International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 04 | Apr 2024 www.irjet.net p-ISSN: 2395-0072

CONTROLLING OF SMART ROAD DIVIDER FOR CLEARANCE OF AMBULANCE PATH

Manoj H M[1], N Sangeetha[2], Nikita Biradar[3], K Deevena Kumari[4], Jyoti Raju Kamati[5]

[1] *Assistant Professor, Dept. of Computer Science Engineering, BMS Institute of Techonology and Management, Bengaluru, India*

[2345] *UG students, Dept. Of Computer Science Engineering, BMS Institute of Techonology and Management, Bengaluru, India*

Abstract - Traffic congestion is a major challenge encountered by urban areas presently despite actions being implemented to alleviate and diminish it. The problem with Static Road Dividers is the fixed number of lanes on each side of the road. Both population growth and the number of cars for each family are on the rise, thereby increasing the count of the cars on roads. The circumstance is worse when an emergency vehicle like an ambulance has to wait for other vehicles to give. This causes a delay in time and may affect the emergency case. All these challenges encountered by faced by ambulances can be averted using the smart movable road divider. It integrates real-time traffic monitoring, data analysis, and intelligent control mechanisms to automatically clear a dedicated lane for ambulance passage. Upon detecting an ambulance approaching, the system triggers the actuation of the smart road dividers located at key points along the road. These dividers can dynamically adjust their positions to make a clear lane for the ambulance, bypassing traffic and reducing response times.

Keywords—Traffic Congestion, Movable Road Divider, IOT, Ambulance, Object Detection.

1. INTRODUCTION

Over time, a single-lane road was constructed, causing numerous issues for commuters due to severe traffic congestion. This situation lacked efficiency, safety, and flexibility. Subsequently, a two-lane road was built, which, unfortunately, did not relieve the traffic problem. Even with the introduction of a four-lane road, the traffic issues persisted, leading to the exploration of innovative solutions.

Many proposed solutions also employed IoT and embedded systems, along with IR sensors, to monitor traffic conditions. However, these systems struggled to accurately detect traffic and incurred high costs for maintenance and installation. Despite these efforts, the problem persisted, necessitating a more advanced solution.

As the count of vehicles continued to rise, the road infrastructure remained largely unchanged, not able to manage with rise in travel delays, congestion, and accidents. Traffic congestion has become a big challenge in modern societies, leads to a myriad of problems. Emergency vehicles, like ambulances, often found themselves stuck in traffic, leading to potentially life-threatening delays. Traffic jams also contribute to road accidents, environmental harm, and pollution, adversely affecting people's well-being. In urban areas, commuters frequently endured prolonged waits in standstill traffic, resulting in wasted time and frustration.

This project aims to address these issues by introducing a movable road divider that adjusts based on real-time traffic conditions. It relies on IoT technology to implement a connection between traffic conditions and the positioning of the divider, utilizing computer vision. This is divided into two phases, inbound and outbound. At peak times, traffic often significantly imbalances between the inbound and outbound lanes. In such scenarios, the divider automatically adapts its position to alleviate traffic congestion. When the amount of vehicles comes to a temporary standstill, this situation is classified as traffic jam. The divider shifts based on signals received from a camera vision module, thus mitigating traffic jams. This system prioritizes the passage for ambulances.

The project leverages cloud computing to manage a database of traffic data captured by camera vision modules positioned on either sides of the road. These cameras capture images of the vehicles and employ deep-learning algorithms to calculate traffic density accurately. The above inventive strategy not only improves traffic flow but also enhances road safety, reduces environmental impact, and addresses the difficulties encountered by emergency vehicles during emergencies.

2. PROBLEM STATEMENT

The problem is that the static road is wide, that is, the count of lanes of traffic on both side of the path is increased. Since the resources are limited and as the population grows, the count of cars per family, and a significant rise in the count of cars on the road. This means a more efficient use of existing resources, such as the count of available lanes.

At this time, there emerged a consistent and significant increase in capacity of congestion on road, causing traffic jams, especially during rush hour.

