Handling: The vehicle count is then used for further processing or to adjust traffic signals if integrated with traffic management systems. This count can also be sent via serial communication for external use.

Part 2: IR Sensor-Based Traffic Density Measurement

Setup: Install IR sensors at various points on each lane to detect the presence and density of vehicles.

Density Calculation: The system continuously monitors the output from IR sensors to estimate vehicle density. A higher frequency of interruptions in the IR beam indicates higher traffic density.

Signal Timing Adjustment: Based on the traffic density data from IR sensors, the traffic light system adjusts the green light duration for each lane to ensure smooth traffic flow.

Part 3: NFC-Based Emergency Vehicle Priority

NFC Integration: Equip emergency vehicles with NFC cards/tags that can be detected by readers installed at traffic signals.

Priority Access: When an NFC reader detects a tag from an emergency vehicle, the system temporarily overrides normal operation to provide immediate green signal access to that vehicle.

System Reset: After the emergency vehicle passes, the system returns to a normal operation based on vehicle counts and IR sensor data.

Part 4: System Integration and Testing

Integration: Combine the outputs of the YOLOv3 system, IR sensors, and NFC reader data to control traffic lights intelligently.

Testing: Test the system under various traffic conditions to ensure it operates reliably and efficiently.

Optimization: Fine-tune the system based on test results to handle different scenarios like peak traffic hours, emergencies, and low-traffic conditions.

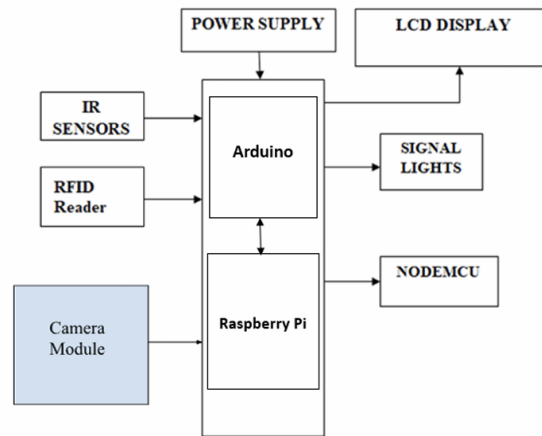


Figure 1: System Architecture

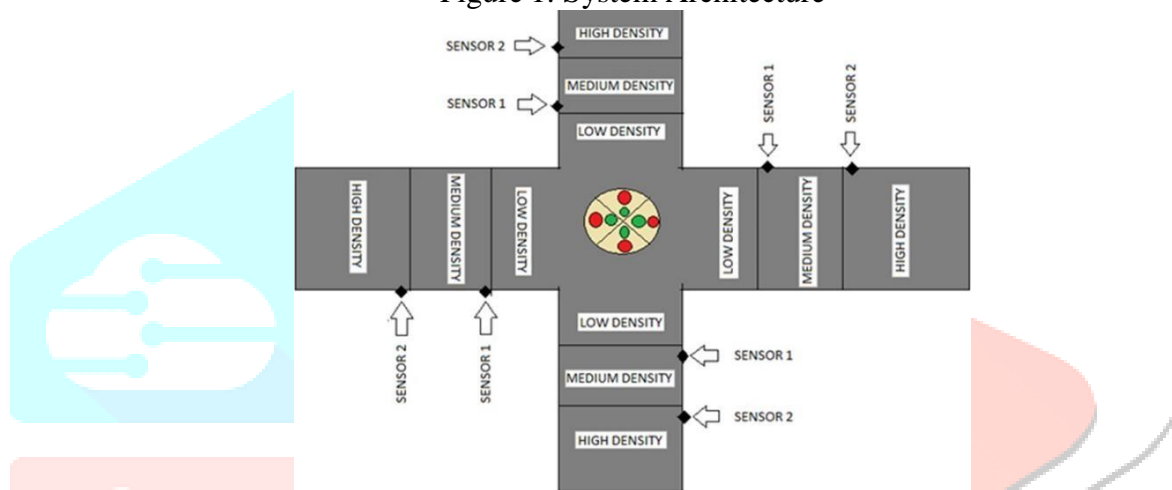


Figure 2: Traffic Density

LITERATURE SURVEY

1) Sabeen Javaid, Ali Sufian, Saima Pervaiz, Mehak Tanveer, "Smart Traffic Management System Using Internet of Things," -2018

