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Automatic Movable Road Divider

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Abstract: *Traffic congestion and inefficient road space utilization are major challenges in modern urban transportation systems. The "Automatic Movable Road Divider" project aims to provide a dynamic and intelligent solution to these problems by designing a road divider system that can be automatically repositioned based on real-time traffic conditions. This system employs sensors, microcontrollers (e.g., Arduino), and motorized mechanisms to detect traffic density in multiple lanes and adjust the position of the divider accordingly. During peak hours, the divider shifts to allocate more lanes to the congested direction, thereby optimizing traffic flow and reducing delays. The system can be controlled automatically through an embedded program or manually via remote control, ensuring flexibility and safety The design integrates infrared or ultrasonic sensors to monitor vehicle count and lane occupancy in real-time. A central microcontroller processes the sensor data and controls a series of motors or actuators that move the divider units along embedded tracks or wheels. Safety features such as emergency stop mechanisms, LED indicators, and obstacle detection ensure reliable and secure operation. The system is powered by either a mains supply or solar energy, promoting sustainability. This adaptable infrastructure can be especially beneficial in cities with varying traffic patterns throughout the day, such as near schools, business districts, or event venues. The project has the potential to replace traditional static dividers in metropolitan areas, offering a cost-effective, adaptive, and technologically advanced approach to traffic management.*

Keywords: *Traffic congestion*

I. INTRODUCTION

Urbanization and the rapid increase in vehicle population have led to significant traffic congestion in cities worldwide. Conventional road infrastructure often lacks the adaptability to handle fluctuating traffic volumes during different times of the day. One common issue is the unequal lane usage during peak hours where one side of the road may experience heavy traffic while the other side remains underutilized. This imbalance causes delays, fuel wastage, and increased pollution levels. Traditional road dividers are static and do not offer any flexibility in lane management. As traffic patterns vary throughout the day, there is a pressing need for a system that can dynamically allocate lanes to suit real-time conditions.

A movable road divider system provides an innovative approach to solve this problem. It offers the ability to adapt lane distribution based on actual traffic demand, optimizing road usage and minimizing congestion. The Automatic Movable Road Divider is a smart system designed to automatically adjust the position of a road barrier depending on traffic flow. It uses a combination of sensors (such as ultrasonic or IR sensors) to detect vehicle density, a microcontroller (like Arduino or Raspberry Pi) to process the data, and motorized mechanisms to move the divider units. The dividers are mounted on tracks or wheels and can shift laterally to expand or reduce the number of lanes in a specific direction.

This system offers several advantages, including improved traffic flow, reduced fuel consumption, and enhanced road safety. It can be especially useful in areas where traffic patterns vary significantly throughout the day, such as near schools, commercial zones, or highways leading into city centres. The system also supports remote and automated control, making it suitable for integration into modern intelligent transportation systems (ITS) and smart city infrastructure. The

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primary objective of this project is to design and prototype a fully functional automatic movable road divider that can operate in real-time based on live traffic data. The system aims to be cost effective, reliable, and scalable for different types of roads and environments.

II. LITERATURE REVIEW

Supriya Sarker *et al.* [1] proposed an IoT-based intelligent accident detection and location tracking model that relies on vehicle-mounted sensing modules to continuously monitor driving conditions. The system was designed to automatically identify accidents by detecting abnormal collision forces and then retrieving real-time GPS coordinates to determine the exact accident location. Once an incident was confirmed, these coordinates were instantly transmitted to a central monitoring server and nearby hospitals through GSM and cloud-based communication channels. This automation minimized the reliance on bystanders or passersby to report accidents, thereby significantly reducing delays in initiating emergency medical services. The authors further highlighted the scalability of their IoT framework, noting its potential integration into smart city infrastructure for large-scale traffic monitoring and coordinated response mechanisms.

