Urban Mobility Optimization Through IoT- Infused Road Dividers

PROF. PRAVEEN B. THUMMALAKUNTA[1], PRAJAKTA KADAM[2], SNEHAL DHINDLE[3], ASHWINI NIMAN[4], VAISHNAVI HAPSE[5]

[1] *Professor, Department of Information Technology, Zeal College of Engineering and Research, Pune, India*

[2, 3, 4, 5] *Student, Department of Information Technology,Zeal College of Engineering and Research, Pune, India*

Abstract— Road dividers are frequently used to keep traffic flowing smoothly by dividing the flow of oncoming and outgoing cars. Usually, the number of lanes allotted to each way is equal. However, during peak hours, traffic frequently flows mostly in one way in certain places, such as shopping industrial districts, underutilizing the other side of the road divider. This mismatch leads to wasteful use of resources, traffic congestion, and time waste. Our solution to this problem is an automated road divider system that can be moved to create extra lanes in the direction of high traffic by dynamically adjusting the lanes. Even one more lane in the rush hour can result in substantial time and fuel savings. This study provides an extensive analysis of the possible advantages, design factors, implementation difficulties, and practical uses of IoT-enabled moveable road dividers. These smart road dividers can respond to changing traffic patterns in real-time, autonomously modify lane configurations, and seamlessly integrate sensors, actuators, and communication networks.

Index Terms— IOT, Arduino Uno, IR sensor, Traffic control, Movable divider, LED lights, DC motor

I. INTRODUCTION

A corresponding rise in the quantity of cars on the road in recent years. The infrastructure of static roads is nearly unchanged and cannot adapt to changes in traffic volume or uncertain travel times, even though the number of vehicles on the road has increased. Despite efforts to lessen it, one of the main issues facing modern metropolises is traffic congestion and congestion. Creating sustainable communities with lanes free of traffic has become one of the biggest difficulties facing urban developers today. The traffic in India is by nature

Fig.1: shows the traffic jam on one side of the dividing road.

noisy and chaotic. To describe the congestion and determine the best course of action, it is imperative to determine the extent of the traffic jam. Our city's road infrastructure is finding it difficult to properly control traffic and provide safe, effective travel in the face of growing urbanization and the accompanying increase in vehicle traffic. This problem has broad ramifications that impact not only our everyday travel but also our surroundings and general standard of living. Understanding this, the main goal of our research is to present a novel solution: a Smart Traffic Management System with Divider Shifting Mechanisms. This system is intended to dynamically modify road configurations in real-time, improving safety and traffic flow. Our system strives to encourage ecofriendly transportation options and lessen traffic congestion while also reducing travel times. It does this by leveraging clever algorithms, innovative technology, and real-time data from monitoring devices, all of which contribute to a more sustainable urban environment.

Envision a dynamic road system that can adjust to changing conditions. This novel technology makes use of a divider or barrier that is movable and can alter the configuration of the lanes on the road. And it goes on from there; technology is entirely responsible for this seemingly magical outcome.

Traffic is being closely observed by sensors placed along the road. They are continuously gathering data on the number of vehicles on the road, their speed, and the presence of any issues like as traffic jams or accidents. All this real-time data is fed into an extremely intelligent computer. The computer uses sophisticated algorithms, which are similar to ingenious recipes, to maximize traffic flow. It can detect traffic jams during rush hour and react by creating extra lanes to handle the influx of traffic. Furthermore, it quickly erects barriers in the event of an emergency to guarantee everyone's safety and hasten the arrival of rescue vehicles. In essence, this technology is a Traffic Management System for Divider Shifting, which changes road layouts automatically to address traffic problems and improve general safety. It serves as a dynamic solution that automatically modifies dividers to improve traffic flow and guarantee an expedited response in an emergency. This system is an essential instrument for contemporary traffic management since its major goals are to maximize safety and preserve traffic flow. The fact that this technology also contributes to environmental protection is one of its greatest features. It can direct vehicles to go less congested, less polluting routes. Additionally, it may encourage people to take the more environmentally friendly buses or trains during rush hour. Using Divider Shifting Mechanisms for Smart Traffic Management is like having a road superhero. It makes our travels safer, quicker, and more environmentally friendly by instantly adjusting to the flow of traffic. We need a lot of clever technology, intergroup cooperation, and road investment to make all of this work, but the payoff is substantial. Thus, the next time you're caught in traffic, try to picture a world with intelligent roadways.

