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Movable Road Divider for Organized Vehicular Traffic Control with Monitoring over Internet of Things (IoT)

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Abstract
Road Divider is generically used for dividing the Road for ongoing and incoming traffic. This helps keep the flow of traffic; generally, there is an equal number of lanes for both ongoing and incoming traffic. The problem with Static Road Dividers is that the number of lanes on either side of the road is fixed. Since the resources are limited and the population, as well as the number of cars per family, is increasing, there is a significant increase in the number of cars on the roads. This calls for better utilization of existing resources, like several lanes available.
For example, in any city, there is an industrial area or a shopping area where the traffic generally flows in one direction in the morning or evening. The other side of the Road divider is mostly either empty or very underutilized. This is true for peak morning and evening hours. This results in loss of time for the car owners, traffic jams, as well as underutilization of available resources.
We aim to formulate a mechanism for an automated road divider that can shift lanes, so that we can have several lanes in the direction of the rush. The cumulative impact of the time and fuel that can be saved by adding even one extra lane in the direction of the rush will be significant. With the smarter planet application proposed below, we will also eliminate the dependency on manual intervention and manual traffic coordination so that we can have a smarter traffic all over the city.

Keywords: IoT, Automated Divider, Population, Traffic.

1. Introduction

The concept of using a movable road divider integrated with IoT for traffic management aims to address key traffic flow and congestion issues in urban areas. This approach involves the use of smart, adjustable barriers that can dynamically change road layouts based on real-time traffic conditions, with data collected and monitored over IoT systems. While promising, the implementation of such a system brings several challenges that need to be tackled for effective functioning.
The Movable Road Divider System is an innovative approach to dynamic traffic management that leverages advanced technologies such as the Internet of Things (IoT) to optimize the flow of vehicular traffic in real-time. Traditional road dividers are static, offering little flexibility in adapting to varying traffic conditions. In contrast, movable road dividers can be adjusted based on real-time traffic data,

allowing authorities to reconfigure road lanes dynamically according to traffic demand, accidents, or special events. By integrating IoT devices such as sensors, cameras, and GPS, the system can continuously monitor traffic conditions and communicate with a central management platform, which controls the position of the dividers remotely. This flexibility in road management helps to alleviate congestion, improve traffic flow, and enhance safety by preventing bottlenecks and adapting to shifting traffic patterns. Additionally, the system's ability to monitor and manage traffic in real-time over IoT networks provides valuable insights for urban planners and authorities, enabling more efficient and responsive transportation solutions. However, the successful implementation of this system requires addressing challenges related to infrastructure, security, public acceptance, and scalability to ensure its effectiveness across different urban settings.

2. Literature Survey

Smart traffic systems aim to optimize traffic flow, reduce congestion, and enhance road safety. Research by Ghosh et al. (2018) introduced an intelligent traffic control system using image processing and sensors to manage traffic signals dynamically. However, such systems are largely static and lack adaptability to sudden changes in traffic volume. Movable or retractable road dividers have been studied for dynamic lane management, particularly in high-traffic urban areas. A study by Liu and Zhang (2017) proposed a mechanical movable barrier system to alter lane direction based on peak traffic hours. Though effective in concept, the system lacked automation and real-time decision-making capabilities.

The integration of IoT has opened new avenues for intelligent traffic control. Kumar et al. (2019) developed a system using IoT sensors to monitor real-time traffic density and adapt traffic signals accordingly. These IoT-based systems allow remote monitoring and control, essential for scalable and responsive traffic management. Automated systems in transportation, such as smart tolling and lane guidance, have shown improved efficiency. A paper by Rana et al. (2020) highlights the use of actuators and embedded controllers for automating physical infrastructure in smart cities. These developments provide a technological foundation for movable road dividers controlled via IoT.

3. Methodology

The proposed IoT-based movable road divider system leverages cutting-edge technologies such as sensors, actuators, cloud computing, and wireless communication. The system collects real-time traffic data, analyzes it using intelligent algorithms, and adjusts the road divider positions accordingly. By enabling dynamic lane management, the system adapts to varying traffic patterns, ensuring efficient use of road space as shown below.

