IOT-ENHANCED MOVABLE ROAD DIVIDERS FOR EFFICIENT MOBILITY

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Abstract — A Road Divider is commonly utilized to separate the traffic flow for both ongoing and incoming vehicles, maintaining a smooth traffic movement. Typically, there are equallanes allocated for both directions. However, in specific are as like industrial or shopping districts, traffic often flows predominantly in one direction during peak hours, leaving the other side of the road divider under utilized. This mismatch results in time wastage, traffic congestion, and inefficient use of resources. To address this issue, our proposal involves an automated movable road divider system that can adjust lanes dynamically, allowing for additional lanes in the direction of heavy traffic. The impact of even asingleextra lane in the rush direction can lead to significant time and fuel savings. Our smart solution aims to eliminate manual intervention and traffic coordination by employing IoT (Internet of Things) technology. Using sensors and Arduino boards,the system detects traffic flow and automatically shifts the divider towards the smoother lane, optimizing traffic distribution efficiently.

Keywords—Raspberry– pi, image processing, traffic control, Vehicle counting, Arduino Board, Pi Camera, Ultrasonic sensors Sensors.

I. INTRODUCTION

The challenge of road traffic congestion is a pressing issue faced by both road traffic authorities and the public due to its significant impacts [1]. The most critical impact is the delay in delivering emergency services to the location, leading to increased costs in terms of deaths, injuries, and financial losses resulting from incidents like fires, car crashes, and terrorist attacks [2]. This situation is not surprising, given that the conditions of roads in many cities worldwide have remained unchanged for decades, with limited development and technological adaptation in road transportation methods [3].

A common scenario observed is heavy traffic on one side of the road divider while the other side remains clear [4]. Addressing this issue, automatic control of the divider position can be implemented to alleviate traffic problems [5]. By utilizing the divider's movement, tratraf clearance can be facilitated for emergency vehicles like ambulances.

In this paper, we propose the design of a movable road divider that adjusts its position based on traffic flow. This system incorporates IoT technology to collect real-time data on vehicular traffic, enabling the assessment of current traffic operations and flow conditions. The sensors will be interconnected, covering various parts of the divider, ensuring seamless communication and efficient traffic regulation.

Fig.1.Traffic congestion on oneside of the road divider.[32]

To address these challenges, extensive research efforts have been undertaken, leveraging Information and Communication Technologies to enhance the traffic signaling system.

The project aim store duce peak-hour journey time sand alleviate traffic congestion, providing a smarter solution for these issues[11]. Static Road Dividers have a limitation – a fixed number of lanes on each side. With limited resources and agrowing population, the number of carsonroads is increasing. Hence, there's a need for optimal utilization ofexistingresources,suchasavailablelanes.Thispr oject,focusingontheInternetofThings,aimstoassis teveryindividualdrivingbyaddressingjourney-relatedproblems,includingtrafficcongestion.

II. LITERATURE SURVEY

1]Anireddy Sushrutha and C.R.K. Reddy [2] The paper titled "Movable Road Divider Using Internet of Things" discusses a novel approach to tackle traffic congestion by employing IoT technology for dynamically adjusting road dividers. The motivation behind this work stems from the pressing issue of traffic congestion in urban areas. The authors aim to provide a solution that can reduce traffic congestion, enhance traffic flow, and improve the efficiency of road usage. The authors discuss the existing systems, such as zipper machines or concrete lane dividers, which can be effective but have limitations, including human intervention and reduced lane width.

In contrast, the proposed system leverages IoT and automated road dividers to address traffic problems on heavily congested roads. The system utilizes IR sensors to detect traffic density, and the road divider adjusts accordingly, facilitating smoother traffic flow. The results and discussion section illustrates how the system operates in different traffic scenarios. It demonstrates that when traffic is low or medium, the road divider remains stationary. However, in the case of high traffic density, the road divider slightly shifts to accommodate the flow, effectively reducing congestion. the paper emphasizes the potential of the proposed system in reducing traffic congestion, enhancing road clearance, and prioritizing roads with higher traffic levels. It also suggests the system's applicability in parking management and future enhancements using cloud-based monitoring.