II. MOTIVATION

The project's motivation is anchored in addressing the persistent challenge of urban traffic congestion. As cities expand and road infrastructure stagnates, traffic jams worsen, leading to wasted time, increased pollution, and heightened stress for commuters. Recognizing these detrimental effects, there's a growing urgency for innovative solutions that can intelligently manage traffic flow. Our project aims to meet this demand by implementing a smart traffic management system utilizing divider shifting mechanisms. By leveraging modern technology, we aspire to create dynamic, adaptable roadways that optimize traffic flow, reduce commute times, and enhance overall urban liability. Ultimately, our vision is to foster a more sustainable urban environment, minimizing the carbon footprint and improving the quality of life for city residents.

III. LITERATURE SURVEY

1.Anireddy Sushrutha and C.R.K. Reddy [1] "Movable Road Divider Using Internet of Things" is a paper that presents an innovative way to address traffic congestion by using IoT technology to dynamically alter road dividers. Urban traffic congestion is a critical issue that serves as the driving force behind this endeavour. The goal of the authors' proposal is to lessen traffic jams, improve traffic flow, and increase the effectiveness of road usage. The writers talk about current methods that can be useful but have drawbacks such requiring human intervention and having narrower lanes. Examples of these systems are zipper machines and concrete lane dividers. In contrast, the suggested method addresses traffic issues on highly congested highways by utilizing automated road dividers and the Internet of Things.

2. Roopa Ravish and Shanta Ranga Swamy [2] paper titled "Intelligent Traffic Management: A Review of Challenges, Solutions, and Future Perspectives" offers a thorough examination of the state of Intelligent Transportation Systems (ITS) and how well-suited they are to deal with the enduring problems brought about by traffic jams. Four domains—traffic data collecting, traffic management, congestion avoidance, and trip time prediction—are carefully distinguished by the authors' classification of ITS-based solutions. Every one of these groups is investigated in detail, emphasizing the different tactics and technologies used, along with an evaluation of their advantages and disadvantages. The study emphasizes how crucial it is to control traffic

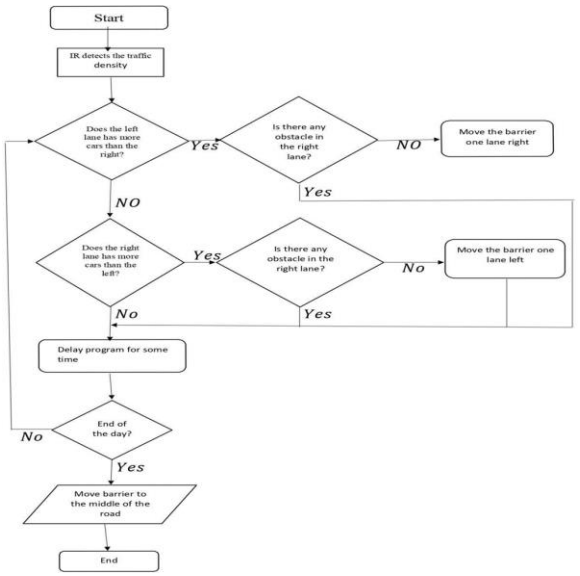
congestion and manage traffic effectively. It illuminates the complex issues encountered in these fields, such as the requirement for precise trip time estimation and the acquisition of real-time traffic data.

3. Rashmi C, Roopa T N, Samrudh R and Sandhya M [3] The paper titled "Movable Road Dividers" presents a novel method that uses movable road dividers to alleviate the ongoing issue of urban traffic congestion. The writers are acutely aware of the basic problem with static road dividers, which is their inability to change with the constantly shifting dynamics of traffic patterns. This is made more urgent by the growing urban population and rising vehicle per home numbers, which call for a more effective use of the current road infrastructure. This paper provides a complete system that uses automated road dividers that are remarkably capable of dynamically switching lanes to optimize traffic flow without requiring significant changes to the actual road layout. An advanced array of sensors, including infrared and ultrasonic sensors, along with microcontrollers and RGB LEDs, form the basis of this creative system. Together, these sensors measure the traffic density in real time, allowing the system to react intelligently by adjusting the road barrier to ease congestion. Additionally, the system's architecture includes a way to prioritize emergency vehicle like ambulance so that they can get through traffic more quickly and exclusively. This innovative method shows a great deal of promise for improving traffic control, lowering traffic jams, and raising the bar for road safety, especially in highly crowded cities. The study makes a significant contribution to the field of traffic management by providing a creative solution to an issue that affects urban areas all over the world.

