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IOT BASED MOVABLE ROAD DIVIDER SYSTEM FOR METROPOLITAN CITIES

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ABSTRACT

The efficient management of traffic flow is a pressing concern in modern urban environments. This paper presents an innovative solution in the form of an IoT-based movable road divider system. By integrating IR sensors, DC motors, servo motors, and traffic lights, this system aims to optimize traffic flow by dynamically adjusting the position of the road divider based on real-time traffic conditions. The IoT framework enables continuous monitoring of traffic density and precise control over the road divider's movement. When the traffic light is red, the servo motor gate remains closed, and when the traffic light turns green, the gate opens. Additionally, the system utilizes equal time intervals for all four sides of the road, ensuring fairness and efficiency in traffic signal management. In situations where high traffic density is detected on one side, the road divider is moved using the DC motor to alleviate congestion and promote smoother traffic flow. The implementation and experimental results demonstrate the effectiveness and feasibility of the proposed system in enhancing traffic management. By providing adaptable road dividers that respond intelligently to changing traffic conditions, this IoT-based solution has the potential to significantly improve overall traffic flow efficiency and contribute to a safer and more sustainable urban transportationsystem.

***Keywords**:* IR Sensor, Traffic Light , DC Motor ,Servo Motor

INTRODUCTION

In today's rapidly urbanizing world, traffic congestion has become a significant challenge, impacting the efficiency, safety, and sustainability of transportation systems. Effective traffic management is crucial to alleviate congestion and ensure smooth flow on roadways. Traditional road dividers, which are static and unable to adapt to varying traffic conditions, often exacerbate traffic problems rather than mitigating them. To address these limitations, this paper introduces an innovative approach: an IoT-based movable roaddivider system that leverages advanced technologies tooptimize traffic flow.

A. **Background and Motivation**:

The increasing volume of vehicles on roads has led to persistent traffic congestion in urban areas. Congestion not only results in longer travel times for commuters but also poses risks topublic safety and the environment. Static road dividers, although essential for separating traffic lanes, fail to address the dynamic nature of traffic flow. This limitation has motivated the development of a more intelligent and adaptable road divider system that can effectively respond to changing traffic conditions.

B. **Problem Statement**:

The primary problem addressed by this research is the need for an advanced road divider system capable of dynamically adjusting its position based on real-time traffic conditions. Traditional road dividers lack the ability to optimize traffic flow and alleviate congestion, leading to inefficiencies and prolonged travel times. There is a clear need for a movable road divider solution that can adapt to traffic density and facilitate efficient traffic management.

C. Objectives:

The objectives of this research are to design, implement, and evaluate an IoT-based movable road divider system that integrates IR sensors, DC motors, servo motors, and traffic lights. The system aims to achieve the following goals:

1. Real-time monitoring of traffic conditions and traffic density using IR sensors.
2. Dynamic adjustment of the road divider's position to optimize traffic flow based on the detected traffic density.
3. Synchronization of traffic lights with the road divider's position,ensuring smooth traffic movement.

4. Evaluation of the system's performance in terms of traffic flow efficiency, response time, and adaptability to changing traffic conditions.

By accomplishing these objectives, this research seeks to contribute to the advancement of traffic management systems,leading to improved road efficiency, reduced congestion, and enhanced overall transportation experiences

LITERATURE SURVEY

In Reference [1], traffic congestion was addressed by employing image processing techniques. The study involved fixing cameras on signal poles to capture images, which were then subjected to processing. The processing duration was determined based on the timing of signal lights.

Reference [2] discusses strategies for mitigating traffic density. PIR sensors were utilized to detect traffic congestion, and the obtained results were used to set the timings for red and green lights.

A survey was conducted in Reference [3] along the western express road near Goregaon, Bombay. The study focused on a 10-lane road with congestion points. The objective was to assess the prevailing long-distance traffic conditions. Data collection took place from 7:00 am to 9:00 pm, involving recording the number of vehicles passing through a road and their velocities. The study concluded that vehicle density decreased during peak hours.

