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Smart Moveable Road Divider for Clearing Ambulance Path

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Abstract: *The Smart Moveable Road Divider for Clearing Ambulance Path is an intelligent traffic management system designed to reduce ambulance delays in congested urban areas. The system uses a camera, machine learning model, laptop controller, motor driver, and DC motor to automatically detect ambulances and create a dedicated emergency lane by moving the road divider. The camera continuously monitors traffic conditions, while the machine learning model identifies emergency vehicles in real time. Once an ambulance is detected, the laptop sends control signals to the motor driver, which activates the DC motor to shift the divider and clear the path. The proposed system improves emergency response time, enhances public safety, and supports efficient smart city traffic management through automation and real-time monitoring.*

Keywords: Smart Traffic Management, Movable Road Divider, Ambulance Path Clearance, Machine Learning, Emergency Vehicle Detection, DC Motor, Motor Driver, Smart City, Artificial Intelligence, Traffic Automation.

I. INTRODUCTION

The rapid growth of urbanization and the increasing number of vehicles on roads have created serious traffic congestion problems in modern cities. One of the major challenges caused by traffic congestion is the delay faced by ambulances and other emergency vehicles while reaching hospitals or accident locations. In critical medical emergencies, even a few minutes of delay can result in severe health complications or loss of human life. Traditional traffic management systems are not capable of providing immediate and dedicated routes for ambulances during peak traffic hours. Therefore, there is a strong need for an intelligent and automated traffic management system that can improve ambulance mobility and reduce emergency response time [1].

The Smart Moveable Road Divider for Clearing Ambulance Path is an advanced traffic control system designed to automatically create a dedicated lane for ambulances by moving road dividers in real time. The proposed system uses modern technologies such as Machine Learning, image processing, cameras, motor drivers, DC motors, and automated control mechanisms to monitor road traffic and identify emergency vehicles. Once an ambulance is detected, the system automatically shifts the divider to clear a separate path for smooth ambulance movement. This automated approach minimizes manual intervention and improves the efficiency of emergency transportation systems [2].

In recent years, intelligent transportation systems have become an important area of research due to the development of Artificial Intelligence and smart city technologies. Researchers have proposed several traffic management techniques such as smart traffic signals, IoT-based traffic monitoring, and dynamic lane allocation systems to reduce traffic congestion and prioritize emergency vehicles. Smart traffic systems use cameras, sensors, and communication technologies to analyze traffic conditions and make real-time decisions. These technologies help improve traffic flow and reduce delays faced by ambulances in congested urban areas [3][4].

The proposed system mainly focuses on integrating machine learning with automated mechanical systems for efficient road divider control. The camera continuously captures road images and sends them to the machine learning model for ambulance detection. The laptop acts as the central controller that processes the detection results and sends control signals to the motor driver. The motor driver then operates the DC motor to move the divider and create a dedicated

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emergency lane. This intelligent coordination between software and hardware components enables real-time traffic management and improves system reliability [5][6].

Another important advantage of the proposed system is its ability to support smart city infrastructure and future intelligent transportation networks. The system can be implemented on highways, urban roads, and high-traffic zones where ambulance delays are common. Automated divider control helps reduce road congestion, improves traffic distribution, and enhances public safety. The use of machine learning algorithms also increases the accuracy of ambulance detection under different environmental conditions. This system can further be integrated with GPS tracking, cloud computing, and smart traffic signals for advanced emergency traffic management applications [7][8].

Although the Smart Moveable Road Divider system offers several benefits, there are also certain challenges associated with its implementation. High installation costs, maintenance requirements, communication delays, and system reliability under heavy traffic conditions are some important factors that need to be addressed. Proper synchronization between the camera, machine learning model, laptop controller, and motor mechanism is essential for smooth system operation. Despite these limitations, the proposed system represents a significant advancement in intelligent traffic management and emergency vehicle prioritization. The project aims to improve ambulance response time, enhance road safety, and contribute toward the development of efficient and smart urban transportation systems [9][10].

