Adjustable Road Divider for Dyanmic Traffic Management Using IOT

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Abstract : Automatic Movable Smart Road Divider using Arduino, LCD, 4 IR Sensors, and L293D Gear Motor is a dynamic way of managing traffic congestion by automating shifting road dividers in response to density of vehicles. It happens that the fixed road dividers do not allow the lanes to be utilized effectively, especially during peak hours. An intelligent divider has been introduced, which automatically shifts lanes. Thus, it alleviates bottlenecks and fairly achieves efficiency on the road. The system has four IR sensors located on both sides of the roads, measuring vehicle density. The sensor data is processed by the Arduino microcontroller, which also drives the L293D gear motor for moving the divider. A real-time status with the display of lane adjustments and traffic conditions will be shown in an LCD. In cases of higher vehicle density on one side, the divider will shift more space for that lane thereby ensuring better channeling of traffic movement. Key advantages of this system include real-time adaptation to traffic, reduced congestion, low power consumption, and cost effectiveness. They will also minimize human intervention and improve road safety.

Keywords **:** Arduino UNO, IOT, LCD, IR Sensors, Movable road divider, RPS, Gear MOTOR.

I.INTRODUCTION

Traffic is one of the greatest troubles faced by cities, delaying time and wasting fuel in addition to the pollution and risks of accidents it generates. Traditional roadways, instead of physically-shaped and fixed-lane width designs, are grossly insufficient in realizing the efficiency of a road on the basis of its dynamic traffic patterns. During some peak periods, certain lanes have high vehicular traffic, while others have little or none at all. To solve this issue, a smart and adaptive traffic management system that is capable of dynamically adjusting the lane configuration based on real-time vehicular density needs to be considered.

This Automatic Movable Smart Road Divider is an attempt at solving the above problem by displacing the road divider based on the traffic flow, which maximizes road space. Using Arduino as the main controller, traffic density monitoring is done continuously via four IR sensors installed on different sections of each lane. Upon any imbalance detected, the system autonomously shifts the divider using gear motors, controlled via an L293D motor driver. A 16x2 LCD display is included to indicate the real-time operation of the system.

This makes traffic more efficient without having to modifiy the major infrastructure themselves. This applicated system could play an important role in cities and highways, where differences in the traffic flow from phenomenon to phenomenon are noticeable.

Increased travel times, fuel wastage, pollution, and economic losses are some of the results of traffic congestion. There is a growing need for smart and automated traffic management systems, as traditional traffic lights or road markings cannot dynamically adapt to changes in traffic load.
Some major challenges that arise in urban traffic management are:

1. Unequal Lane Usage – Fixed lane widths cannot accommodate diverse traffic densities.
2. Traffic Jam at the Intersection – Often less than optimal flow results in stop-and-go behavior and then outright congestion.
3. Slow Adjustment to Changing Traffic Conditions – Manual interventions tend to be slow and not very efficient.
4. Higher Risk of Road Accidents – Lanes not being properly distributed elevate the risks of collisions.
5. Environmental Effects – Increased emissions due to idling vehicles in congested areas.

This automated, sensor-based, real-time traffic control upgraded systems will be a great achievement towards optimum utilization of the road space, and relieve the problems mentioned above.

II. LITERATURE SURVEY

2.1 Satya Srikanth Palle , " Implementation of Smart Movable Road Divider and Ambulance Clearance using IOT", IEEE Xplore, May 2019.

The research paper of Satya Srikanth Palle, " Implementation of Smart Movable Road Divider and Ambulance Clearance using IOT", IEEE Xplore, May 2019.A majority of the

Nations of the World are facing Traffic Congestion problems because the number of vehicles is increasing day by day. Even though the number of automobiles has increased, the Road infrastructure remains nearly the same which cannot be able to cope up with the transformation like unforeseen journey delays, traffic congestion and accidents. The main flaw with Static Road Divider is that the lanes on both sides of the road are fixed. Since the population and number of vehicles per family is increasing and resources are limited, a lot of vehicles are placed on roads, and therefore traffic control over the road is a serious problem in the modern world.