Passengers have to meet the extreme traffic at peak times, on a day-to-day basis, consequently, there will be a postponement in reaching their destination. During rush hour, the traffic on one side of road in contrast to the another side of the road, and the situation is the same in the evening.

3. OBJECTIVES

Enhance Emergency Response Times: The primary objective is to decrease assistance times for emergency services, such as ambulances, by swiftly creating a dedicated and clear pathway for them through traffic.

Dynamic Positioning of Road Dividers: Create a system of Smart movable road dividers that can dynamically adjust their positions for the clearence of ambulance path to pass through.

Safety and Reliability: Ensure that the system is crafted to operate safely and reliably, with fail-safe mechanisms in place to prevent accidents or malfunctions.

Intelligent Control Mechanisms: Develop intelligent control algorithms and mechanisms that can used to make quick decisions on when and where to move the dividers, ensuring a safe and efficient path for the ambulance while minimizing disruption to other road users.

Real-Time Traffic Monitoring: Implement a system that continuously monitors traffic conditions in real-time using various sensors and data sources, such as cameras and vehicular movement data.

4. LITERATURE REVIEW

The "Controlling of smart movable Road divider and Clearance Ambulance Path Using IOT Cloud" paper presented at the 2021 international conference on Computer communication and Informatics in Coimbatore, India, focuses on implementing a System that dynamically adjusts road dividers to manage traffic congestion and prioritize ambulance clearance using IoT technology [1]. This system aims to optimize traffic flow and enhance emergency response efficiency by leveraging cloud computing and IoT solutions.

The research by M. D. Sinha et al. introduces and emphasize the utilization of cloud computing and IoT for effective traffic monitoring and management. This technology is essential in real-time traffic analysis and decision-making processes to improve overall traffic control mechanisms [2].

The research by S. Ahn and M. J. Cassidy [3] delves into "Freeway traffic oscillations and vehicle lane change manoeuvres," highlighting complexities of traffic dynamics and the consequence of lane changes on overall traffic flow, as shown at the Transportation and Traffic Theory 2007 conference. This study sheds light on the intricate interactions between vehicle movements and traffic oscillations, useful perspectives for crafting effective traffic management strategies.

B. D. Sri, K. Nirosha, and S. Gouse's [4] work on the "Design and the Implementation of Smart Movable road divider using IOT" at the 2017 international conference on Intelligent sustainable systems showcases innovative solution for Traffic management through IoT technologies. This research emphasizes the importance of dynamic road dividers in optimizing traffic flow and enhancing emergency vehicle clearance, contributing to more efficient urban mobility solutions.

The research by Z. Jan, B. Verma, J. Affum, S. Atabak, and L. Moir [5] focuses on a "Convolutional Neural network-based Deep Learning techniques for finding road attributes," showcasing the implementation of advanced Deep Learning methods in road attribute recognition. This study emphasizes the potential of Artificial intelligence in extracting valuable insights from road data to enhance traffic management systems.

Additionally, A. Wujcicki's [6] work on "Automatic detection of lane count into which a road is divided," as detailed in the US Patent 9,355,321, emphasizes innovations in lane detection technologies capable of greatly enhacing lane-specific traffic control measures. This technology offers a promising solution for accurately detecting and categorizing lanes on roads to optimize traffic flow and enhance road safety.

A. J. Ghandour, H. A. Krayem, and A. A. Jezzini [7] presented a study on "Autonomous vehicle detection and classification in high-resolution satellite imagery" at the 2018 International Arab Conference on Information Technology (ACIT). This research focuses on utilizing high-resolution satellite imagery for autonomous vehicle detection and classification, contributing to advancements in intelligent transportation systems.

The paper "Traffic image processing Systems" by Surgailis , T.; valinevicius, A.; Zilys , M . [8], presented at the Second international conference on Advances in Circuits, Electronics, and Micro-electronics (CENICS '09) in 2009, focuses on the Development and Application of image processing systems in Traffic Surveillance and analysis. This study contributes to the advancement of intelligent transportation systems by utilizing image processing technologies to monitor traffic dynamics, optimize traffic flow, and enhance road safety through real-time analysis and control mechanisms.