2] Sonali Naram, PradnyaMahabale and Ashlesha Nemane [4] paper titled "Smart Traffic Flow Management System using ATmega 328 Microcontroller" introduces an innovative system designed to enhance traffic flow management by deploying movable road dividers under the control of an ATmega 328 microcontroller. The primary objective of this system is to optimize traffic flow more efficiently by utilizing cutting-edge technology. The system utilizes image processing techniques to capture live traffic data, which is subsequently transmitted to the cloud for in-depth analysis and user accessibility. In a remarkable display of adaptability, the system adjusts the road divider based on real-time traffic density on each side of the road. When one side experiences congestion, the road divider dynamically shifts to provide more space to alleviate the traffic pressure. The paper thoroughly discusses the system's objectives, methodology, and operational principles, accompanied by a presentation 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. By harnessing image processing, cloud-based analytics, and adaptable road dividers, the system demonstrates a forward-thinking solution to address the ever-growing challenges of urban traffic congestion. This work showcases the potential for technology to significantly improve the efficiency of traffic flow management, offering a promising avenue for better traffic control in metropolitan areas.

3] Roopa Ravish and Shanta Ranga Swamy [3] paper titled "Intelligent Traffic Management: A Review of Challenges, Solutions, and Future Perspectives" provides an in-depth exploration of the landscape of Intelligent Transportation Systems (ITS) and their potential to address the persistent challenges posed by traffic congestion.The authors meticulouslycategorize ITS-based solutions into four distinct domains: traffic data collection, traffic management,

congestion avoidance, and travel time prediction. Each of these categories is thoroughly examined, with a focus on the various technologies and strategies deployed, and an assessment of their respective merits and limitations. The paper underscores the paramount importance of effective traffic management and traffic congestion control. It sheds light on the intricate challenges faced in these domains, such as the need for accurate travel time prediction and the necessity for real-time traffic data collection. Furthermore, the authors present insightful suggestions and avenues for future research, providing a roadmap for further advancements in the field. In sum, this comprehensive review serves as a valuable resource for stakeholders, decision-makers, and researchers in the realm of urban traffic management. By offering a thorough overview of existing solutions, their strengths and weaknesses, and by highlighting the pressing challenges that need to be addressed, the paper empowers professionals and researchers to make informed choices regarding the adoption of suitable technologies and strategies for effective traffic management in urban environments. This paper, therefore, significantly contributes to the ongoing discourse surrounding the enhancement of traffic management systems and paves the way for more efficient and innovative approaches to urban transportation challenges.

4] Rashmi C, Roopa T N, Samrudh R and Sandhya M [1] paper titled "Movable Road Dividers" introduces an inventive solution for addressing the chronic problem of urban traffic congestion through the implementation of movable road dividers. The authors keenly recognize a fundamental issue with static road dividers, which lies in their incapacity to adapt to the ever-changing dynamics of traffic conditions. This becomes increasingly pressing as urban populations burgeon and the number of vehicles per household escalates, necessitating a more efficient use of existing road infrastructure. The paper presents a comprehensive solution involving automated road dividers that possess the remarkable capability to dynamically shift lanes, thereby optimizing traffic flow without the need for extensive alterations to the physical road structure. At the heart of this innovative system are a sophisticated array of sensors, including ultrasonic and IR sensors, coupled with microcontrollers and RGB LEDs. These sensors work in tandem to detect real-time traffic density, enabling the system to respond adaptively by moving the road divider as needed to alleviate congestion. Furthermore, the system's design encompasses a prioritization mechanism for emergency vehicles, such as ambulances, creating a dedicated and expedited pathway for them to navigate through the traffic. This pioneering approach exhibits considerable potential in terms of reducing traffic congestion, enhancing traffic management, and elevating road safety standards, particularly within densely populated urban areas. The paper's contribution to the field of traffic management is substantial, offering a forward-thinking solution to a problem that plagues urban areas globally. By introducing the concept of movable road dividers and leveraging sensor-based technology, this innovative approach has the capacity to transform the way we address and mitigate traffic congestion in our cities, ultimately leading to more efficient and safer urban transportation systems.