2.2 Gupta, A., Verma, R., & Singh, P. "Automated Road Dividers for Traffic Congestion Reduction," pp. 120-125, IEEE Xplore, March 2020.

Research article by Gupta, A., Verma, R., & Singh, P. titled "Automated Road Dividers for Traffic Congestion Reduction." published in IEEE Xplore in March 2020.Traditional traffic management implements fixed lane allocations, which are ineffective to meet varying traffic densities during different times of the day. Motorized road dividers shifting lanes at fixed time intervals are studied here to overcome congestion. The system is effective to reduce bottlenecks but lacks real-time vehicle sensing. Sensor-based dynamic adjustments are emphasized as a requirement rather than time-based movements by the authors because traffic patterns can turn out to be uncertain.

2.2 Sharma, V., & Kumar, R. "Implementation of IR and Ultrasonic Sensors for Smart Traffic Control," pp. 88-92, Springer, October 2021.

Sharma, V., & Kumar, R. "Implementation of IR and Ultrasonic Sensors for Smart Traffic Control," Springer, October 2021.Accurate vehicle detection is important for the control of real-time traffic. In this paper, Infrared (IR) sensors and ultrasonic sensors are compared for vehicle detection in intelligent traffic systems. IR sensors are inexpensive, power-saving, and provide accurate vehicle counting under normal circumstances. However, the study acknowledges limitations during dusty, foggy, or rainy environments, where IR sensor accuracy is degraded. The authors propose the utilization of multiple redundant sensors and data fusion techniques to improve detection accuracy to mitigate this.

22.3 Reddy, K., Banerjee, A., & Joshi, M. "Microcontroller-Based Adaptive Traffic Signal System," pp. 215-220, Elsevier, June 2019.

The work of Reddy, K., Banerjee, A., & Joshi, M. "Microcontroller-Based Adaptive Traffic Signal System," pp. 215-220, Elsevier, June 2019.Microcontrollers such as Arduino UNO play a vital role in automating intelligent traffic control systems. This work develops an adaptive traffic signal system with dynamic adjustment of signal timings based on real-time vehicle density. The result indicates that Arduino-controlled systems reduce waiting times at intersections significantly. Nevertheless, the study leaves out physical lane re-allocation, which is a crucial aspect of dynamic lane management. The authors suggest the use of automated lane changing mechanisms alongside adaptive traffic lights to optimize road capacity.

1. Introduction:

Normally designed for a fixed distribution of lanes over roadways, traditional road infrastructures lead to traffic, especially at peak hours, when such one-sided heavy traffic is experienced. These problems bring the need for introducing an Adjustable Road Divider, which will actually dynamically reallocate the lanes according to real-time traffic density. The system incorporates IoT (Internet of Things), Arduino UNO, IR Sensors, Gear Motor, and Rack & Pinion System (RPS), which will monitor the traffic conditions and adjust the divider accordingly.

You are to point out a traditional roadway design of a fixed lane distribution and lead to traffic congestion, especially in peak hours when one side of the road suffers heavier traffic than the other. To solve this problem, an Adjustable Road Divider will introduce in which the divider will dynamically reallocate lanes based on traffic density in real-time. This system is made of IoT (Internet of Things) devices, Arduino UNO, IR Sensors, Gear Motors, and Rack & Pinion System (RPS) to monitor the traffic conditions and make the necessary alterations onto the divider.

This system is designed primarily to decongest traffic, improve the efficiency of traffic flow, and provide real-time data to traffic authorities for better decision making.