The methodology employed in this research utilizes a hybrid approach that combines centralized and decentralized systems, leveraging traffic density data from cameras and sensors. Advanced AI algorithms are employed for accurate traffic prediction, while RFID technology is utilized for emergency vehicle prioritization. Additionally, the system incorporates smoke sensors for fire detection, enhancing overall safety measures. Through extensive observations, the system has been found to effectively address traffic congestion in metropolitan cities, significantly improving traffic signal management through the utilization of real-time data. Its primary objective is to support authorities in efficient traffic planning and management. The results of this research include the development of a functional prototype showcasing the system's effectiveness in optimizing traffic flow and seamlessly connecting rescue departments during emergencies. Furthermore, the system provides graphical data representation, aiding authorities in informed planning and decision-making processes.

2) Md. Imran Uddin, Md. Shahriar Alamgir, Md. Mahabubur Rahman, Muhammed Shahnewaz Bhuiyan and Md Asif Moral, "AI Traffic Control System Based on Deepstream and IoT Using NVIDIA Jetson Nano", 2021.

In the study by Md. Imran Uddin et al. titled "AI Traffic Control System Based on Deep Stream and IoT Using NVIDIA Jetson Nano" (2021), the methodology incorporates advanced technologies such as NVIDIA Jetson Nano for AI and machine learning tasks, Pi cameras for real-time traffic monitoring and license plate capture, SSD (Single Shot Multibox Detector) for object detection, and MQTT protocol for efficient communication and alerts.

The key observations highlight the system's effectiveness in addressing traffic congestion in megacities, its ability to detect traffic violations and notify law enforcement, and its integration of traffic light management based on real-time vehicle density. The results demonstrate a remarkable 97% success rate in traffic congestion management and a 90% success rate in image processing for detection techniques. Future enhancements include integrating a server and cloud-based database for enhanced data storage and scalability of traffic management solutions.

3) Mansoor Akhtar, Ali Ramzan, Muhammad Raffeh, Sohaib Aslam, Fakhar ul Zaman, Faisal Usman, "Development of Congestion Level Based Dynamic Traffic Management System Using IoT," -2020.

The methodology employed in this research utilizes ultrasonic sensors for measuring traffic congestion, adopting a phased approach encompassing simulation, IoT system development, and hardware implementation. The system architecture involves the integration of ESP 32 Wi-Fi controller, Raspberry Pi, and Node-Red software for seamless data processing and communication. Through focused observations on urban traffic congestion issues, the research aims to enhance traffic light control by leveraging real-time congestion data and considering various congestion levels for efficient traffic light regulation.

The results of this study include the successful development and testing of a real-time traffic management prototype, demonstrating effective traffic regulation based on congestion levels. The research also suggests future enhancements such as integrating emergency vehicle prioritization and AI technologies to further improve traffic management capabilities.

4) Motaz Amer, Rana Maher, "PV/IoT based Smart Traffic Management System," -2022.

The methodology adopted in this research involves the integration of solar power (PV) with IoT for traffic management, leveraging cameras for traffic detection, Raspberry Pi for data processing, and cloud services for seamless connectivity. System simulations are conducted using MATLAB Simulink and Any Logic software to evaluate system performance and efficiency.

Through targeted observations of traffic congestion issues in urban areas, the research focuses on reducing fuel consumption and enhancing traffic flow efficiency. The emphasis lies on real-time adjustment of traffic signals based on congestion data, aiming to optimize traffic management in dynamic environments.

The results of the study showcase the system's capability in efficiently managing traffic, with simulations demonstrating potential reductions in fuel consumption and improvements in traffic flow. Furthermore, the research suggests additional benefits such as enhanced safety, reduced emissions, and cost savings, highlighting the holistic advantages of implementing solar-powered IoT solutions for traffic management.

5) Shamitha.C, S.Radhika, Malathy K, S. Ranjith, N.Sasirekha, "An intelligent IoT Enabled Traffic queue handling System Using Machine Learning Algorithm," 2022.