The paper titled "Smart Traffic Optimisation using image processing" by Pranav maheshwari, Deepanshu suneja, Praneet singh, and Yogeshwar Mutneja [9], focuses on

adopting the image processing techniques of smart traffic optimization. This research emphasizes the advantage of real-time monitoring and study of traffic conditions using cameras at intersections to dynamically optimize traffic flow. The proposed system in this paper offers a dynamic and autonomous approach to traffic management, potentially saving critical resources and enhancing overall traffic efficiency at junctions.

Yasuo Kudo et al . [10] presented a study on "Traffic Flow Measurement System using image processing" at the Vehicular Technology Conference. This research focuses in employing image processing methods for traffic flow measurement, highlighting the adoption of advanced technologies in monitoring and analyzing traffic dynamics for improved traffic management strategies.

5. LIMITATIONS OF EXISTING SYSTEM

Our project aims to solve the following limitations: The limitations of the present traffic Management systems are apparent in their reliance on outdated methodologies, resulting in inadequate responsiveness to real-time traffic demands. The utilization of conventional IR sensors often leads to inaccuracies in assessing traffic density and fails to provide comprehensive insights into traffic patterns during peak hours. Furthermore, the lack of a dedicated mechanism for ensuring the swift passage of emergency vehicles contributes to potentially life-threatening delays, particularly in critical situations. The elevated upkeep expenses linked to maintaining and revising the current infrastructure present significant financial constraints, impeding the comprehensive implementation of advanced traffic management solutions. The absence of robust data analysis capabilities further restricts the capability of these systems to effectively predict traffic patterns and implement proactive traffic flow management strategies. In addition, worries w.r.t data confidentiality and the reliance on manual intervention for decision-making underscore the urgency for an upgraded system that prioritizes accuracy, adaptability, and seamless integration of modern technologies for efficient traffic management

6. RESEARCH GAPS AND CHALLENGES

A. Research gaps

Data Integration with Accuracy: One research gap is the necessity for enhanced data amalgamation and accuracy in real-time traffic monitoring. Present systems may deal with inaccuracies, and also is crucial to explore advanced sensor technologies and data fusion techniques to enhance the dependability of traffic data.

Algorithm Development: Developing robust and adaptive algorithms for intelligent control mechanisms is a important research gap. The system must accurately predict and respond to ambulance movements while minimizing disruption to regular traffic flow.

Human Behaviour and Compliance: Understanding and addressing human behavior is a challenge. Study must investigate driver compliance with the smart divider system and develop strategies to encourage proper yielding to emergency vehicles.

Interoperability: Ensuring interoperability with present traffic regulation systems and infrastructure is another gap. Researchers need to focus on creating standards and protocols that allow the smart divider system to work seamlessly with other traffic control devices.

B. Research Challenges

Privacy and Security: Protecting the privacy of individuals in a system that relies heavily on data collection is challenging. Researchers must work on privacy-preserving data handling and secure communication protocols.

Reliability and Redundancy: Ensuring the reliability of this system is a critical challenge. Developing redundant systems and fail-safe mechanisms to prevent accidents or system failures is essential.

Adaptive AI: Building AI algorithms that can adapt to dynamic traffic conditions and emergencies is challenging. These algorithms must consider various factors, including weather, road conditions, and different types of emergency vehicles.

Legislation and Regulation: Working within existing traffic laws and regulations while introducing a new traffic Management system is complex. Researchers must navigate the legal landscape and work with authorities to ensure compliance.

Public Acceptance: Overcoming public skepticism and gaining acceptance for the new system is a challenge. Public awareness campaigns and education efforts are necessary to inform people about the benefits of the system as well as how it works.

Cost Management: Implementing the system cost-effectively is a challenge, especially when retrofitting existing road infrastructure. Balancing the costs of development, installation, and maintenance with the benefits is essential.