2.System Design and Components

a) 2.1. Microcontroller: Arduino UNO

The Arduino UNO is the system's CPU. It collects data from IR sensors, processes the data about the traffic condition, and sends control signals to the gear motor for moving the road divider.

b) 2.2. IR Sensors for Traffic Detection

- Infrared sensors are deployed on both sides of the road to count the number of vehicles passing during a certain time frame.
- The sensors continuously send signals to the Arduino UNO, which accordingly determines the traffic density.
- The system establishes predefined threshold values to declare when the divider is to be actuated.

c) 2.3. Movable Road Divider Mechanism

- A Gear Motor Selected and Configured for Work with A Racking And Pinion System (RPS) Allows Motion of The Road Divider According to Traffic Requirements.
- The gear motor receives signals from the Arduino UNO to either move the divider forward or backward.
- This ensures the movement of the divider along the road in a smooth linear manner.

d) 2.4. LCD Display for Real-Time Information

- Some more features like time of the day, distances from the user's location, emergency help, and parking availability can make this system more usable for drivers and safety agencies.
- he system also has several parking spaces that could be integrated with this system so as to support parking space information to the drivers.

e) 2.5. IoT Integration for Remote Monitoring

- The system is connected to an IoT module(Most Probably ESP8266 or GSM module) from which it can send real time traffic data to cloud server for mobile applications.
- Better urban planning and monitoring could be done using this data by traffic authorities from remote.

3. Working Principle

f) 3.1. Traffic Sensing and Data Collection

- Strategically placed IR sensors within the automobile count detect and send this information to the Arduino UNO.
- The microcontroller continuously monitors traffic density on either side of the road.

g) 3.2. Decision-Making Algorithm

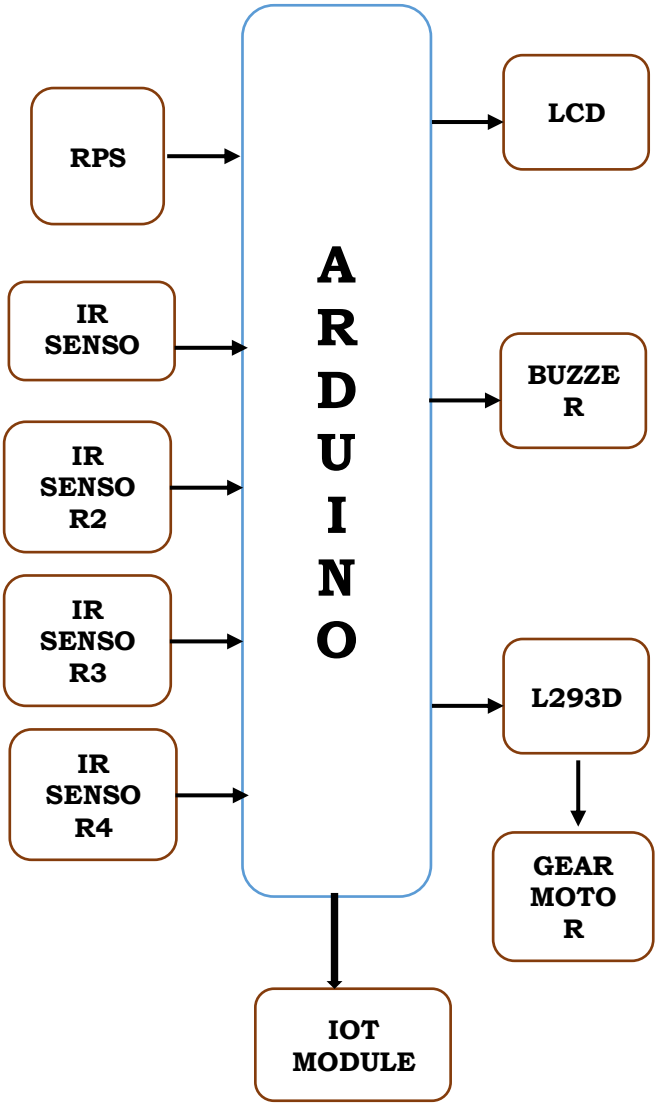
- If the number of vehicles on one side surpasses an established value, the system decides the necessity of adjusting the lane.
- The data will now be processed by the Arduino to make a decision about moving the divider either toward the left or toward the right.

h) 3.3. Divider Movement Mechanism

- Signals are sent from Arduino to the gear motor, which, in turn, drives the RPS system to reposition the divider.
- The divider shifts in the appropriate direction to provide more lanes on the side where the traffic is heavier.