The methodology employed in this study revolves around the implementation of IoT and Machine Learning for Intelligent Traffic Management (ITM). The research utilizes a combination of sensors, actuators, and IoT devices to collect and process real-time traffic data. An integral part of the system is the integration of a machine-learning-based DBSCAN clustering algorithm for anomaly detection, enabling the identification of irregular traffic patterns.

One of the key observations of this research is its focus on reducing traffic congestion and improving route efficiency. The study emphasizes the critical role of real-time data in effectively managing traffic flow, recognizing the challenges faced by current traffic management systems in handling congestion and accidents.

The results of the study showcase significant improvements in traffic management compared to traditional methods. The system demonstrates the ability to adjust traffic signals dynamically based on real-time traffic flow, leading to reduced traffic jams, fewer traffic fatalities, and an overall enhanced route experience. The efficiency of the system is validated through rigorous MATLAB simulations and testing across various traffic scenarios, highlighting its potential impact on improving urban traffic management.

6) Paul Jasmine Rani. L, Khoushik Kumar. M, Naresh. K. S, Vignesh. S, "Dynamic Traffic Management System using Infrared (IR) and Internet of Things (IoT)," 2017 Third International Conference on Science

Technology Engineering & Management (ICONSTEM).

This project is centred around the dynamic management of traffic using a combination of IoT, IR sensors, and Image Processing technologies. Its implementation includes key components such as traffic lights, IR sensors for vehicle detection, a Wi-Fi transmitter for data transmission, and a Raspberry Pi microcontroller for processing. The system's core functionality involves the detection of vehicle presence by IR sensors, which then transmit this data via Wi-Fi to the Raspberry Pi. The Raspberry Pi dynamically adjusts traffic signal timings based on real-time traffic data, thereby optimizing traffic flow. Additionally, the system provides real-time traffic updates to mobile devices, ensuring commuters stay informed about traffic conditions. Through this approach, the project aims to address the limitations of static traffic management systems that often struggle to adapt to fluctuating traffic densities. By dynamically adjusting traffic signal timings based on actual traffic conditions, the project seeks to reduce congestion and improve overall traffic efficiency, particularly at busy junctions. The integration of cloud-based data storage further enhances the system's capabilities, allowing for centralized management of traffic status information accessible via mobile devices, and contributing to a more efficient and responsive traffic management system.

7) Arash Farahdel, Seyed Shahim Vedaiei, Khan Wahid, "An IoT Based Traffic Management System Using Drone and AI," 2022 14th International Conference on Computational Intelligence and Communication Networks (CICN).

This project presents an innovative approach to traffic management through the integration of IoT, drones (UAVs), and AI technology. Drones equipped with high-definition cameras capture real-time traffic videos over highways, while a frame selection algorithm optimizes data transmission efficiency, reducing bandwidth and power consumption. An AI-based object detection algorithm on a cloud server accurately detects vehicles, enabling real-time traffic flow analysis. The system's decision-making algorithm further enhances traffic control actions. This methodology aims to address traffic congestion issues and improve traffic management in smart cities by leveraging UAVs, IoT, and AI for dynamic and efficient traffic monitoring. The project's focus on reducing video frame size for efficient transmission while maintaining image quality underscores its commitment to effective traffic data analysis. Results indicate successful bandwidth reduction with acceptable video quality, high accuracy in vehicle detection using AI, and promising capabilities in managing traffic flow and identifying congestion in real time. These outcomes suggest the potential of this system to significantly enhance overall traffic management, potentially reducing congestion and improving city traffic dynamics.

8) Abdullahi Chowdhury, "Priority Based and Secured Traffic Management System for Emergency Vehicle using IoT," Federation University Australia.

The study introduces an Intelligent Traffic System (ITS) with a focus on prioritizing emergency vehicles based on incident types, integrating IoT technology for enhanced efficiency. A key feature is the Emergency Priority Code System (EPCS) that dynamically manages traffic signals, taking into account the type of emergency to facilitate smoother passage for emergency vehicles. Moreover, the system includes a robust mechanism to detect and respond to traffic signal hacking, bolstering overall security. Simulation of Urban Mobility (SUMO) software was utilized for comprehensive testing and evaluation.