5] Shubhankar Bhate, Prasad Kulkarni, Shubham Lagad, Mahesh Shinde, Shivprasad Patil [5] The paper titled "IoT-based Intelligent Traffic Signal System for Emergency Vehicles" addresses the growing challenge of traffic congestion in India due to the increasing number of vehicles on the road. The authors propose a solution that utilizes IoT technology to efficiently manage traffic and prioritize emergency vehicles like ambulances, fire brigades, and police vehicles. They introduce components such as : Node MCU, Rasbery Pi, RFID tags
and MQTT protocol to enable communication between vehicles and traffic signals. When an emergency vehicle approaches, the system automatically detects it through RFID tags, communicates with central control systems, and adjusts traffic signals to give priority passage to the emergency vehicle. The literature review highlights related work in traffic management and emphasizes the unique contribution of this proposed system in addressing traffic congestion and ensuring swift access for emergency vehicles.

III. PROPOSED ARCHITECTURE

In the proposed system, a module has been developed, comprising an IR sensor designed for measuring traffic density [6]. When a vehicle passes these IR sensors, they detect the vehicle and transmit the information to the Raspberry Pi [7]. A variable resistance sets a reference according to the required sensing range, counting events from LOW to HIGH, indicating vehicle passage [13]. The system calculates the percentage of traffic density on each side of the divider based on these events. If the traffic density is high, the movable divider adjusts and displays the percentage of traffic for both lanes on an LCD display, along with the direction of movement. If an obstacle is detected during divider movement, it halts until the obstacle is cleared. In case of emergency vehicles, the traffic light's red light turns green, and red LEDs either on the divider side or at lane ends indicate other vehicles to clear the lane for the emergency vehicle.

A. Measuring traffic density using IR sensor[25]

IR sensors, positioned on the road divider, face both sides of the road to measure traffic density in terms of the percentage. They record reflection times during a fixed period, indicating passing vehicles based on the infrared rays. This reflection time correlates with vehicle count, speed, and lane number. The obtained reflection times are converted into percentages relative to the total reading time. By comparing these percentages, high traffic density is identified. The divider is then shifted towards the lower density side, creating an extra lane for the busier side. LCD display screens alert approaching vehicles about the divider movement, ensuring a clear lane for the transition

B . Resolving the inconsistencies in the Data[25]

The data reveals inconsistencies in traffic density on each side of the street. At different times, traffic flow is asymmetric: in the early hours, the side leading to commercial areas experiences more congestion, while during the evening and night, the opposite side toward residential blocks faces higher traffic. This pattern results in surplus space on the other lanes, providing an opportunity to optimize traffic flow during specific times.

Certainly! We make decisions based on traffic density, choosing from three options:

1) Ideal Situation: The divider remains stationary, avoiding any movement.

2) Shift Left: Move the divider x lanes to the left to accommodate traffic flow.

3) Shift Right: Move the divider x lanes to the right for optimal traffic management.

This decision-making process is repeated as needed. In an ideal scenario, we aim to minimize divider movements throughout the day. It is crucial to avoid overworking the mechanism by limiting lane changes in response to traffic inconsistencies.

C.Process the data to move the divider

To shift the barrier along the lane, the program assesses the vehicle distribution on each side of the divider, as depicted in Figure. By examining the percentage of vehicle density on the left and right sides of the road, the program initially presents the traffic density for both sides on the LCDdisplay. Subsequently, the program determines the direction for moving the divider based on this traffic density, as revealed in Figure. Additionally, the divider is equipped with an ultrasonic sensor, serving to alert the program of any obstacles in its path and ensuring a safe relocation.