7. SYSTEM REQUIREMENTS

A. Functional Requirements

Ambulance Detection: This system should detect approaching ambulances using a combination of sensors, including visual (flashing lights recognition), and GPS tracking.

Real-time Monitoring: Continuously monitor the road and surrounding areas in real-time to detect emergency vehicles.

Data Processing: Process IoT device sensor data and edge devices for accurate ambulance detection.

Ambulance Verification: Verify the identity and status of the ambulance to prevent misuse of the clearance system.

Emergency Services Communication: Integrate with the local emergency services communication network to facilitate coordination with first responders.

Cloud-based Decision Making: Use cloud-based software to make decisions based on incoming data. Determine when to move the road dividers to clear a path for an approaching ambulance.

Road Divider Control: Activate the road divider's motorized or hydraulic systems to create a lane for ambulance when necessary.

B. Non-Functional Requirements

Performance:

1. Response Time: The system should respond to ambulance detection and clearance requests within a defined, low-latency time frame to ensure quick emergency response.

2. Scalability: The system should be able to handle an increasing number of road dividers, sensors, and users as needed without significant degradation in performance.

Reliability:

1. Availability: The system should have a high level of availability to ensure it is accessible and operational when needed, 24/7.

2. Fault Tolerance: The system should be designed to withstand hardware or software failures and continue to operate with minimal disruption.

3. Redundancy: Implement redundant components and failover mechanisms to minimize downtime.

8. PROPOSED METHODOLOGY & DESIGN

A. Proposed System

This suggested system employs IoT technology and cloud-based algorithms to swiftly detect approaching ambulances and autonomously adjust smart movable road dividers to clear their path. This system features a user-friendly interface, real-time monitoring, robust security, and scalability. It optimizes emergency response times, generates valuable data insights, and ensures regulatory compliance, marking a significant advancement in urban traffic control and emergency services coordination.

B. Proposed Methodology

Traffic detection: The primary objective of this module is to determine the number of vehicles, which influences operation of the divider. Infrared Sensors are positioned at the dividers entry point to obtain vehicle counts, reflecting the level of traffic congestion. When the traffic density is high, the divider moves towards less less-density side. If the traffic density remains average, then no action is implemented, and the median remains centrally positioned.

- In this suggested system, a component has been formulated utilizing a microcontroller that contains an ultrasonic sensor, employed for gauging traffic.
- The infrared sensor can be considered to be a part of vehicle to evaluate the density and is on a one-lane road.

Ambulance Detection:

RGB LEDs stationed on either sides of road.

Whenever the divider receives a signal from the ambulance RGB LEDs networked to the side will light up.

The ambulance can be detected 100m away in our plan so based on those signals, path will be cleared to the Ambulance.

One narrow path will be created where only an ambulance is allowed.

Whenever an ambulance is detected on either of the roads the colour of the road will change and display on the LCD.

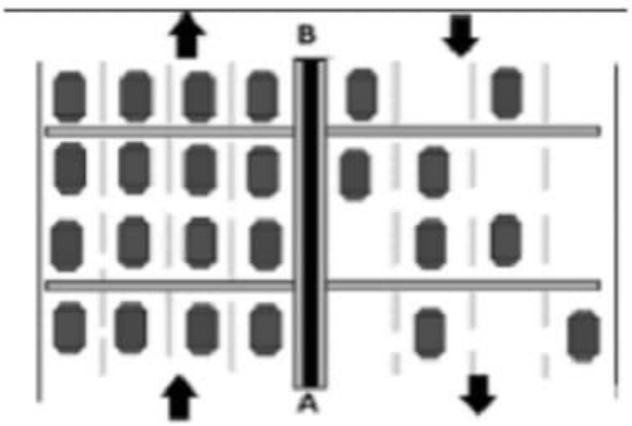

Fig 1 : When traffic is heavy on the left side of the road.