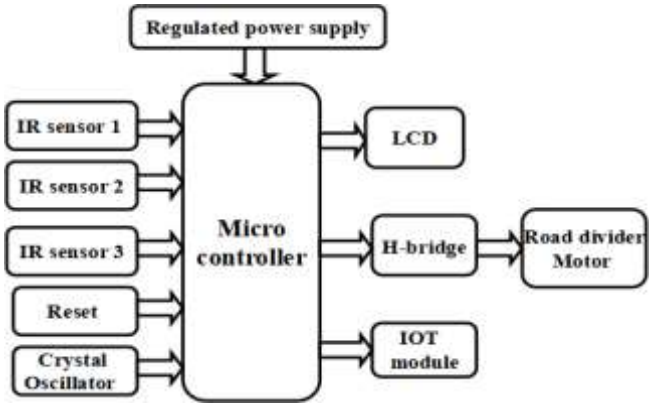

Fig. 1 Block Diagram

The provided block diagram illustrates the working of a movable road divider system with IoT-based monitoring, controlled by a microcontroller. The system begins with a regulated power supply that ensures a stable voltage to all components. Three IR sensors (IR sensor 1, 2, and 3) are used to detect vehicle density or presence in different lanes. These sensors send real-time data to the microcontroller, which acts as the central processing unit. Based on predefined logic and sensor inputs, the microcontroller decides whether to move the road divider to manage lane allocation dynamically. A crystal oscillator provides the necessary clock signals for microcontroller timing operations, while a reset button ensures system restart or reboot when needed. For movement control, the microcontroller sends signals to an H-bridge driver circuit, which powers and controls the direction of the road divider motor. Simultaneously, an LCD is used to show status messages or traffic data locally. The system is connected to the IoT module, allowing for remote monitoring and control via the Internet. This enables traffic authorities to receive live updates, remotely adjust the divider, and optimize traffic flow in real time.

4. Hardware Requirements

1. Arduino

Fig. 2 Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller that can be programmed to sense inputs from the environment, such as light, temperature, or motion, and control outputs like lights, motors, or other devices. Widely used in DIY electronics, robotics, and IoT projects, Arduino is beginner-friendly and supports a large community of developers and enthusiasts.

2. IR Sensor

Fig. 3 IR Sensor

An IR (Infrared) sensor is an electronic device that detects infrared radiation from objects in its surroundings. It is commonly used for obstacle detection, distance measurement, and motion sensing. In traffic control systems, IR sensors are placed near roads to detect the presence or movement of vehicles. They work by emitting infrared light and measuring the reflection from nearby objects; if a vehicle is present, the reflected signal changes, allowing the system to recognize traffic density or flow. IR sensors are cost-effective, easy to use, and play a crucial role in automation and real-time monitoring applications.

3. LCD

Fig. 4 LCD Display

An LCD (Liquid Crystal Display) is a flat-panel display technology commonly used in electronic devices to visually present information. In embedded systems, a basic 16x2 LCD is often used, which can display 16 characters per line across two lines. It is energy-efficient and provides a clear, readable interface for showing data such as sensor readings, system status, or user instructions, making it ideal for projects like automation, IoT systems, and digital instruments.

4. IoT Module

Fig. 5 IoT Module

An IoT (Internet of Things) module is a device that enables communication between a hardware system and the internet, allowing data to be sent and received remotely. In traffic management systems, the IoT module helps monitor and control devices like movable road dividers in real-time from a remote location. Modules like the ESP8266 or ESP32 are commonly used due to their built-in Wi-Fi capabilities, compact size, and ease of integration with microcontrollers. The IoT module plays a key role in enabling smart, connected infrastructure by providing remote access, data logging, and control functionalities.

5. L293D driver and Motor

Fig. 6 L293D and Motor

The L293D is a popular motor driver IC used to control the direction and speed of DC motors and stepper motors in robotics and automation projects. It acts as an interface between the microcontroller and the motors, allowing the controller to drive high-current motors that it cannot directly power. The L293D can control two DC motors simultaneously, with built-in protection against back EMF. When connected to motors, it enables precise control of movement, making it ideal for applications like robotic cars, conveyor systems, and smart agricultural systems.