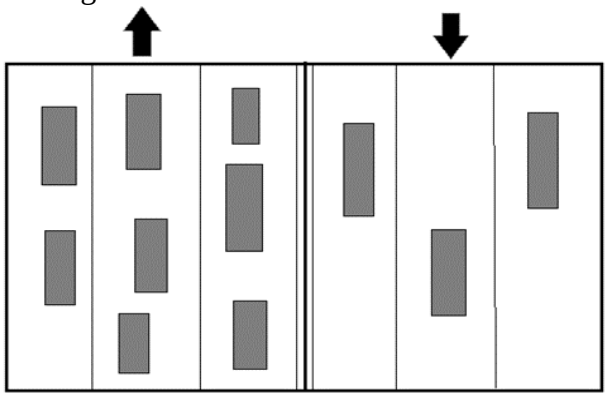

Fig.2a.Heavy traffic on left side of road[1]

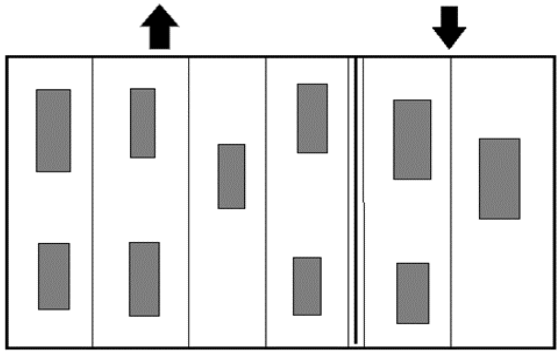

Fig.2b.Shifting of Divider towards right side[1]

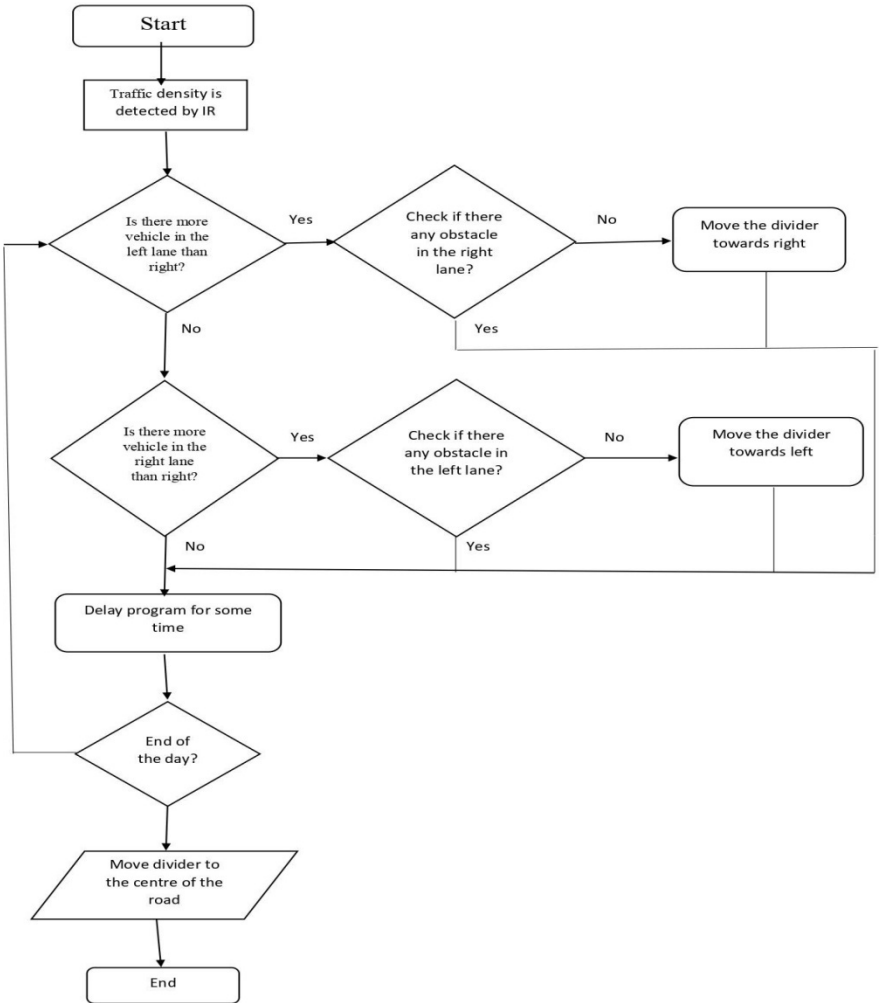

Fig.3.Flowchart representing the algorithm of program[7]

IV. IMPLEMENTATION

In the implementation of the divider-shifting mechanism, the project leverages Proteus software and Arduino IDE for simulation purposes [7]. Initially employing a switch in the simulation, the actual model will incorporate an IR sensor for more precise detection of vehicle volume on the road [8]. The switch is linked to the input of the Arduino, while the IR sensor will play a crucial role in providing real-time traffic information. Utilizing output pins 0-13 for receiving and transmitting signals, four LEDs (red, green, yellow, and blue) are connected to pins 0-4. The red, green, and yellow LEDs emulate a traditional traffic light system, while the blue LED serves as an indicator for the impending movement of the divider.