The study also explored how hospital networks could be integrated with the system, enabling medical facilities to receive accident alerts in advance and prepare resources such as ambulances and emergency staff proactively. This proactive approach could drastically reduce the "golden hour" response time, which is critical for saving lives in road accidents. Additionally, the authors emphasized the role of cloud connectivity in maintaining historical crash data, which could later be used for accident analysis, insurance verification, and road safety audits. Another significant contribution of their work was the foresight in suggesting the use of artificial intelligence and predictive analytics. By combining real-time crash data with machine learning models hosted on the cloud, the system could potentially move beyond detection to accident prevention by identifying high-risk driving behaviours and hazardous zones. Their research thus set a strong foundation for future intelligent transportation systems that combine IoT, cloud, and AI for holistic accident management and prevention.

R. Thamizharasi *et al.* [2] developed a real-time drowsiness detection system using an infrared (IR) eye-blink sensor that continuously tracked the driver's eye movements to determine levels of alertness. The system operated on the principle that prolonged eyelid closure or irregular blink patterns strongly correlate with fatigue and drowsiness. Once such conditions were detected, the system instantly activated an audio alarm to alert the driver and prevent a potential accident. The study demonstrated that this approach was particularly effective in reducing accidents caused by driver fatigue during night journeys, highway driving, and long-haul operations where concentration typically declines over time.

Although the system was cost-effective and simple to implement, the authors identified several limitations. Sensor accuracy was reduced under strong sunlight, where IR interference affected detection reliability, and the system occasionally misinterpreted normal eye movements as drowsiness. The presence of spectacles or tinted glasses further complicated detection due to reflection and obstruction of IR light. To address these issues, the authors suggested a hybrid approach that integrates IR sensors with complementary technologies such as image processing through cameras or EEG-based monitoring of brain activity. Such integration could enhance detection accuracy by validating IR sensor readings against additional physiological parameters.

The research also emphasized the broader implications of fatigue detection systems in intelligent transportation. By incorporating such drowsiness monitoring into modern vehicles, accidents related to human error could be significantly reduced, which is vital given that driver fatigue remains one of the leading causes of road mishaps globally. The authors further recommended connecting the system with communication modules such as GSM or IoT platforms, which would not only alert the driver but could also notify emergency contacts or fleet management systems when critical drowsiness levels were recorded. This extension would transform the solution from a simple alert system to a proactive accident-prevention and safety management tool. Thus, the study highlighted how low-cost, sensor-driven solutions, when integrated with advanced communication and analytics, could substantially enhance driver safety and road accident prevention.

R. Krishnan *et al.* [3] presented a system for alcohol detection and vehicle ignition control that utilized the MQ-3 alcohol sensor integrated with an Arduino microcontroller to enhance road safety. The system was designed to analyse the alcohol concentration in a driver's breath, and if the value exceeded a predefined threshold, the ignition circuit of the vehicle was

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automatically disabled, preventing the engine from starting. This direct intervention mechanism effectively discouraged drunk driving by ensuring that intoxicated drivers could not operate their vehicles. The authors emphasized that the MQ-3 sensor, known for its high sensitivity to ethanol vapours, offered a reliable method for identifying alcohol consumption in real time, making it a practical choice for low-cost safety solutions.

Their experiments demonstrated that the system could consistently detect alcohol within seconds, offering immediate feedback and control. However, the study also highlighted some limitations related to environmental influences. Factors such as humidity, temperature, and the presence of other volatile gases could affect sensor readings, leading to possible false positives or reduced accuracy over time. These challenges necessitated periodic calibration of the sensor to maintain reliability, particularly in diverse driving environments. The researchers suggested that calibration routines could be automated or supplemented with advanced filtering algorithms to address these environmental interferences.