4. Sonali Naram et al [4] The innovative system described in the paper "Smart Traffic Flow Management System using ATmega 328 Microcontroller" by Sonali Naram, Pradnya Mahabale, and Ashlesha Nemane aims to enhance traffic flow management by deploying movable road dividers controlled by an ATmega 328 microcontroller. Its primary goal is to optimize traffic flow efficiency by employing cutting-edge technology. The system employs image processing techniques to capture live traffic data, which is then transmitted to the cloud for in-depth analysis and user accessibility. Notably adaptable, the system adjusts the road divider based on real-time traffic density on each side of the road. In instances of congestion on one side, the road divider dynamically shifts to provide more space, thus easing traffic pressure. The paper thoroughly discusses the system's objectives, methodology, and operational principles, accompanied by presentations of car detection results and real-time traffic updates on a cloud-based platform. Furthermore, the authors outline future research directions aimed at further enhancing traffic control and congestion management. In summary, this paper presents a practical and technologically- driven approach to traffic management, demonstrating the potential for technology to significantly improve traffic flow management efficiency and offering a promising avenue for better traffic control in metropolitan areas.

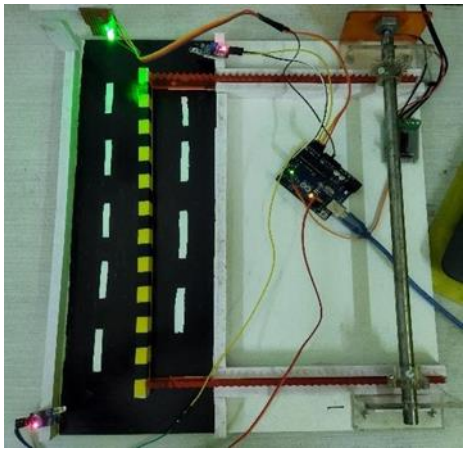
IV. METHODOLOGY

The proposed methodology outlines a comprehensive approach to developing and implementing a smart traffic flow management system utilizing Arduino technology. This methodology involves several key steps, each carefully crafted to ensure the system's effectiveness and efficiency in managing traffic flow. Through a combination of hardware construction, software programming, data acquisition, and safety measures, the methodology aims to create a dynamic and adaptive system capable of optimizing traffic flow in real-time.



1. Develop a Divider System: Devise a physical divider system utilizing a rack and pinion mechanism, facilitating vertical movement for lane adjustments.
2. Motor and Driver Configuration: Link the DC motor to the L293D motor driver, interfacing with the Arduino for precise control over motor direction and velocity through proper wiring and connections.
3. Arduino Code Authoring: Script Arduino functions to manage motor actions in response to live traffic data, employing sensors and cameras for the data acquisition and decision-making regarding divider shift.
4. Traffic Data Gathering: Deploy road sensors for the real-time collection of traffic metrics like volume, speed, and congestion levels, crucial for informed traffic management strategies.
5. Data Interpretation: Develop Arduino algorithms for processing gathered data, establishing lane shift criteria such as congestion thresholds or designated time frames.
6. Flexible Lane Allocation: Configure the Arduino to dynamically reposition the divider based on processed data, redistributing lanes to alleviate heavy traffic directions.
7. LED Signalling: Integrate LED indicators onto the divider to communicate lane alterations to drivers, utilizing varying colors or patterns to denote lane status and speed restrictions.
8. Safety Protocols: Introduce safety measures like obstacle detection sensors to avert accidents during divider adjustments, ensuring emergency stops and fail-safes are operational.
9. Evaluation and Adjustment: Conduct rigorous testing of the system under controlled conditions to validate responsiveness to changing traffic dynamics, calibrating sensors and mechanisms accordingly.
10. Linkage with Traffic Control Hub: Establish communication channels between the Arduino system and a central traffic management facility, enabling manual intervention or lane reconfigurations as needed.
11. Power Management: Secure a reliable power source for continuous system operation, incorporating backup power options like UPS to mitigate disruptions during power failures.
12. Ongoing Maintenance and Oversight: Regularly inspect and maintain system components to address wear, sensor issues, and software updates, integrating remote monitoring capabilities for real-time system diagnostics.

V. IMPLEMENTATION



An IR sensor intended to measure traffic density is part of a module that has been created for the proposed system. These infrared sensors recognize when a car approaches and send the data to the Raspberry Pi. In order to count events from LOW to HIGH and indicate vehicle passage, a variable resistance sets a reference based on the necessary sensing range. Based on these occurrences, the algorithm determines the proportion of traffic density on each side of the partition. When there is a high traffic density, the moveable divider adjusts and shows the direction of travel and the

proportion of traffic in each lane on an LCD display. When divider movement encounters an obstruction, it stops until the obstruction is removed.