The research underscores the critical need for efficient traffic management, especially in urban areas, to ensure clear pathways for emergency vehicles. It highlights the limitations of current traffic systems in effectively handling emergency vehicle prioritization and vulnerabilities to hacking attempts. The proposed system addresses these challenges by considering various emergency scenarios and assigning priority levels to emergency vehicles accordingly.

Simulation results reveal a significant improvement in travel time for emergency vehicles, meeting the standards set by the Department of Treasury and Finances Budget and Financial Management Guidance (BFMG). Additionally, the system demonstrates its capability to effectively handle traffic signal hacking incidents, ensuring reliable and swift clearance for emergency vehicles. Compared to existing traffic management systems, the proposed ITS exhibits superior performance in reducing congestion and ensuring timely responses for emergency vehicles, marking a significant advancement in urban traffic management.

9) Wania Tahir, Dr. Raja Asif Wagan, Dr. Bushra Naeem, "Intelligent Traffic Handling System Using Point Tracker Algorithm," Balochistan University of Information Technology, Engineering, and Management Sciences, Quetta, Balochistan, 2021.

The study introduces an intelligent traffic handling system leveraging the Point Tracker Algorithm, which encompasses vehicle detection, tracking, and prioritization based on size, type, and emergency situations. The methodology enhances the Point Tracker Algorithm to include emergency detection and route planning for vehicles in case of accidents or road blockages. The system categorizes vehicles and non-vehicles, employing Gaussian smoothing for image pre-processing and the Kanade-Lucas-Tomasi (KLT) feature tracker for vehicle detection.

The research highlights the escalating issue of traffic congestion in urban areas and emphasizes the necessity for efficient traffic management systems. The proposed system targets intelligent detection and prioritization of vehicles to streamline traffic flow and effectively address emergencies. It aims to enhance traffic management by categorizing vehicles based on size, type, and emergency situations, providing priority accordingly.

Results indicate that the Point Tracker Algorithm achieves good accuracy in vehicle detection and classification. The system successfully detects and categorizes vehicles across various scenarios, showcasing its potential in real-time traffic management. The algorithm's effective prioritization of vehicles suggests its applicability in intelligent traffic handling, contributing towards the development of smart city infrastructures.

10) Anamika Larhgotra, Rakesh Kumar, Meenu Gupta, "Traffic Monitoring and Management System for Congestion Control using IoT and AI," Chandigarh University, Gharuan, Punjab, India, 2022.

The study introduces a sophisticated traffic monitoring and management system that integrates Semantic Web Techniques (SWT), the Internet of Things (IoT), and Artificial Intelligence (AI) to tackle traffic congestion effectively. This system incorporates intelligent road traffic planning and routing strategies aimed at optimizing traffic flow in urban areas. To evaluate its efficacy, a sample dataset of 9,792 vehicles from the Kaggle repository was analysed, providing insights into the system's performance.

The research underscores the pressing challenges posed by increasing vehicle density in urban environments and emphasizes the urgent need for smart mobility solutions within the framework of the smart city vision. It recognizes the multifaceted impact of traffic congestion, encompassing aspects such as time, cost, social well-being, and economic productivity. Furthermore, the study delves into a comprehensive review of existing models and methodologies for traffic management, contributing valuable insights into current practices and future directions.

The results of the study reveal an impressive efficiency rate of over 90% in managing and controlling traffic congestion using the proposed system. Leveraging AI and IoT technologies, the system showcases significant potential in reducing traffic jams and enhancing overall traffic management capabilities. Ultimately, the research concludes that a well-implemented traffic monitoring and management system can substantially alleviate urban commuting challenges, paving the way for more sustainable and efficient urban mobility solutions.

11) M P Mohandass, Kaliraj I, Maareeswari R, Vimalraj R, "IoT Based Traffic Management System for Emergency Vehicles," KIT-Kalaignarkaranidhi Institute of Technology, Coimbatore, India, 2023.