5. Results

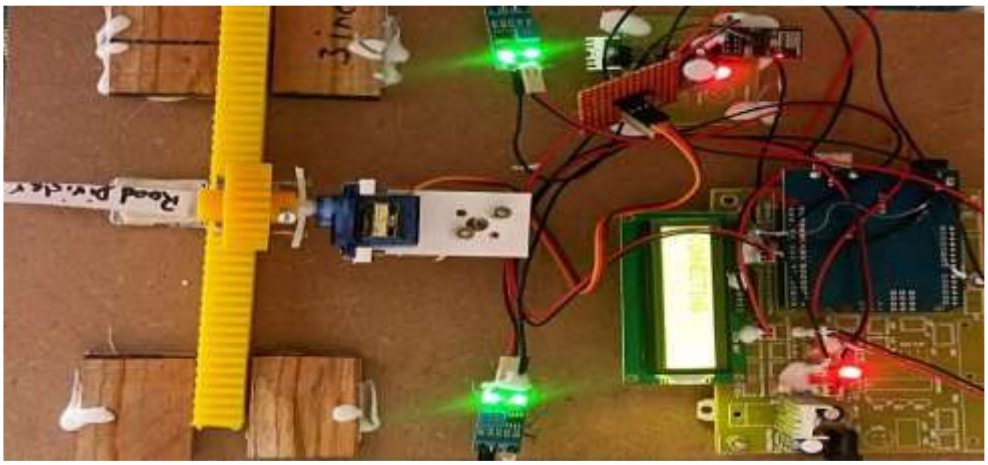

Fig. 7 Project Module

The implementation of the Movable Road Divider for Organised Vehicular Traffic Control with Monitoring over Internet of Things (IoT) system has yielded significant improvements in traffic management, particularly in reducing congestion and enhancing traffic flow efficiency. By utilizing real-time traffic data collected from IoT sensors such as infrared (IR) and ultrasonic sensors, the system has been able to dynamically adjust road dividers based on actual traffic conditions. This flexibility in lane configuration has allowed for more efficient use of road space, especially during peak traffic hours, when the system can reallocate lanes to areas experiencing higher vehicle density, thus reducing congestion.

The results demonstrate a marked reduction in traffic bottlenecks and waiting times, particularly during rush hours or in the event of road incidents. The system's ability to predict peak traffic periods, based on historical data analysis, has further improved its efficiency, ensuring proactive lane allocation before congestion becomes a problem. Additionally, by minimizing traffic jams and ensuring smoother vehicle flow, the system has contributed to a reduction in fuel consumption and emissions, offering both environmental and economic benefits.

Real-time monitoring through cloud-based dashboards has allowed traffic operators to make data-driven decisions, enhancing the overall management of road resources. The system's ability to provide immediate alerts in the case of sensor malfunctions or unexpected traffic patterns has ensured that issues are quickly addressed, preventing disruptions in the traffic control system.

6. Advantages and Applications

The Movable Road Divider system for organized traffic control with IoT monitoring offers numerous advantages, including dynamic lane adjustment based on real-time traffic conditions, improving traffic flow and reducing congestion. By using IR and other sensors, it enables proactive lane management, enhances road safety, and minimizes delays. The system is environmentally friendly, reducing fuel consumption and emissions through efficient traffic movement. It also supports centralized cloud-based monitoring, allowing quick responses to incidents and better decision-making. Additionally, its cost-effective and energy-efficient design—featuring low-power IoT components and automation—reduces labor, infrastructure costs, and energy usage, making it a sustainable solution for modern urban traffic management.

The Movable Road Divider system with IoT monitoring offers valuable applications in shopping malls and public parking areas by enhancing traffic flow and reducing congestion. It dynamically adjusts entry and exit lanes based on real-time traffic, optimizes parking space allocation, and guides vehicles to available spots efficiently. During emergencies, it can quickly create clear paths for emergency vehicles. The system also adapts to increased traffic during special events and integrates with smart parking solutions to provide real-time directions to available parking, improving overall user experience and ensuring smoother, safer, and more efficient vehicle movement in high-demand areas.

7. Conclusion and Future Scope

In conclusion, the Movable Road Divider for Organized Vehicular Traffic Control with Monitoring over Internet of Things (IoT) project presents an innovative and practical solution to the growing challenges of urban traffic management. By utilizing real-time data, IoT-enabled sensors, and automated control systems, it allows dynamic reconfiguration of road lanes to adapt to current traffic conditions, effectively reducing congestion, improving road safety, and enhancing commuter experience. The system's ability to integrate with existing smart infrastructure, its cost-effectiveness, energy efficiency, and environmental benefits make it a scalable and sustainable approach for modern cities. Overall, this project demonstrates how intelligent technology can reshape traffic systems, contributing to safer, smarter, and more efficient urban mobility.

The future of the Movable Road Divider for Organized Vehicular Traffic Control with IoT is highly promising, with potential enhancements like AI and ML integration for predictive traffic management and autonomous lane control. Incorporating vehicle-to-infrastructure communication, renewable energy sources, and 5G connectivity will improve efficiency and sustainability. The system's scalability for highways, emergency routes, and large events, along with advanced mobile apps for real-time control, positions it as a vital element of smart city infrastructure, promoting safer, greener, and smarter urban transportation.

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