When an emergency vehicle is present, the traffic light's red light turns green, and red LEDs at the extremities of lanes or on the divider side signal to other cars to move over so the emergency vehicle can pass.

A) Measuring traffic density using IR sensor to estimate traffic density in terms of percentage, infrared sensors are mounted on the road divider and face both sides of the street. They use infrared photons to detect passing vehicles and record reflection times over a predetermined time. The number of vehicles, speed, and lane number are correlated with this reflection time. In relation to the entire reading time, the obtained reflection times are transformed into percentages. High traffic density is found by comparing these percentages. The busier side is then given an extra lane when the divider is moved to the side with lower density.

LCD display screens alert approaching vehicles about the divider movement, ensuring a clear lane for the transition.

B) Resolving the inconsistencies in the Data

There are variations in the amount of traffic on either side of the road, according to the data. Traffic flow is asymmetrical at different times. During the morning, there is more traffic on the side that leads to business areas; in the evening and at night, there is more traffic on the opposite side that leads to residential blocks. Because of the extra space created by this design in the other lanes, there is a chance to optimize traffic flow at periods.

Our decision-making regarding traffic density revolves around three options:

1) Ideal Situation: Maintain the divider in a fixed position, minimizing movement.
2) Shift Left: Adjust the divider x lanes to the left to align with traffic flow.
3) Shift Right: Move the divider x lanes to the right for optimal traffic management.

This decision process iterates as necessary. Our goal is to minimize divider movements throughout the day for efficiency. It's essential to prevent excessive adjustments to avoid straining the mechanism due to frequent lane changes in response to traffic fluctuations.

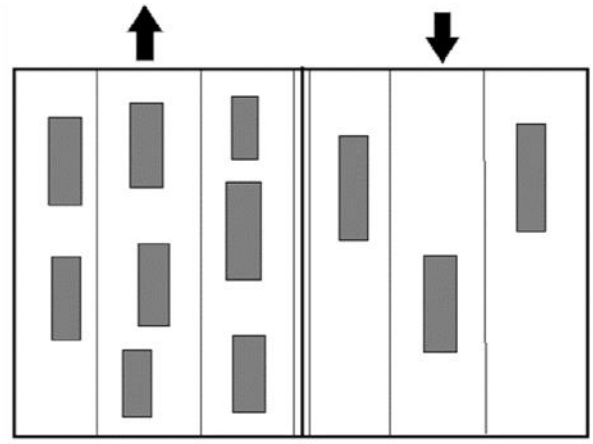


Fig. 1. Traffic on the left side of road

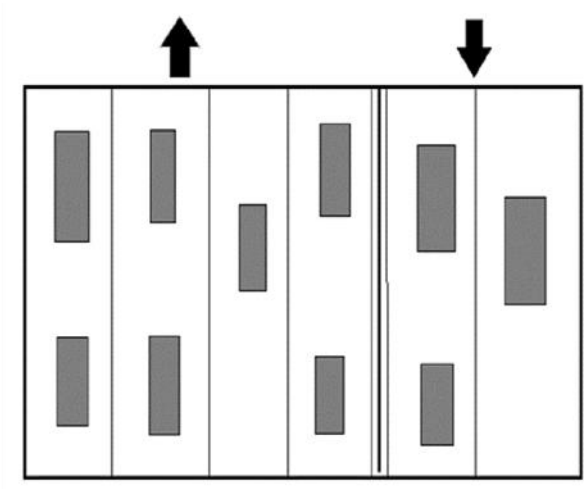


Fig. 2. Shifting of Divider towards right side.