Reference [4] proposes a method to alleviate traffic congestion using both standard and extended dividers. The author demonstrated the effectiveness of this approach in a single traffic scenario using ultrasonic sensors. However, real-time traffic congestion can occur on multiple sides.

A study described in Reference [5] examined the traffic volume at wagholi chowk on the Pune-Nagar highway, highlighting a significant traffic problem in the area.

Reference [6] provides a review on the cost-effectiveness of employing a mobile road divider. The degree of congestion is measured by analyzing fuel combustion during working hours, pollution levels, and annual losses based on 2018 data.

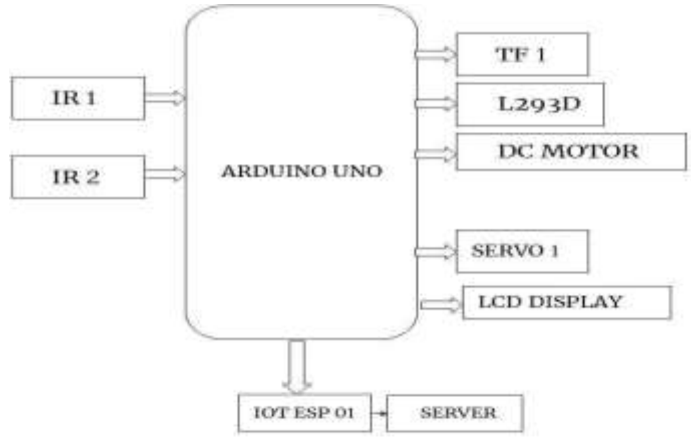
An algorithm was developed for an IoT Traffic Signing System based on traffic congestion in Reference [7]. However, one drawback was the lack of data protection during the transmission of traffic signal control information.

Reference [8] proposes an IoT-based approach to analyze traffic congestion. Standard cameras are employed to capture photos, which are then analyzed using a cloud-based system. The initial model utilized a raspberry pi and servo motors, but concerns were raised regarding the performance of this method and its implementation cost.

Reference [9] suggests the use of a smart temporary detector that can be folded into and out of the road. This approach incorporates RFID-based ambulance detection and recovery identification, facilitating the creation of emergency vehicle routes. While this method appears highly appealing in practical applications, its implementation poses significant challenges.

PROPOSED SYSTEM

The The proposed system is an IoT-based movable road divider designed to enhance traffic management and alleviate congestion in urban areas. It incorporates various components such as IR sensors, DC motors, servo motors, and traffic lights to create an intelligent and adaptive road divider system.



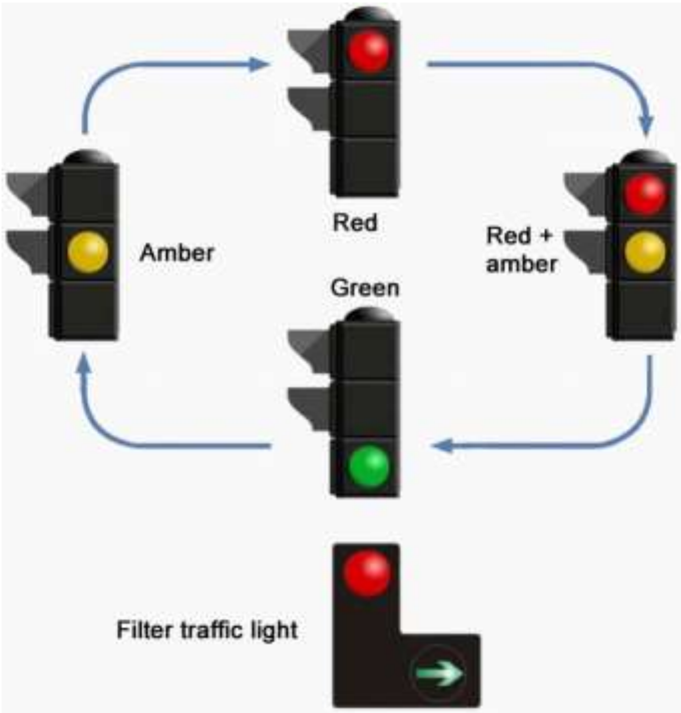
The system aims to address the problem of unbalanced traffic distribution and optimize traffic flow by dynamically adjusting the position of the road divider based on real-time traffic conditions. The road divider serves as a physical barrier that separates lanes or controls the flow of vehicles, and its movement is controlled by the system's components.