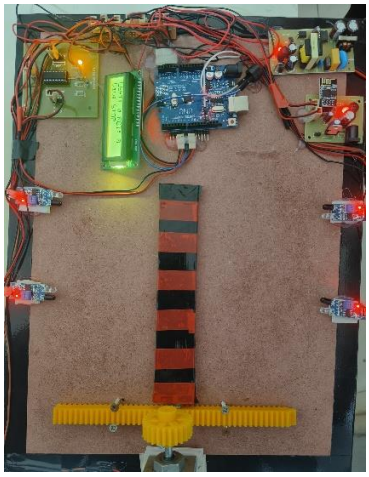
i) 3.4. Real-Time Updates and IoT Communication

- The difference status and transport updates are displayed on the LCD screen.
- The IoT module sends real-time traffic data to be available on an online server from where traffic management authorities can access it.



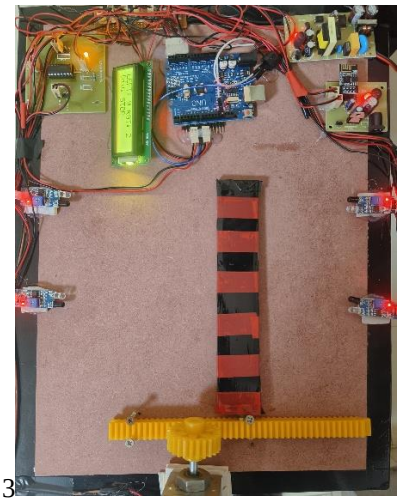
IV.RESULTS

The movable road divider experiment includes many IR Sensors which have been deployed on either side of a divider to detect the presence of density of vehicles, it senses the traffic density. Now according to the density of vehicles as determined by observing the IR sensors, the divider now moves on either side to give more space for the smooth flow of traffic in that area to overcome the density.



Divider in Constant Position

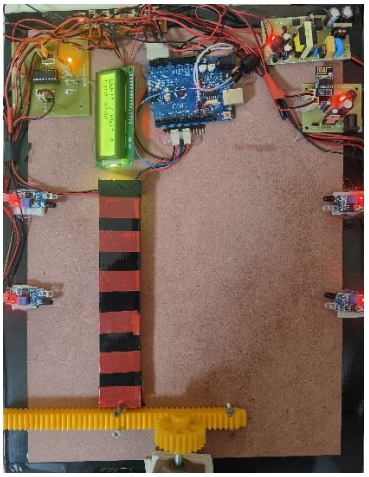
Thus, the Fig below represents the prototype of a Movable Road Divider, where the high traffic in lane I, and the divider is 1 shifted towards lane 2 after intimidating the driver about the movement of the divider by means of the buzzer.



3

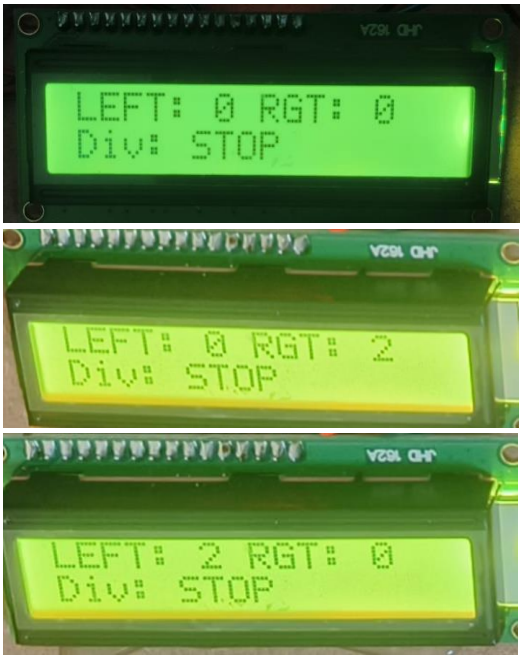
Divider is Moving Towards Right side

The below Fig portrays the Movable Road Divider's model that displays high traffic in lane 2 where the divider is moved to lane I after intimation of the movement of the divider to the driver by a buzzer, and the divider resets once the Traffic returns to normal.