In addition to ignition control, the authors proposed extending the system's capabilities by integrating it with GSM and GPS modules. Such an integration would allow the system not only to prevent the vehicle from starting but also to send emergency alerts or notifications to authorities, family members, or fleet managers if intoxication was detected. This enhancement could transform the system from a preventive tool into a comprehensive safety solution that actively engages emergency communication channels. The study concluded that incorporating alcohol detection into vehicular systems could significantly reduce one of the leading causes of traffic accidents worldwide—drunk driving—and emphasized its potential for integration into both private vehicles and commercial fleets to improve overall transportation safety.

A. Kumar *et al.* [4] designed a cost-effective accident detection and alert system by integrating an ADXL335 accelerometer with GPS and GSM modules, controlled through an Arduino microcontroller. The accelerometer was tasked with continuously monitoring acceleration along multiple axes, and sudden changes beyond a predefined threshold were interpreted as collision events. Once such an event was detected, the system immediately collected GPS coordinates to identify the exact accident location and transmitted these details via GSM to preconfigured emergency contacts. This rapid communication reduced the dependency on external reporting and enabled emergency services to be dispatched more quickly, thereby addressing the critical time gap that often determines survival rates in road accidents.

The authors validated their design through experimental testing, which showed reliable detection of collision scenarios and swift message delivery within a matter of seconds. The use of low-cost sensors and open-source hardware platforms made the system both affordable and accessible, presenting a viable solution for large-scale deployment in developing regions where advanced safety features are often absent in vehicles. However, the researchers also observed certain drawbacks. The system occasionally generated false alarms, particularly when the vehicle traversed rough terrains, speed breakers, or potholes, where the accelerometer registered abrupt movements that mimicked collision signatures. To overcome this issue, the study suggested the implementation of adaptive thresholding or machine learning algorithms capable of distinguishing between normal driving vibrations and actual accidents.

In addition, the authors emphasized that the integration of GPS and GSM modules extended the utility of their system beyond simple detection. By ensuring that real-time location data was transmitted immediately after an incident, the system created a direct channel of communication between vehicles and emergency responders. This could significantly reduce the "golden hour" response delay, which is critical in saving lives. The researchers also pointed to future advancements where such systems could be linked with centralized databases, traffic management centres, or hospital networks to enhance large-scale accident management. Overall, their work demonstrated that combining accelerometers with communication technologies provides a practical, low-cost framework for accident detection, while highlighting the importance of continuous innovation to minimize false triggers and increase reliability under real-world driving conditions.

P. Singh *et al.* [5] developed a comprehensive vehicle safety prototype that combined multiple modules, including alcohol detection, accident detection, and GSM-based emergency alerts, into a single unified framework. The system employed Arduino as the central processing unit to coordinate data from various sensors and generate corresponding outputs. For alcohol detection, the MQ-3 sensor was used to monitor the driver's breath and prevent vehicle ignition if intoxication was detected. Accident detection was managed using an accelerometer that identified sudden changes in motion, while a GPS module retrieved real-time location data, which was then transmitted through GSM to emergency contacts. Additionally, buzzers and alert systems were incorporated to provide immediate warnings in critical situations. This

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multi-layered approach provided both preventive and responsive measures, making it more effective than single-feature systems.

The authors emphasized that their innovation lay in the integration of different safety features into a single low-cost platform. By combining preventive measures such as alcohol detection and drowsiness monitoring with responsive actions like automatic emergency alerts, the system addressed multiple dimensions of road safety simultaneously. Experimental results validated the reliability of sensor fusion, as the coordinated use of multiple modules reduced the probability of missed detections compared to standalone solutions. However, the prototype was tested only on a small scale and under controlled conditions, limiting its ability to fully represent real-world driving environments. The authors noted that large-scale implementation would require additional calibration and field testing to handle factors such as varying road conditions, climate, and user behaviour.