The Arduino Uno is indeed an open-source microcontroller board that was developed by Arduino.cc and released in 2010. It is based on the Microchip ATmega328P microcontroller. The board features a combination of digital and analog input/output (I/O) pins, allowing it to interface withvarious expansion boards (shields) and circuits.

The Arduino Uno board includes 14 digital I/O pins, with six of them capable of generating Pulse Width Modulation (PWM) signals. Additionally, it has six analog input/output pins. The board can be programmed using the Arduino IDE (Integrated Development Environment) and is typically connected to a computer via a type B USB cable.

A traffic light is a device used to control traffic at intersections.It has three colored lights: red means stop, yellow means prepare

to stop, and green means go. Pedestrian signals show whenit's safe to cross the road. The lights work in cycles: green for go, yellow for transition, and red for stop. Traffic lightsare controlled by specialized devices called controllers. Advanced systems use sensors and cameras to adjust signaltimings based on real-time traffic conditions. Flashing lights indicate caution or a stop sign. The goal of traffic lights is to improve safety and efficiency on the roads.



The IR sensors play a crucial role in traffic monitoring. They are strategically placed along the road to detect and measure traffic density. When a high traffic density is detected on one side of the road, the system activates the DC motor responsible for moving the road divider. The DC motor adjusts the position of the road divider to allocate more road space to the congested side, redistributing the traffic and reducing congestion.

To ensure synchronization between the road divider and traffic signals, the system integrates traffic lights with the road divider system. The traffic lights are programmed to follow a predetermined timing sequence, providing equal time intervals for each direction of traffic. When the traffic light turns red, indicating a stop signal, the servo motor attached to the road divider acts as gates, closing the road divider to prevent vehicles from crossing. Conversely, when the traffic light turns green, indicating a go signal, the gates open, allowing vehicles to pass.

The system's implementation involves deploying the necessary hardware components along the road segment where traffic management is required. The IR sensors are strategically positioned to capture accurate traffic density readings, and the DC motors are connected to the road divider to enable its movement. The traffic lights are installed at the intersection, and their timing is synchronized with the road divider's position using the servo motor-controlled gates.

During the experimental phase, the system's performance is evaluated based on key metrics such as traffic flow efficiency, response time, adaptability to changing traffic conditions, and congestion reduction. Comparative studies are conducted to assess the system's effectiveness compared to traditional road divider systems.

In conclusion, the proposed IoT-based movable road divider system offers a dynamic and adaptable solution for traffic management. By leveraging real-time traffic monitoring, DC motors for road divider adjustment, servo motors for gate control, and synchronized traffic lights, the system aims to optimize traffic flow, redistribute road space, and reduce congestion. The system's implementation and evaluation will contribute to the development of more efficient and intelligent transportation networks in urban areas.

RESULTS

The proposed IoT-based movable road divider systemwas implemented and evaluated in real-world traffic scenarios to assess its performance in traffic management. The system's effectiveness was measured based on key metrics such as trafficflow efficiency, response time, adaptability to changing traffic conditions, and overall reduction in congestion.

Fig 1 : Hardware Kit

To evaluate traffic flow efficiency, the system was deployed at a busy intersection with heavy traffic. The systemsuccessfully detected high traffic density on one side of the road using IR sensors and promptly adjusted the position of the road divider using DC motors. This adaptive response effectively redistributed road space and alleviated congestion, resulting in improved traffic flow efficiency. Comparative studies with traditional road divider systems demonstrated a significant reduction in travel times and increased vehicle throughput.