II. PROBLEM STATEMENT

Traffic congestion in urban areas creates major obstacles for ambulances and other emergency vehicles, resulting in delayed medical assistance and increased risk to human life. Conventional traffic management systems are unable to provide a dedicated and uninterrupted path for ambulances during peak traffic conditions. Existing solutions such as manual traffic control and fixed emergency lanes are often inefficient, time-consuming, and difficult to manage in highly crowded roads. Therefore, there is a need for an intelligent and automated system that can dynamically create a clear route for ambulances by controlling movable road dividers using IoT, AI, and real-time communication technologies to reduce emergency response time and improve overall traffic management efficiency.

III. OBJECTIVES

- To study the use of IoT sensors for real-time ambulance and traffic detection.
- To develop an AI-based system for automatic movement of road dividers during emergencies.
- To implement Vehicle-to-Infrastructure (V2I) communication for efficient coordination between ambulances and traffic systems.
- To design and develop a smart movable road divider prototype using laptop, sensors, and motor drivers.
- To improve ambulance response time and optimize overall traffic flow in congested urban areas.

IV. LITERATURE SURVEY

1. "Intelligent Traffic Management for Emergency Vehicle Priority Using IoT and AI" by Sharma et al. (2023)

This paper presented an advanced traffic management system that combines IoT sensors and Artificial Intelligence to provide priority access for emergency vehicles in urban traffic. The system continuously monitors traffic density through smart sensors and automatically controls traffic movement based on ambulance detection. The authors highlighted that AI-based decision-making improves route clearance efficiency and minimizes delays during emergencies. The research demonstrated significant improvements in emergency response time and overall traffic flow management. However, the system required a strong communication infrastructure and high computational resources for real-time operation.

2. "Smart Ambulance Clearance System Using IoT and Machine Learning" by Patel and Verma (2022)

This paper focused on developing a smart ambulance clearance mechanism using machine learning algorithms and IoT-enabled sensors. The proposed model used GPS tracking and traffic monitoring cameras to identify ambulance locations and create faster routes. Machine learning techniques were applied to analyze traffic conditions and optimize lane management dynamically. The study reported reduced ambulance waiting time at traffic junctions and enhanced

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coordination between vehicles and infrastructure. The authors also emphasized the importance of integrating smart transportation technologies into modern city planning.

3. "Dynamic Lane Management System for Smart Cities" by Lee, Kim, and Park (2021)

This research introduced a dynamic lane allocation framework designed to manage urban traffic congestion and support emergency vehicle movement. The system used automated movable barriers and sensor networks to adjust lane directions according to traffic conditions. Real-time monitoring and cloud-based data analysis enabled rapid decision-making and efficient lane control. The research showed that dynamic lane systems can improve road utilization and reduce congestion significantly. The authors also discussed challenges related to maintenance costs and the reliability of automated barriers under different environmental conditions.

4. "Vehicle-to-Infrastructure Communication for Emergency Transportation Systems" by Chen et al. (2023)

This paper explored the application of Vehicle-to-Infrastructure (V2I) communication in emergency traffic management. The proposed system enabled ambulances to communicate directly with road infrastructure and traffic control units to obtain a clear path during emergencies. The study utilized wireless communication protocols and intelligent controllers to coordinate traffic signals and lane movements effectively. Experimental results showed improved travel speed for ambulances and reduced traffic disruption. The paper concluded that V2I technology plays a critical role in building efficient smart transportation systems.

5. "IoT-Based Smart Road Divider System for Urban Traffic Control" by Ahmed and Khan (2022)

This study proposed an IoT-based movable road divider system aimed at reducing traffic congestion and improving emergency vehicle mobility. The divider mechanism was controlled using embedded systems, sensors, and wireless communication modules. The system automatically adjusted divider positions depending on traffic density and emergency conditions. According to the authors, the proposed solution improved traffic distribution and reduced waiting time on congested roads. The research also discussed the scalability of the system for smart city applications and future intelligent transportation systems.