III. METHODOLOGY

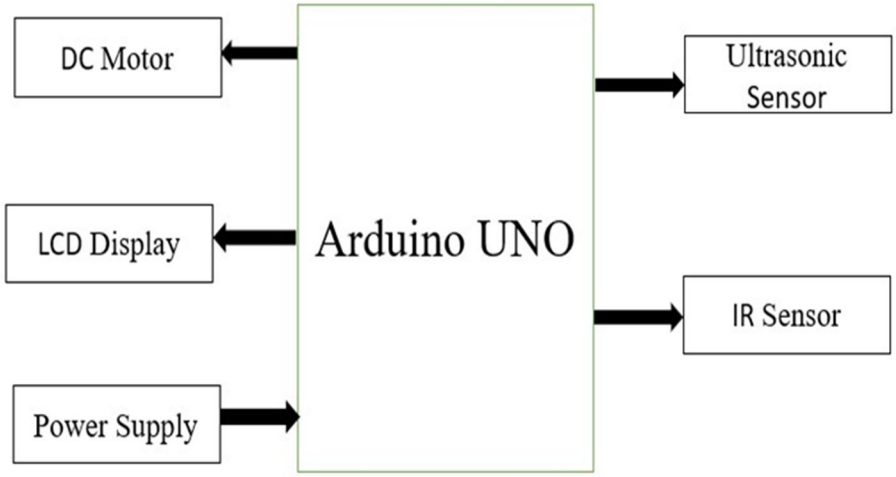

Fig1. Block Diagram of the System

Arduino UNO:

Fig2. Arduino UNO

The Arduino UNO is a microcontroller board based on the ATmega328P chip, and it functions as the brain of many DIY electronics projects. It works by reading inputs—such as light from a sensor or a button press—and converting them into outputs, like turning on an LED or spinning a motor, based on instructions written in the Arduino programming language (C/C++). These instructions are uploaded to the board through a USB connection using the Arduino IDE. The board has digital and analog input/output pins to connect sensors and actuators, and it operates on 5V power. Its simplicity and flexibility make it ideal for beginners and prototyping.

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IR Sensor:

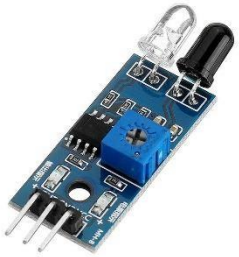

Fig3. IR Sensor

The Infrared (IR) sensor used as an eye blink sensor plays a vital role in detecting driver drowsiness. It operates on the principle of infrared light reflection, where an IR transmitter emits light toward the driver's eye, and the reflected light is received by an IR receiver. When the driver's eyes are open, the reflection pattern differs from when they are closed, allowing the system to detect eye blinks or prolonged eye closure. This data is processed by the ESP32 microcontroller to determine signs of fatigue or sleepiness. If the eyes remain closed beyond a specific duration, the system triggers a drowsiness alert to prevent accidents. The sensor is noncontact, fast-responding, and reliable, making it highly suitable for real-time driver monitoring applications in intelligent vehicle safety systems.

LCD Display:

Fig4. LCD Display

The 16x2 LCD is a display module that shows 16 characters per line on 2 lines. It operates on 5V and is commonly used in embedded systems to display data like temperature, humidity, or status messages. It uses either 4-bit or 8-bit parallel communication with microcontrollers.

Gear Motor:

Fig5. Gear Motor

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A gear motor is an electromechanical device that integrates an electric motor with a gearbox to deliver controlled rotational motion. While the motor provides high-speed rotation, the gearbox reduces this speed and increases the torque, making the output powerful and suitable for practical mechanical tasks. This combination allows gear motors to handle heavier loads and operate more efficiently at lower speeds. The gearbox also provides better control and stability in motion, which is why gear motors are widely used in various industries and automation systems.

There are different types of gear motors based on their power source and design. DC gear motors are very popular in small-scale applications such as robotics, DIY projects, and IoT systems because they run on low-voltage batteries, are lightweight, and easy to control. AC gear motors, on the other hand, are used in larger and more industrial applications where more power and continuous operation are required. Worm gear motors are known for their high torque and compact design, often used in conveyor systems and lifting equipment. Planetary and spur gear motors are used when precision and efficiency are needed, such as in 3D printers, CNC machines, and automated doors.