The study focused on integrating ambulances and traffic lights using various embedded systems, including RF transmitters and receivers, alongside IoT technologies. This integration resulted in a system designed to prioritize emergency vehicles at traffic intersections, where RF signals are used to identify these vehicles. A Decision Support System complements this setup by aiding in the efficient clearance of traffic in the path of emergency vehicles.

The research observed that traffic congestion, especially in urban areas, leads to significant delays and potential hazards during emergency situations. Existing traffic systems often lack coordination, overlooking critical factors such as adjacent traffic lights, diverse traffic flows, and the necessity to prioritize emergency vehicle passage. The proposed system addresses these challenges by dynamically managing traffic lights to reduce congestion and

effectively prioritize emergency vehicles.

The results of the implementation were promising, showcasing significant improvements in managing traffic flow for emergency vehicles. The system successfully reduced delays for these vehicles by clearing their path efficiently at intersections. The integration of IoT and RF technology proved to be an effective solution for identifying and prioritizing emergency vehicles, particularly in congested traffic scenarios, contributing to enhanced emergency response capabilities in urban environments.

12) Satbir Singh, Baldev Singh, Ramandeep Baljit Singh, Amitava Das, "Automatic Vehicle Counting for IoT-based Smart Traffic Management System for Indian Urban Settings," CSIR-CSIO, Chandigarh, India, 2019.

The study proposed an IoT-based framework for efficient road traffic management in urban Indian settings, particularly focusing on Chandigarh. It utilized image processing techniques and IoT to continuously relay vehicle counts to a central control station. The system, comprising a camera, Raspberry Pi, and OpenCV software, accurately counted vehicles in real-time and transmitted this data for better traffic management. Results showed that the system effectively managed traffic, offering a cost-effective solution suitable for urban Indian environments.

13) Bandi Narasimha Rao, Kondepudi Prudhvi Raj, Modela Balakrishna, Guniseti Ranganadh, Reddy Sudheer, Sayyad Naeem Ahmed, Rajala Govardhan Reddy, "Smart Traffic Management System using IoT," National Institute of Technology Warangal, India, Rajiv Gandhi University of Knowledge Technologies Nuzvid, India, 2022.)

The study developed a smart traffic management system using IoT to address traffic congestion issues. It employed infrared sensors to count vehicle density and control traffic signals through an ESP8266-based Node MCU, with data processing and control conducted in a central cloud system. The system integrated seamlessly with existing traffic models and required minimal installation time. The study introduced ARTEMIS (Autonomous and Real-Time signal control based on Estimation of traffic demand for Minimization of Signal waiting time), a novel signal control system that optimizes signalling by predicting traffic flow.

The observations highlighted the factors contributing to traffic congestion, including the increase in vehicle numbers, poor infrastructure, and inefficiencies in existing traffic systems like image processing and laser tracking. The study recognized the pivotal role of IoT in enhancing effective traffic monitoring and control.

Results from the proposed system showed a notable 35% reduction in traffic congestion, offering a more dynamic and responsive approach to traffic management compared to traditional methods. ARTEMIS proved effective in optimizing traffic signal timings based on real-time traffic flow estimations, showcasing the system's potential for improving urban traffic management.

14) Dr. Vikram Bali, Ms. Sonali Mathur, Dr. Vishnu Sharma, Dev Gaur, "Smart Traffic Management System using IoT Enabled Technology," JSS Academy of Technical Education, Noida, UP, Galgotia College of Engineering & Technology, Noida, UP, 2020.

The study proposed an IoT-enabled Smart Traffic Management System (STMS) aimed at establishing "Green Corridors" for emergency vehicles in urban areas. It employed RFID technology, with RFID tags on emergency vehicles and RFID scanners at traffic signals. When an emergency vehicle approached, the RFID scanner read the tag, triggering the traffic light to switch to green. The system also included an LCD display to alert other vehicles to clear the path. Implementation utilized Arduino microcontrollers and cloud computing for processing and data transmission. The observations addressed the issue of traffic congestion causing delays for emergency vehicles in urban cities. It highlighted the limitations of manual and automatic traffic control methods in current urban scenarios and emphasized the uniqueness of the proposed system with its integration of RFID technology.