6. "Artificial Intelligence Techniques for Smart Traffic and Emergency Management" by Johnson et al. (2024)

This paper reviewed the role of Artificial Intelligence in modern traffic management and emergency response systems. The authors explained how AI algorithms, computer vision, and predictive analytics can enhance traffic monitoring and automate decision-making processes. The study highlighted the use of deep learning models for ambulance detection, traffic prediction, and automated route optimization. Results indicated that AI-based traffic systems can significantly improve emergency response efficiency and minimize road congestion. The paper concluded that integrating AI with IoT and smart infrastructure technologies will be essential for future intelligent transportation networks.

V. WORKING OF SYSTEM

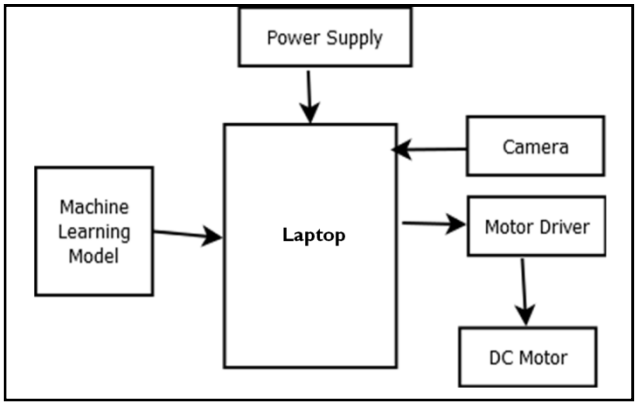

Fig 1: System architecture

1. Power Supply Unit

The power supply unit is one of the most important components of the proposed system because it provides the required electrical power to all hardware modules such as the , camera module, motor driver, and DC motor. A stable power

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source ensures smooth and uninterrupted operation of the system during ambulance detection and divider movement. The power supply converts the available electrical input into suitable voltage levels required by the electronic components. Proper voltage regulation is necessary to avoid hardware damage and maintain system reliability. In the proposed model, the power supply continuously supports real-time monitoring and automatic control operations.

3. Machine Learning Model

The machine learning model is used to identify ambulances and analyze traffic conditions in real time. It processes the captured images or video frames from the camera and detects emergency vehicles based on trained algorithms and image recognition techniques. Once an ambulance is detected, the machine learning model sends the information to the for further action. Artificial Intelligence helps improve the accuracy and speed of detection compared to manual monitoring systems. The use of machine learning also allows the system to adapt to different traffic scenarios and environmental conditions, making the system more intelligent and efficient.

4. Camera Module

The camera module is used for continuous traffic monitoring and ambulance detection. It captures live video footage of the road and sends the data to the and machine learning model for processing. The camera plays a major role in identifying approaching ambulances and monitoring traffic density on the road. High-resolution image capture improves detection accuracy and system performance. The camera operates in real time and helps the system respond quickly during emergency situations. By continuously monitoring road activity, the camera enables automated decision-making for movable divider control.

5. Motor Driver and DC Motor

The motor driver acts as an interface between the and the DC motor. Since the cannot directly drive high-power motors, the motor driver is used to amplify control signals and provide sufficient current to operate the motor. The DC motor is responsible for physically moving the road divider to create a dedicated lane for ambulances. When the detects an ambulance, it sends commands to the motor driver, which activates the DC motor to shift the divider. After the ambulance passes, the motor moves the divider back to its original position. This automatic movement ensures efficient traffic management with minimal human intervention.