The performance of a gear motor is usually determined by several key specifications, including voltage, current, RPM (revolutions per minute), torque, gear ratio, and shaft size. A higher gear ratio means greater torque but lower speed, while a lower gear ratio provides higher speed but less torque. This allows engineers and designers to choose gear motors based on the specific needs of their project.

Gear motors offer several advantages: they are compact, energy-efficient, and provide high torque at low speeds, which is ideal for controlled mechanical movement. They are also reliable and can last long with proper care. However, they may produce some mechanical loss due to friction inside the gears, and they need periodic maintenance like lubrication. They are not suitable for extremely high-speed applications because the gearbox is designed mainly for torque multiplication and speed reduction.

Motor Driver:

Fig 6. L298N

The L298N motor driver is a dual H-bridge driver module used to control the direction and speed of DC motors. It acts as an interface between the ESP32 microcontroller and the vehicle's motor by amplifying the control signals to drive high-current motors. In this project, the motor driver is utilized for vehicle movement control, such as stopping the motor when drowsiness or an accident is detected. It can control two DC motors independently and supports both forward and reverse motion. The L298N module is efficient, reliable, and easy to interface, making it ideal for embedded and automation applications. Its use ensures safe and precise control of vehicle operations in the proposed accident prevention system.

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Rack and pinion gear:

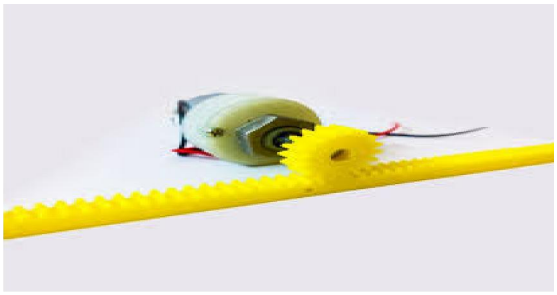

Fig7.Rack and pinion gear

A rack and pinion gear is a simple and efficient mechanical system used to convert rotational motion into linear motion. It consists of two main parts: the pinion, which is a circular gear, and the rack, which is a flat, straight gear with teeth. When the pinion rotates, its teeth mesh with the teeth on the rack, causing the rack to move in a straight line. Similarly, if the rack moves, it can make the pinion rotate. This system is widely used in machines where precise linear movement is needed.

Rack and pinion gears are commonly found in steering systems of vehicles, allowing the circular motion of the steering wheel to turn the wheels in a controlled linear way. They are also used in CNC machines, industrial automation, elevators, gates, and robotic systems where smooth and accurate movement is required. One of the biggest advantages of this mechanism is its high efficiency, simple design, and compact size. Unlike other gear systems, rack and pinion setups provide a direct and reliable transfer of motion without complex components.

The performance of a rack and pinion system depends on factors like gear material, tooth size, and gear ratio. A smaller pinion provides higher torque but slower movement, while a larger pinion provides faster movement but less torque. Materials like steel, aluminum, and hardened plastic are commonly used depending on the application and required strength.

Rack and pinion systems are easy to maintain and offer accurate control, which is why they are preferred in many mechanical and electromechanical devices. However, they do require proper alignment and lubrication to reduce friction and wear. Overall, the rack and pinion gear is a versatile and dependable mechanism that plays a key role in modern machinery and automation.