Results from the study showcased a significant improvement in traffic management for emergency vehicles through the creation of efficient "Green Corridors." This resulted in reduced time delays for emergency responses, potentially saving lives. The system's effectiveness surpassed traditional traffic management approaches, offering a scalable solution for urban traffic control challenges.

15) **Abdul Kadar Muhammad Masum et al., "An Internet of Things (IoT) based Smart Traffic Management System: A Context of Bangladesh", Year: Not specified.**

The system employs IoT and data analytics, utilizing ultrasonic sensors to measure traffic density. A management algorithm sets traffic signal times, with data transmitted to a cloud server via Wi-Fi. It integrates RFID for vehicle identification and a mobile app for fine processing.

Observations note the system's focus on addressing traffic congestion, time and fuel wastage, and pollution. It prioritizes emergency vehicles and enforces fines for traffic signal violations. The system is cost-effective, and easy to install and maintain, enhancing traditional traffic management approaches.

Results show the system effectively measures traffic density and adjusts signal times accordingly. It also detects and penalizes traffic signal violations, improving rule enforcement. Overall, it demonstrates improved traffic management, particularly in challenging weather conditions.

VI. IMPLEMENTATION

The traffic management project seamlessly integrates hardware and software components for efficient traffic control and management. The hardware setup includes a power supply, Arduino for sensor data processing, NodeMCU for network connectivity, Raspberry Pi for complex algorithms and data processing, IR sensors for traffic density measurement, RFID reader for emergency vehicle prioritization, camera module for vehicle detection, LCD display for system status, and signal lights for traffic control. On the software side, the implementation focuses on vehicle detection using YOLOv3 on Raspberry Pi, traffic density calculation and control logic on Arduino, emergency vehicle prioritization via RFID data processing, and a user interface for real-time system monitoring and alerts. These components work in tandem to ensure effective traffic flow management and decision-making based on real-time data and conditions.



Figure 3: Raspberry Pi, Node MCU and camera module for traffic detection.

VI. RESULTS AND DISCUSSION

The integrated traffic management system employs YOLOv3 for real-time vehicle detection, IR sensors for traffic density measurement, and NFC for emergency vehicle prioritization. YOLOv3, a deep learning model, accurately identifies vehicles in video feeds, enabling continuous monitoring of traffic. This data is pivotal for vehicle counting, allowing dynamic adjustments of traffic signals based on real-time traffic conditions to optimize traffic flow. IR sensors strategically placed along lanes detect vehicle presence and density by monitoring interruptions in the infrared beam. This information guides the traffic light system in adjusting green light durations, prioritizing lanes with higher traffic density for smoother traffic flow.

NFC technology enhances emergency response by equipping emergency vehicles with NFC tags detected by readers at traffic signals. Upon detection, the system grants immediate green signal access, expediting emergency vehicle passage without disrupting regular traffic operations. Integration and testing ensure seamless operation under diverse traffic scenarios, from peak hours to emergencies and low-traffic periods. Rigorous testing validates

the system's reliability, accuracy, and efficiency, with ongoing optimizations to fine-tune performance and responsiveness.

The integrated system combines advanced technologies to manage traffic intelligently, offering real-time insights, optimized signal timings, and prioritized emergency vehicle access. Ongoing development aims to enhance system capabilities for efficient traffic management further.