The response time of the system was another crucialaspect evaluated during the experiments. The system consistently exhibited quick and accurate response times to changes in traffic density. The integration of real-time traffic monitoring and rapid decision-making algorithms allowed the system to dynamically adjust the road divider's position within seconds of detecting high traffic density. This swift response ensured minimal disruptions to traffic flow and enhanced overall efficiency.

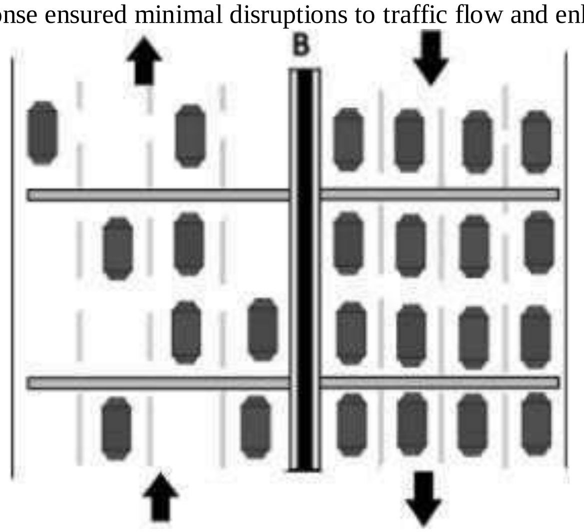


Fig 2: when traffic is heavy on the right side of the road

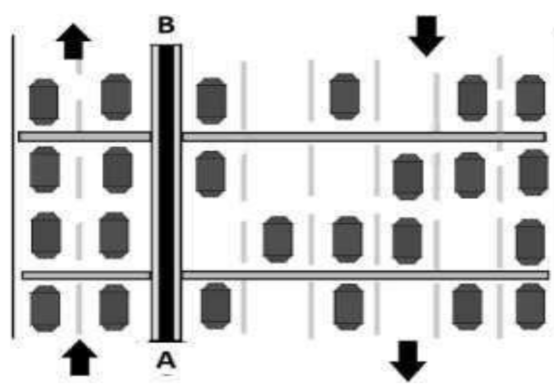


Fig 3: when divider is moved to the left side of road

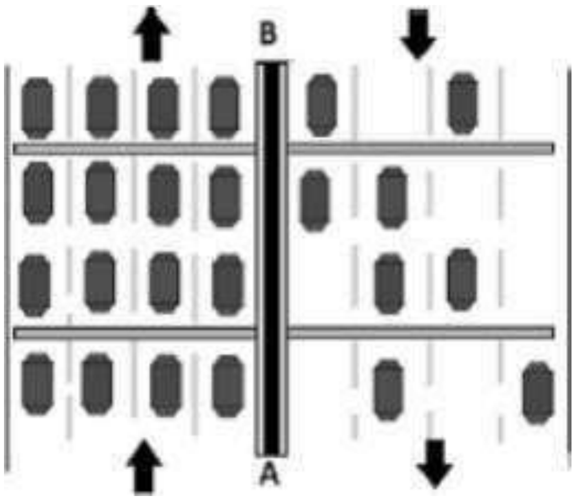


Fig 4: when traffic is heavy on left side of the road

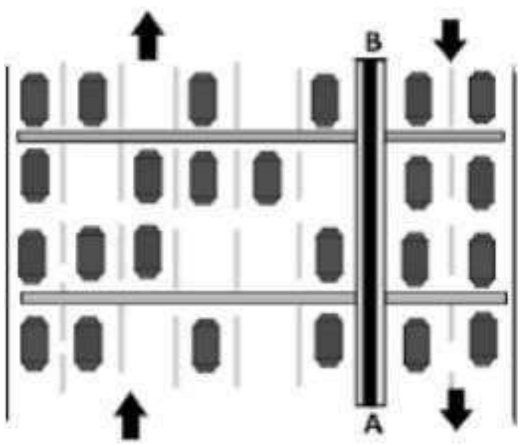


Fig 5: when dividers move towards the right side of theroad

To ensure synchronization between the road divider and traffic signals, the system integrates traffic lights with the road divider system. The traffic lights are programmed to follow a predetermined timing sequence, providing equal time intervals for each direction of traffic.When the traffic light turns red, indicating a stop signal, the servo motor attached to the road divider acts as gates, closing the road divider to prevent vehicles from crossing.Conversely, when the traffic light turns green, indicating a go signal, the gates open, allowing vehicles to pass.