IV. RESULTS

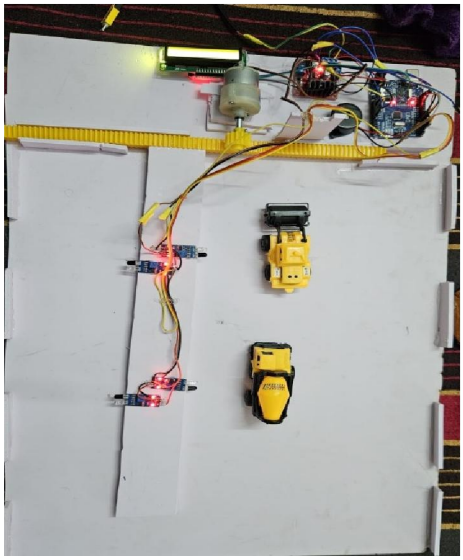

Fig1. Result-1

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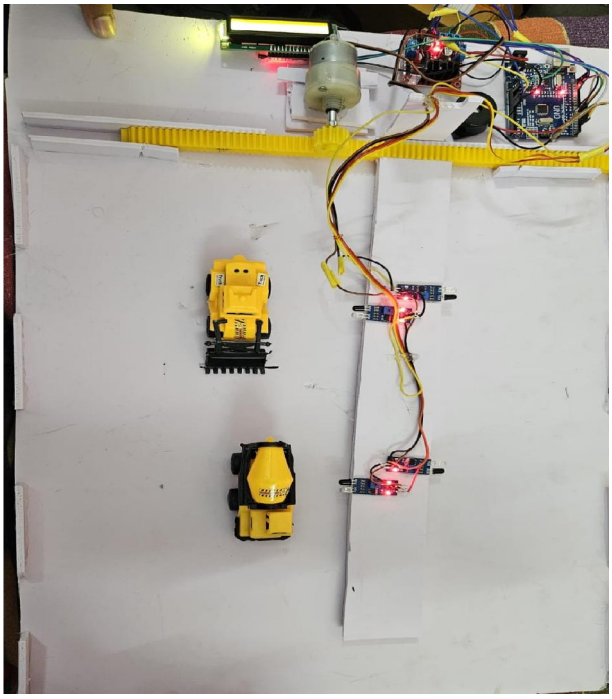

Fig2. Result-2

V. DISCUSSIONS

The Automatic Movable Road Divider System was tested under controlled scenarios to evaluate the performance of its sensing and actuation modules. The DC gear motor, controlled through the L298N motor driver, demonstrated smooth and precise movement of the divider, ensuring stable operation during both forward and reverse directions. The system maintained consistent speed and torque, enabling the divider to shift lanes accurately and efficiently without instability. The IR obstacle detection sensors accurately identified the presence of vehicles and pedestrians, triggering the motor to stop or adjust movement in real time. This prevented potential collisions, confirming the reliability of the obstacle detection mechanism.

During testing, the system responded effectively to various scenarios such as peak traffic flow, emergency lane creation, and obstruction detection. The motor's performance remained stable even under continuous operation, and the IR sensors consistently provided accurate and quick feedback.

Overall, the Automatic Movable Road Divider System exhibited high accuracy, quick response, and strong operational stability. The successful integration of IR sensors with the motor control system demonstrates the feasibility of this technology for smart traffic management. It has the potential to reduce congestion, improve road safety, and enable dynamic lane management in urban areas, making it a practical and efficient solution for modern transportation systems.

VI. CONCLUSION

The Automatic Movable Road Divider System provides an efficient and practical solution for managing traffic flow in real time. By using a DC gear motor and IR obstacle detection sensors, the system allows smooth and controlled movement of road dividers without manual intervention. It can be used to create or adjust lanes during peak traffic hours or emergency situations. The reliable response of the sensors ensures safe operation.

This system helps reduce congestion, improve lane usage, and increase overall road safety. The use of basic, cost-effective components makes it suitable for real-world applications and easy to maintain. The motor's stable performance under various test conditions shows its ability to function continuously and effectively. The quick response of the sensors enhances its reliability in dynamic traffic environments.

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In conclusion, the Automatic Movable Road Divider System is a smart and innovative approach to modern traffic management. It combines mechanical movement with sensor-based control to provide flexible lane management. This technology can be implemented in cities to improve road efficiency and safety. Its simplicity and effectiveness make it a sustainable and scalable traffic solution for the future.

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