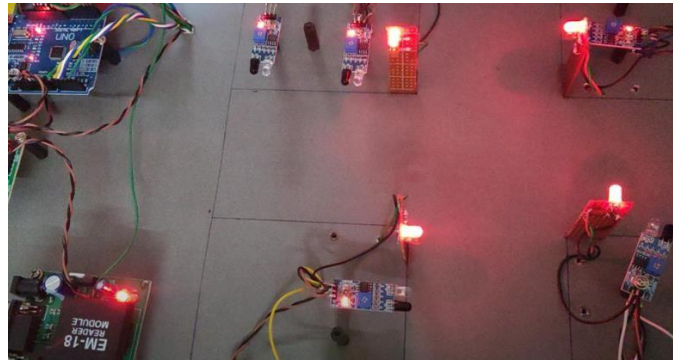


Figure 4: Traffic lights, RFID and Arduino

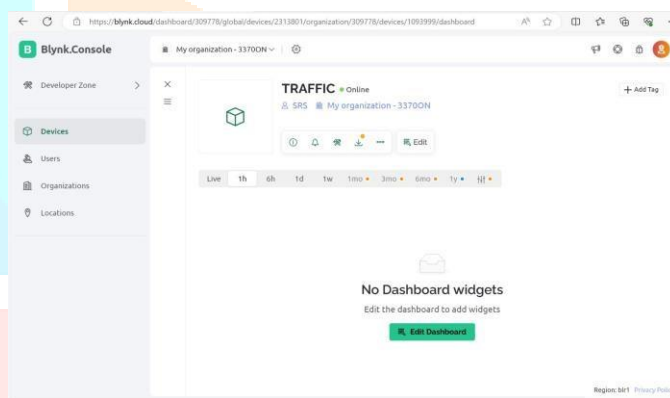


Figure 5: BLYNK console

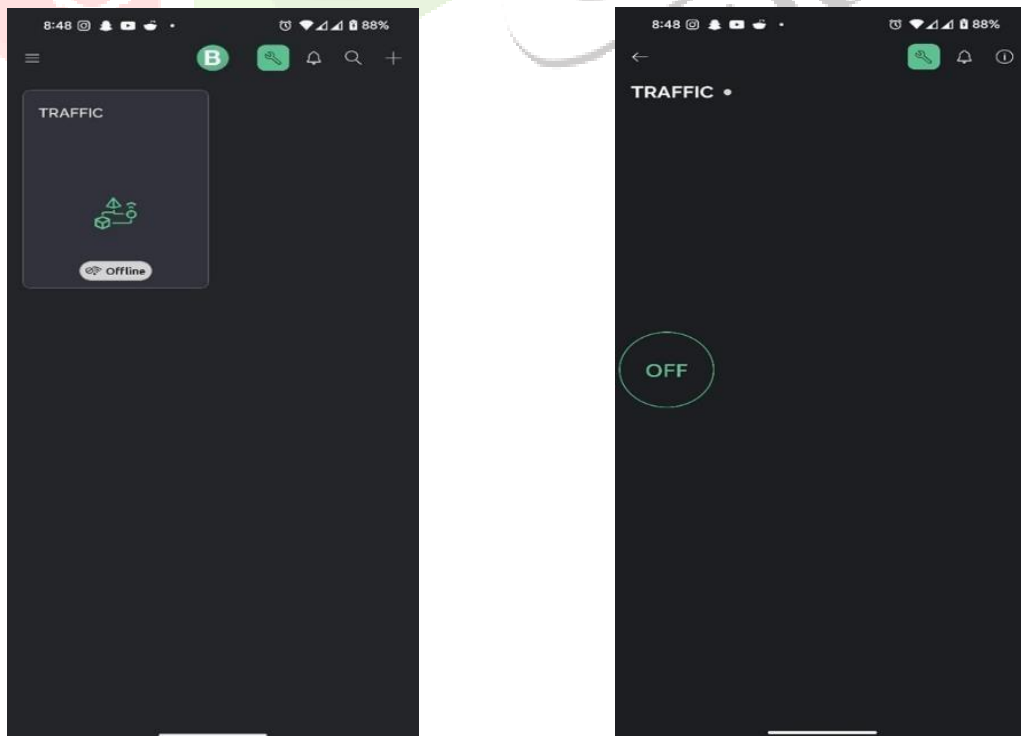


Figure 6: BLYNK app and Traffic module

CONCLUSION

The combined use of AI for vehicle detection, IR sensors for traffic density measurement, and NFC technology for emergency vehicle prioritization provides a comprehensive solution to traffic management. This system not only enhances the efficiency of traffic flow but also ensures quick clearance for emergency responses, making it a valuable project for urban traffic management.