VI. RESULT

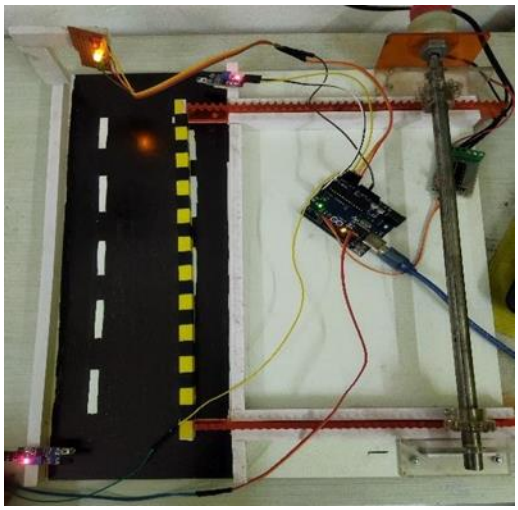


Fig:1 Movement of Divider Towards Right

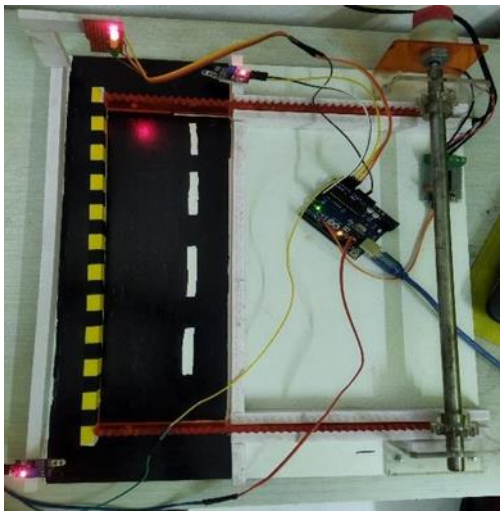


Fig:2 Movement of Divider Toward Left

A movable road divider will save delays in traffic and remove traffic congestion. We discuss the necessity and significance of a movable road barrier using IOT in this project. On the roadways where width expansion is not possible and where there is more one-way traffic during peak hours, movable road dividers are installed.

Movable road dividers equipped with IoT technology offer a dynamic solution to traffic congestion in areas where road expansion isn't feasible. By intelligently adjusting lane configurations based on real-time data, these barriers enhance safety, optimize road space, and reduce emissions.

CONCLUSION

1. Traffic Congestion Relief: [1] Traffic congestion is a major issue in urban areas, leading to wasted time, increased fuel consumption, and heightened pollution levels. Movable road dividers can help alleviate congestion by dynamically adjusting lane configurations based on real-time traffic conditions.

2. Flexibility in Lane Management: In situations where widening roads is impractical or impossible due to space constraints, movable road dividers offer a flexible solution. They allow authorities to adapt lane configurations according to varying traffic demands throughout the day.

3. Enhanced Safety: Movable road dividers can improve road safety by creating physical barriers between opposing lanes of traffic. This reduces the risk of head-on collisions and minimizes the likelihood of accidents caused by lane incursions.

4. Efficient Use of Road Space: By efficiently allocating road space based on traffic flow, movable road dividers optimize the utilization of existing infrastructure. This is particularly beneficial in areas with limited space for road expansion or where land acquisition is challenging.

5. Integration with IoT: Incorporating IoT technology into movable road dividers enables them to be remotely controlled and monitored. Sensors embedded in the barriers can collect real-time data on traffic flow, allowing automated adjustments to lane configurations for optimal traffic management.

6. Adaptive Traffic Management: Through the use of data analytics and machine learning algorithms, IoT-enabled movable road dividers can intelligently predict traffic patterns and proactively adjust lane configurations to prevent congestion before it occurs.

7. Cost-Effective Solution: Compared to traditional methods of traffic management such as road widening or constructing new lanes, movable road dividers offer a more cost-effective solution. They

require less infrastructure investment and can be deployed relatively quickly.

8. Environmental Benefits: By reducing traffic congestion and idling times, movable road dividers contribute to lower emissions and improved air quality. This aligns with sustainability goals and promotes eco-friendly transportation practices.

In summary, the implementation of movable road dividers with IoT technology presents a forward-thinking approach to traffic management, offering a range of benefits including congestion relief, enhanced safety, efficient space utilization, and environmental sustainability.

VII. FUTURE SCOPE

The future prospects for this intelligent traffic management initiative are promising, poised to revolutionize our daily commutes significantly. As technology advances, we anticipate the development of even more sophisticated and efficient traffic management systems. Real-time data analysis will become quicker and more precise, enabling swift responses to evolving traffic conditions.[3] Integrating advanced sensors and artificial intelligence will enhance decision making, further reducing congestion and bolstering road safety.

Looking ahead these systems may interface with vehicles directly, facilitating automated adjustments to speed limits and lane configurations, thereby enhancing safety and convenience for drivers. Additionally, with a growing emphasis on sustainability, we envision these systems promoting the use of eco-friendly transportation modes and advocating for energy efficient routes. Collaborating with autonomous vehicles presents another exciting possibility, fostering seamless traffic management in our progressively smart cities.

Ultimately, the future trajectory of this project aims to enhance the efficiency, safety, and Eco friendliness of our daily commutes through the ongoing evolution of intelligent traffic management systems.

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