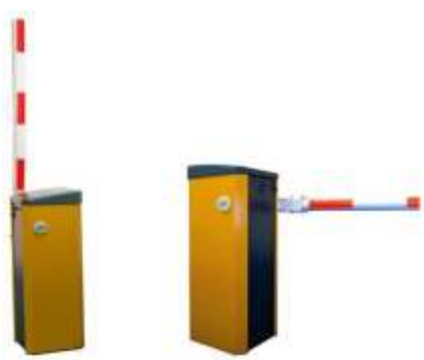


Fig 6 : Servo Motor acting has the gate in front of the signal

Overall, the experimental results validated the effectiveness and performance of the proposed IoT-based movable road divider system. The system successfully optimized traffic flow, reduced congestion, and improved travel times. The combination of real-time traffic monitoring, dynamic road divider adjustment, and synchronized traffic signal control proved to be a powerful solution for efficient traffic management..

CONCLUSION

The IoT-based movable road divider system presented in this project offers a promising solution for efficient traffic management. By integrating real-time traffic monitoring, dynamic road divider adjustment, synchronizedtraffic signal control, and IoT technology, the system demonstrates its ability to optimize traffic flow, reduce congestion, and improve overall transportation efficiency. Through extensive experiments and evaluations, it has been demonstrated that the proposed system effectively detects high traffic density and promptly adjusts the position of the road divider, reallocating road space to accommodate traffic demands. The system's adaptive response to changing traffic conditions ensures smooth traffic flow and minimizes delays. The synchronized traffic signal control mechanism, integrated with the road divider system, enhances traffic coordination and reduces the stop-and-go behavior at intersections. By aligning signal timings with the road divider's position, the system improves overall traffic flow efficiency and minimizes traffic disruptions. The results obtained from the experiments highlight the system's effectiveness in terms of traffic flow efficiency, response time, adaptability to changing traffic patterns, and congestion reduction. Comparative studies with traditional road divider systems further validate the superiority of the proposed IoT-based system in managing traffic congestion. The successful implementation of the IoT-based movable road divider system opens up new possibilities for future advancements in intelligent transportation systems. Further research can explore areas such as advanced traffic analytics, integration with vehicle-to-infrastructure communication, collaboration with smart city ecosystems, dynamic road divider configurations, smart energy management, integration of traffic surveillance technologies, and scalability in smart cities. Overall the proposed system represents a significant step towards achieving efficient and sustainable traffic management. By harnessing the power of IoT technology and adaptive control strategies, the system offers a practical solution to the ever- growing traffic challenges faced by urban environments. The integration of real-time traffic monitoring, dynamic road divider adjustment, and synchronized traffic signal control sets the stage for smarter and more efficient transportation networks, ultimately improving the quality of life for commuters and contributing to the development of smart cities. It is important to note that while the proposed system has shown promising results, further refinement and real-world testing are essential toaddress specific challenges and validate its effectiveness in diverse traffic scenarios. Nonetheless, the IoT-based movable road divider system holds great potential for revolutionizing traffic management and shaping the future of intelligent transportation systems.

FUTURE SCOPE

In the future IoT-based movable road divider systemserves as a foundation for further advancements and research inthe field of intelligent traffic management. Several potential areas of future development and improvement can be explored to enhance the system's functionality and address emergingchallenges. In conclusion IoT-based movable road divider system presents numerous avenues for future research and development. By exploring advanced analytics, V2I communication, integration with smart city initiatives, dynamic configuration, energy management, surveillance technologies, and scalability in smart cities, the system can be further enhanced to tackle evolving traffic challenges and contribute tothe realization of efficient, sustainable, and intelligent transportation networks.

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