To facilitate the physical movement of the divider, two motors are integrated into the system. The first motor is connected to pins 10 and 11, while the second motor is linked to pins 12 and 13[17]. These motors actively contribute to shifting the divider based on the traffic conditions observed through the IR sensor[19]. The entire system is orchestrated through a meticulously crafted Arduino code, ensuring seamless integration and synchronization of the various components

Additionally, the use of IR sensors enhances the accuracy of vehicle detection, contributing to a more reliable traffic volume assessment. The incorporation of LEDs not only serves a functional purpose in signaling but also adds a visual dimension to the mechanism, aiding in the intuitive understanding of the system's operation. The assignment of specific pins for motor control ensures a systematic and organized implementation of the divider-shifting mechanism.

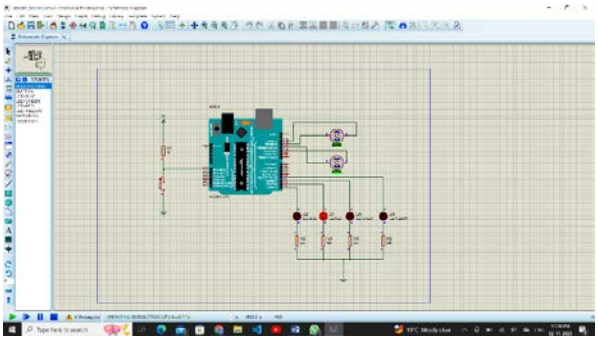

Fig.4a.Simulation with Red LED Active

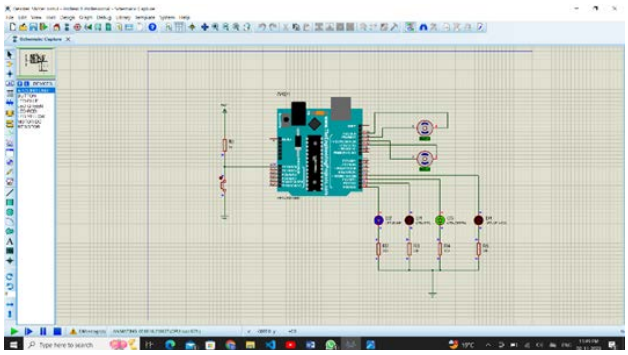

Fig.4a.Simulation with Blue and Green LED Active

V. FUTURE SCOPE

The future scope of this project involves transitioning from simulation to a fully functional model by incorporating various hardware components [11]. One significant enhancement is the replacement of the simulated switch with a real-world IR sensor for accurate vehicle detection [26]. Integrating this hardware element will enhance the reliability of the system, providing more precise data on road traffic conditions [28].

Furthermore, the utilization of actual LEDs and motors in the model will offer a tangible representation of the divider-shifting mechanism. Implementing the traffic light system with physical LEDs will not only add a practical dimension to the project but also contribute to improved visibility and understanding of the traffic control aspects.

To achieve this transition, the project will involve the assembly of all required hardware components, including the IR sensor, LEDs, and motors. The Arduino code will need to be adapted to interface seamlessly with the physical components. Calibration and testing procedures will be essential to ensure the accurate functioning of the entire system in real-world scenarios.

Additionally, exploring the integration of wireless communication modules or connectivity options can be considered for remote monitoring and control of the divider-shifting mechanism. This opens avenues for smart city applications and centralized traffic management.

Overall, the future scope of the project involves bridging the gap between simulation and reality, transforming the divider-shifting mechanism into a practical and deployable solution with tangible hardware components and enhanced functionality.

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