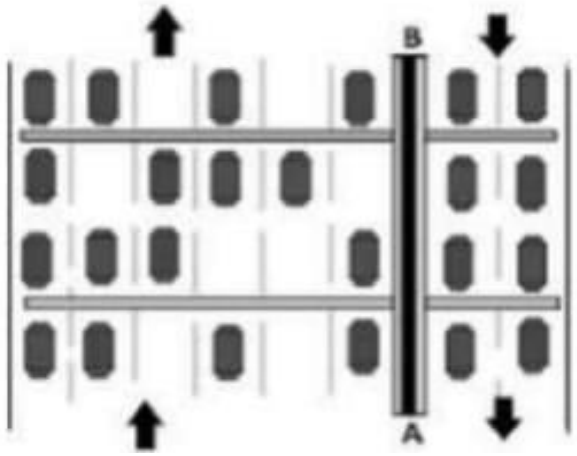

Fig 2 : Divider is moved to the right side.

The overall methodology of the system is shown in below figure.

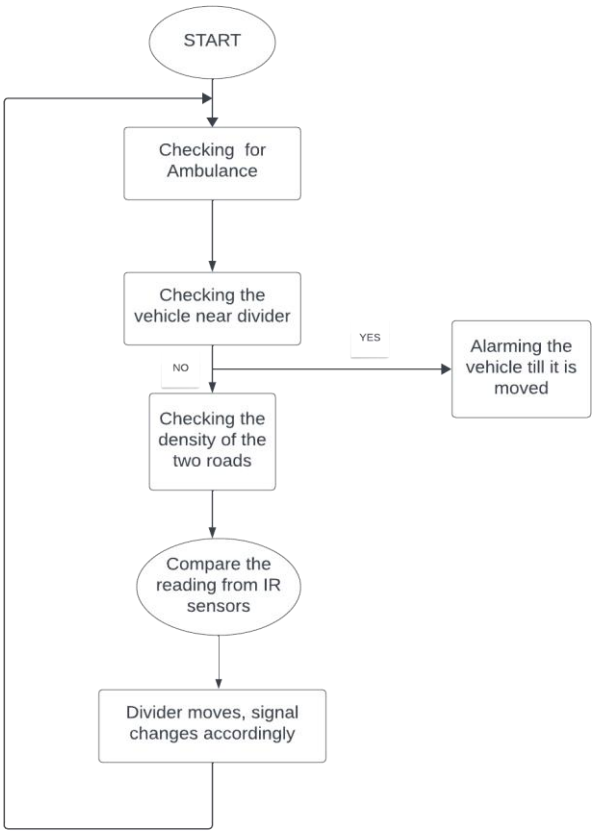

Fig 3 : Flowchart for divider movement under traffic conditions.

9. OUTCOME

Reduced Emergency Response Times: The primary outcome is a significant reduction in emergency response times, particularly for ambulances. This might potentially avert loss of life by allowing medical professionals to reach patients more quickly.

Improved Traffic Flow: The project aims to alleviate congestion of traffic and enhance overall traffic flow, leading to shortened commuting time for every road users, increased productivity, and reduced fuel consumption.

Enhanced Safety: The use of smart movable road dividers with adaptive control mechanisms is expected to improve road safety by minimizing the risk of accidents involving emergency vehicles and other vehicles on the road.

Public Awareness and Education: An expected outcome is improved public awareness and education regarding the importance of giving way to emergency vehicles and understanding how the smart divider system works.

Interoperability: The successful integration of the smart divider system with existing traffic management infrastructure and protocols is expected, contributing to smoother traffic management overall.

10. RESULT

Smart movable road dividers reduce congestion by providing additional lanes in peak traffic directions for AM and PM commuters, thereby increasing safety, decreasing travel time, and offering environmental benefits such as improved air quality, fuel efficiency, and reduced atmospheric CO2 levels. By dynamically adjusting divider positions based on real-time traffic conditions, these systems effectively manage traffic flow and alleviate congestion hotspots.

Moreover, by optimizing road capacity usage, these dividers can reduce the necessity for costly infrastructure development projects, such as constructing new bridges or expanding existing roads. Their ability to be easily reconfigured and relocated makes them adaptable to changing traffic conditions or temporary roadwork. Integrated with IoT technology, the system further enhances its functionality and effectiveness in controlling traffic congestion.