Divider is Moving Towards left side

Traffic density was indeed put on display for both lanes. The LCD in that case would display "Less Traffic" if the density of the traffic were less for those lanes. If the density of traffic is less than medium, then the LCD display will show "Medium Traffic". In case of high density, the dictionary says "high traffic", an alarm sounds to show that the divider is about to move and actually works to move the divider.



LCD Display the Traffic Density

Under the high traffic condition in the traffic signal, it displays "High Traffic" on the LCD, followed by the buzzer sound which indicates that the divider will open and the divider will be opened soon. The Ambulance unit in Fig 10 consists of an Ambulance which has an RF Transmitter with an attached battery. When this

RF Transmitter is operational, then the nearby RF Receiver close to the traffic signal receives the signal of this Ambulance through the RF Transmitter within a certain range immediately making the traffic signal green.

V.FUTURE SCOPE

The future scope for the project "Adjustable Road Divider for Dynamic Traffic Management using IoT" is an extremely fascinating research area. AI and machine learning would increase the ability of the system to predict traffic patterns and to dynamically adjust dividers for optimizing traffic flow. With great innovations in sensor technology, there could be accurate traffic density detection and adaptability, to the environmental conditions. Scalability is also a positive avenue whereby the system could be customized for large metropolitan cities with complex traffic networks. Solar power could also be utilized to further advance energy efficiency and sustainability. The profuse traffic data generated could also be put to use for urban planning and infrastructure development.

The sounds of vehicle and traffic letter communication can open up possibilities for real-time coordination between vehicles and road separators as well as features favoring emergency vehicles prioritize traffic management efficiency in critical situations. The system could easily be integrated with smart city initiatives, thereby promoting a seamless urban management. Minimal cost would be achieved by the use of affordable materials and technologies, even making the system more widely accessible. Cyber security will also be very relevant to guarantee reliability against possible cyber attack threats for the infrastructure. The use of user-friendly interfaces for traffic authorities can further maximize operational efficiency, while global adaptability can customize the system to suit varying traffic rules as well as conditions across the globe. Commuters can also use mobile applications or digital boards to obtain real-time updates on traffic to better plan their travels.

The Adjustable Road Divider System shows promise for advancement and implementation on a wider scale in the near future. With additional research and the integration of technologies still on their way to commercial application, the system can evolve into a totally automated smart traffic management solution. The following are some potential future improvements:

1. Integrating AI and Machine Learning

• AI will predict traffic congestion based on historical data.

• Machine Learning algorithms can dynamically optimize lane assignment rather than having predefined thresholds.

• Automated decision-making can enhance traffic efficiency in real-time by responding to road conditions.

2. Leading IoT Connectivity and Cloud Computing

• 5G technology enables fast transmissions for real-time traffic monitoring.

• A cloud-based platform saves and analyzes traffic data for urban planners.

• Traffic authorities receive instant alerts in case of unusual congestion patterns or accident situations.

3. Integration with Smart Traffic Signals

•The system can be integrated with adaptive traffic signals capable of optimizing the red and green light phases according to lane occupancy.

•Smart signals integrated with a movable divider can effectively increase vehicular movement efficiency.

4. Solar-Powered and Sustainable Design

• The installations of solar panels into the divider system would enable it to be energy-efficient and self-sustained.

• Solar power is used in driving gear motors, sensors, and IoT modules instead of using the external power source.

5. Vehicle-to-Infrastructure(V2I) Communication

• Cars with the V2I technology will have the provision to communicate with the system for advance requests for lane adjustment.

- This might manage the emergency lanes for emergency vehicles, priority lanes for VIP convoys, and even lanes for public transport at certain times.

6. Expansion to Smart City Applications

- 'Metros' can have the system installed under expressway or highway segments that will help largely in traffic management.

- The system may be interfaced with other smart city components, such as autonomous traffic monitoring drones, intelligent transport systems.

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