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REFERENCES

- [1] V. Bali, S. Mathur, V. Sharma, and D. Gaur, "Smart Traffic Management System using IoT Enabled Technology," presented at the 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), 2020, pp. 565.
- [2] S. Javaid, A. Sufian, S. Pervaiz, and M. Tanveer, "Smart Traffic Management System Using Internet of Things," presented at the International Conference on Advanced Communications Technology (ICACT), 2023, pp. 393.
- [3] A. Larhgotra, R. Kumar, and M. Gupta, "Traffic Monitoring and Management System for Congestion Control using IoT and AI," presented at the Seventh International Conference on Parallel, Distributed and Grid Computing (PDGC), 2022.
- [4] M.I. Uddin, M.S. Alamgir, M.M. Rahman, M.S. Bhuiyan, and M.A. Moral, "AI Traffic Control System Based on Deepstream and IoT Using NVIDIA Jetson Nano," presented at the 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST), 2021.
- [5] S. C., S. Radhika, M. K., S. Ranjith, and N. Sasirekha, "An intelligent IoT Enabled Traffic Queue Handling System Using Machine Learning Algorithm," presented at the International Conference on Innovative Computing, Intelligent Communication and Smart Electrical Systems (ICSES), 2022, DOI: 10.1109/ICSES55317.2022.9914294.
- [6] A. K. M. Masum, M. K. A. Chy, I. Rahman, M. N. Uddin, and K. I. Azam, "An Internet of Things (IoT) based Smart Traffic Management System: A Context of Bangladesh," presented at the 2nd International Conference on Innovations in Science, Engineering and Technology (ICISSET), 27-28 October 2018, Chittagong, Bangladesh, IEEE, 2018, ISBN: 978-1-5386-8524-2, DOI: 10.1109/ICISSET.2018.8662876.
- [7] A. Farahdel, S.S. Vedaei, and K. Wahid, "An IoT Based Traffic Management System Using Drone and AI," presented at the 14th IEEE International Conference on Computational Intelligence and Communication Networks, 2022, DOI: 10.1109/CICN.2022.5.
- [8] S.S. Bal, B. Singh, R. Singh, A. Das, "Automatic Vehicle Counting for IoT-based Smart Traffic Management System for Indian Urban Settings," presented at [Conference Name], ISBN: 978-1-7281-1253-4, © 2019 IEEE.
- [9] M. Akhtar, M. Raffeh, F.U. Zaman, A. Ramzan, S. Aslam, F. Usman, "Development of congestion level based

dynamic traffic management system using IoT," presented at the 2nd International Conference on Electrical, Communication and Computer Engineering (ICECCE), 12-13 June 2020, Istanbul, Turkey.

- [10] P.J. Rani, K.K. M, N.K.S., V.S., "Dynamic Traffic Management System Using Infrared (IR) and Internet of Things (IoT)," presented at the Third International Conference on Science Technology Engineering & Management (ICONSTEM), 2017, IEEE, ISBN: 978-1-5090-4855-7.
- [11] W. Tahir, R.A. Wagan, B. Naeem, "Intelligent Traffic Handling System Using Point Tracker Algorithm," presented at the IEEE 18th International Conference on Smart Communities: Improving Quality of Life using ICT, IoT & AI (HONET 2021), IEEE.
- [12] I. Kaliraj, R. Maareeswari, V. Rimalraj, "IoT Based Traffic Management System for Emergency Vehicles," presented at the 9th International Conference on Advanced Computing and Communication Systems (ICACCS), 2023, ISBN: 979-8-3503-9737-6.
- [13] A. Chowdhury, "Priority based and secured traffic management system for emergency vehicle using IoT," 2016 International Conference on Engineering & MIS (ICEMIS), Agadir, Morocco, 2016, pp. 1-6, doi: 10.1109/ICEMIS.2016.7745309.
- [14] M. Amer and R. Maher, "PV/IoT based Smart Traffic Management System," 2022 International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME), Maldives, Maldives, 2022, pp. 1-6, doi: 10.1109/ICECCME55909.2022.9988110.
- [15] A. Larhgotra, R. Kumar and M. Gupta, "Traffic Monitoring and Management System for Congestion Control using IoT and AI," 2022 Seventh International Conference on Parallel, Distributed and Grid Computing (PDGC), Solan, Himachal Pradesh, India, 2022, pp. 641-646, doi: 10.1109/PDGC56933.2022.10053260.