Smart movable road dividers offer numerous advantages, and their proper usage is essential for maximizing benefits and ensuring safe traffic control.

11. CONCLUSION

In conclusion, this project addresses a critical urban challenge of traffic congestion caused by the static road infrastructure's inability to adapt to the growing population and increased car ownership.

By introducing a smart movable road divider system, we have demonstrated the potential to significantly reduce emergency response times, improve traffic flow, and enhance road safety.

The outcomes of this project underscore the importance of embracing innovative solutions to meet the evolving transportation needs of our metropolitan areas.

As we look to the future, it is imperative to continue refining and expanding such initiatives to create more sustainable and livable cities.

REFERENCES

[1] "Controlling of Smart Movable Road Divider and Clearance Ambulance Path Using IOT Cloud," in 2021 International Conference on Computer Communication and Informatics (ICCCI -2021), Jan. 27 – 29, 2021, Coimbatore, INDIA.

[2] M. D. Sinha, D. M. R. Babu, D. R. Patan, D. P. Jiao, M. K. Barri, and D. A. H. Alavi, "Internet of Things-based Fog and Cloud Computing Technology for Smart Traffic Monitoring," Internet of Things, vol. 100175, 2020, Doi: 10.1016/j.iot.2020.100175.

[3] S. Ahn and M. J. Cassidy, "Freeway traffic oscillations and vehicle lane change maneuvers," in Transportation and Traffic Theory 2007. Papers Selected for Presentation at ISTTT17, 2007.

[4] B. D. Sri, K. Nirosha, and S. Gouse, "Design and implementation of smart movable road divider using IOT," in 2017 International Conference on Intelligent Sustainable Systems (ICISS), 2017, doi:10.1109/iss1.2017.8389364.

[5] Z. Jan, B. Verma, J. Affum, S. Atabak, and L. Moir, "A convolutional neural network based deep learning technique for identifying road attributes," in 2018 International Conference on Image and Vision Computing New Zealand (IVCNZ). IEEE, 2018, pp. 1–6.

[6] A. Wujcicki, "Automatic detection of the number of lanes into which a road is divided," May 31, 2016, US Patent 9,355,321.

[7] A. J. Ghandour, H. A. Krayem, and A. A. Jezzini, "Autonomous vehicled detection and classification in high-resolution satellite imagery," in 2018 International Arab Conference on Information Technology (ACIT). IEEE, 2018, pp. 1–5.

[8] Surgailis, T.; Valinevicius, A.; Zilys, M., "Traffic Image Processing Systems," in Advances in Circuits, Electronicsmand Micro-electronics, 2009. CENICS '09. Second International Conference on, vol., no., pp.61-66, 11-16 Oct. 2009

[9] Pranav Maheshwari, Deepanshu Suneja, Praneet Singh, Yogeshwar Mutneja, "Smart traffic optimization using image processing",2015 IEEE 3rd International conference on MOOC's, Innovation and Technology in Education (MITE), ISBN: 978-1-4673-9/15/$31.00, 2015 IEEE.

[10] Kudo, Y.; Yamashita, T.; Tsurutani, T.; Naniwada, M., "Traffic flow measurement system using image processing," in Vehicular Technology Conference, 1983. 33rd IEEE, vol.33, no., pp.28-34, 25-27 May 1983

[11] S. Djahel, Nicolas Smith, John Murphy, "Reducing emergency services response time in smart cities: An advanced adaptive and fuzzy approach" in International Smart Cities, 28 October 2015

[12] L. Sumia, V. Ranga "Intelligent Traffic Management System for Prioritizing Emergency Vehicles in a Smart City" in IJE TRANSACTIONS B: Applications Vol. 31, No. 2, (February 2018) 278-283

[13] W. Yu, W. Bai, W. Luan and L. Qi, "State-of-the-Art Review on Traffic Control Strategies for Emergency Vehicles," in IEEE Access, vol. 10, pp. 109729-109742, 2022, doi:10.1109/ACCESS. 2022. 3213798