6. Overall Working of the Proposed System

The proposed Smart Movable Road Divider system works by integrating Artificial Intelligence, IoT, image processing, and automated mechanical control. Initially, the camera continuously captures road traffic data and sends it to the machine learning model for analysis. When an ambulance is detected, the information is transmitted to the controller. The processes the data and sends control signals to the motor driver, which activates the DC motor to move the road divider and create a clear emergency lane. The system continuously monitors traffic conditions until the ambulance safely passes through the congested area. Afterward, the divider automatically returns to its normal position. This intelligent and automated approach helps reduce ambulance delays, improve emergency response time, and optimize urban traffic flow.

VI. SYSTEM DESIGN

The Smart Movable Road Divider for Ambulance Paths is designed using intelligent hardware and software components to create a dedicated emergency lane during traffic congestion. The system integrates camera module, machine learning model, motor driver, DC motor, and power supply for automated traffic control and ambulance path clearance.

1. Power Supply

The power supply unit provides the required electrical power to all system components such as, camera, motor driver, and DC motor. It ensures stable and continuous operation of the system without interruption. Proper voltage regulation is important for protecting electronic devices and maintaining reliable performance.

Specifications

Input Voltage: 230V AC
Output Voltage: 5V DC / 12V DC
Power Source: SMPS or Battery

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Function: Provides regulated power supply to all modules

2. Laptop (Control Unit)

The laptop acts as the main controlling and processing unit of the proposed system. It receives input data from the camera and machine learning model, processes the information, and makes decisions based on ambulance detection. The laptop controls the overall operation of the system by sending commands to the motor driver for divider movement. It also manages image processing, traffic monitoring, and real-time decision-making. Due to its high processing capability, the laptop can efficiently handle machine learning algorithms and traffic analysis tasks.

3. Camera Module

The camera module continuously monitors road traffic and captures real-time images or video for ambulance detection.

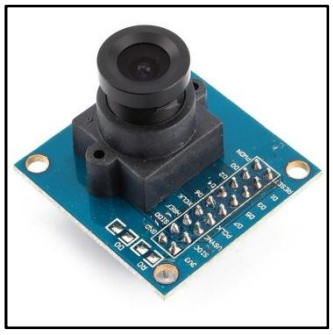

Fig 2:Camera module

The captured data is sent to the and machine learning model for analysis.

Specifications

Resolution: 5MP or Higher

Video Support: HD Video Recording

Interface: CSI Camera Port

Function: Traffic monitoring and ambulance detection

4. Machine Learning Model

The machine learning model is used to identify ambulances from captured images using Artificial Intelligence techniques. It improves detection accuracy and enables automatic decision-making for divider movement.

Specifications

Technology: Artificial Intelligence / Machine Learning

Algorithm: Image Processing and Object Detection

Input: Camera Images/Videos

Output: Ambulance Detection Signal

Function: Real-time ambulance recognition

5. Motor Driver

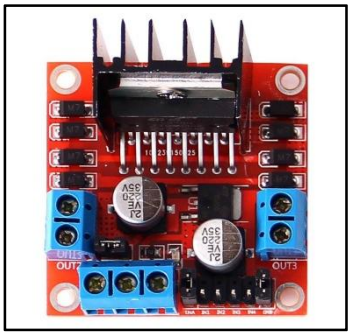

Fig 3: Motor driver

The motor driver acts as an interface between the and DC motor. It receives low-power control signals from the and provides sufficient current to drive the motor.

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Specifications
Driver IC: L293D / L298N
Operating Voltage: 5V–12V
Motor Support: DC Motor Control
Function: Controls motor direction and speed

6. DC Motor

The DC motor is responsible for the physical movement of the road divider. When an ambulance is detected, the motor rotates and shifts the divider to create a dedicated emergency lane.

Fig 4: DC motor

Specifications
Motor Type: DC Geared Motor
Operating Voltage: 12V DC
Speed: 30–100 RPM
Function: Automatic divider movement

7. Working Principle of System Design

The camera continuously captures traffic images and sends them. The machine learning model analyzes the images and detects the ambulance. Once detected, the sends control signals to the motor driver, which activates the DC motor to move the road divider. This creates a clear path for the ambulance. After the ambulance passes, the divider automatically returns to its original position. The entire process is automated and works in real time for efficient traffic management and faster emergency response.

VII. RESULTS

The proposed Smart Moveable Road Divider for Clearing Ambulance Path was successfully designed and implemented using a camera, machine learning model, laptop controller, motor driver, and DC motor. The system continuously monitored road traffic and detected ambulance movement in real time through image processing techniques. The machine learning model accurately identified the ambulance and transmitted the information to the control unit for further action.

During testing, the laptop successfully processed the ambulance detection data and sent control signals to the motor driver for automatic divider movement. The DC motor efficiently shifted the road divider to create a dedicated emergency lane, allowing the ambulance to move smoothly through congested traffic. The divider also returned to its original position automatically after the ambulance passed, ensuring proper traffic management.

The overall system demonstrated reliable and real-time performance with minimal human intervention. The prototype results showed that the proposed system can significantly reduce ambulance delays, improve emergency response time, and enhance urban traffic flow. The integration of machine learning and automated mechanical control proved effective for intelligent transportation and smart city applications.

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Model prototype

Fig 5: Model view 1

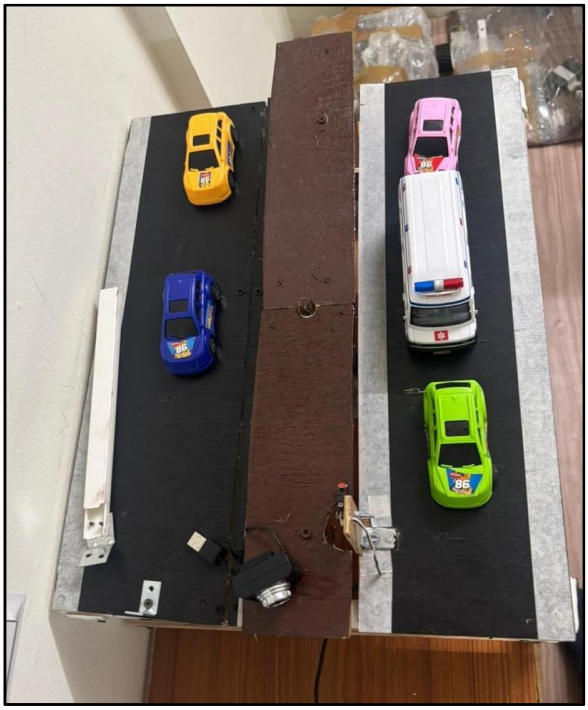

Fig 6: Model view 2

VIII. CONCLUSION

The Smart Movable Road Divider for Ambulance Paths is an innovative and intelligent traffic management system developed to reduce ambulance delays in congested urban areas. The proposed system successfully integrates IoT, Artificial Intelligence, camera modules, and motor-driven divider mechanisms to create a dedicated emergency lane automatically. The prototype demonstrated effective ambulance detection and smooth divider movement for emergency

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path clearance. The system improves emergency response time, enhances public safety, and optimizes overall traffic flow with minimal human intervention. The project also supports the development of smart city infrastructure by providing an automated and reliable solution for emergency vehicle prioritization. Overall, the proposed system offers an efficient, scalable, and modern approach to urban traffic management.

IX. FUTURE SCOPE

The system can be integrated with smart traffic signals for fully automated city-wide emergency traffic control.
Advanced deep learning algorithms can be implemented to improve ambulance detection accuracy under different weather and lighting conditions.
GPS and cloud-based monitoring systems can be added for real-time ambulance tracking and centralized traffic management.
Solar-powered movable divider mechanisms can be introduced to reduce energy consumption and improve sustainability.
The system can be expanded for use by fire brigades, police vehicles, and disaster management services.
Integration with 5G communication technology can further improve real-time response and system reliability.
Large-scale implementation in smart cities can help improve urban transportation efficiency and reduce emergency response delays significantly.

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