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SMART MOVABLE ROAD DIVIDER

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ABSTRACT

The Smart Road Divider Project represents a groundbreaking initiative leveraging Internet of Things (IoT) technology to transform traditional road systems into intelligent, responsive networks. With a primary focus on enhancing emergency vehicle response times, the project aims to establish a dynamic road division mechanism that autonomously facilitates the swift and unobstructed passage of emergency vehicles, notably ambulances, during critical situations. The core functionality of the project revolves around the implementation of intelligent road dividers that can dynamically adjust their positioning to create an unimpeded pathway for approaching emergency vehicles. Additionally, the Smart Road Divider Project incorporates predictive analytics to anticipate potential traffic congestion and preemptively adjust road configurations to prevent impediments to emergency vehicles. This proactive element enhances the overall efficiency of the emergency response system.

INTRODUCTION

In the rapidly evolving landscape of urbanization, the efficiency of emergency medical services plays a pivotal role in safeguarding public health and well-being. The contemporary urban environment, characterized by congested traffic arteries, poses a formidable challenge to the swift and unimpeded movement of emergency vehicles, particularly ambulances. Timely response during medical emergencies is paramount, as every second holds critical importance in determining patient outcomes. Unfortunately, the existing traffic management infrastructure falls short in providing a dedicated, adaptive solution that ensures the expeditious passage of ambulances through crowded city thorough fares.

This inadequacy in the current traffic management paradigm prompts the exploration of innovative solutions to address the pressing issue of delayed emergency response times. One key aspect of this challenge lies in the absence of a standardized, Internet of Things (IoT)-integrated automatic road divider system explicitly designed to prioritize ambulance movement. The conventional road infrastructure lacks the agility to dynamically adapt to real-time traffic conditions, hindering emergency vehicles' ability to navigate swiftly through congested areas. This introduction seeks to illuminate the critical issues surrounding the current state of emergency vehicle mobility in urban environments and underscores the necessity for a transformative solution. The lack of a dedicated infrastructure that seamlessly integrates with existing traffic management frameworks to prioritize ambulance movement not only compromises patient care but also poses a significant challenge to the overall effectiveness of emergency response systems.

Against this backdrop, the exploration and development of an IoT-based automatic road divider system tailored for ambulance priority emerge as a crucial avenue of inquiry. This solution holds the promise of revolutionizing urban emergency response by providing a dynamic, adaptive, and technology-driven approach to traffic management. By seamlessly integrating with existing infrastructure and leveraging real-time data, such a system has the potential to optimize emergency vehicle routes, significantly reduce response times, and enhance overall public safety.

In the subsequent sections, we delve into the specific challenges faced by the current traffic

management systems, emphasizing the need for a comprehensive and innovative solution. The problem statement underscores the urgency of addressing these challenges, and the following discussions will explore potential avenues for the development and implementation of an IoT-based automatic road divider system tailored to prioritize ambulance movement in urban environments.

SYSTEM ANALYSIS

- **Smart Traffic Lights**:
  Some cities have implemented smart traffic lights that use IoT technology to adapt to real-timetraffic conditions.
  These systems can prioritize emergency vehicles by adjusting signal timings, allowing for fasterresponse times.

- **Dynamic Lane Management:**
  Some regions utilize IoT-connected road infrastructure to dynamically manage laneconfigurations based on traffic conditions. These systems can potentially be adapted to create temporary lanes for emergency vehicles whenneeded.

- **Sensor Integration:**

  Traffic management systems often integrate various sensors, such as cameras, radar, and lidar, to monitor traffic flow and detect congestion These sensors can be leveraged to identify the presence of emergency vehicles and trigger adaptive measures in the road infrastructure.

Proposed System

The Smart Road Divider Project integrates IoT (ESP32 controller), IR sensors, and servo motors to create an intelligent road system that facilitates the swift and unobstructed passage of emergency vehicles, specifically ambulances. The proposed system architecture is designed to detect approaching emergency vehicles using IR sensors, communicate with the ESP32 microcontroller, and actuate servo motors to dynamically create a dedicated lane for the emergency vehicle.

IR Sensor Array:

- Deploy an array of Infrared (IR) sensors strategically along the road to detect the presence of vehicles.
- IR sensors are chosen for their ability to detect objects, including vehicles, based on the reflection of infrared light.

ESP32 Microcontroller:

- Utilize the ESP32 microcontroller as the central processing unit to manage data acquisition, communication, and control functions.
- Leverage the ESP32's built-in Wi-Fi capabilities for seamless connectivity and communication with other components.

Emergency Vehicle Identification:

- Implement a vehicle detection algorithm within the ESP32 to analyze data from the IR sensor array.
- When an emergency vehicle is detected, trigger the servo motor control mechanism to initiate road division.

Servo Motor Control:

- Integrate servo motors with road dividers to physically adjust their positions.
- Upon detection of an emergency vehicle, activate the servo motors to reconfigure the road dividers and create a clear pathway.

User Interface:

Develop a user interface, such as a mobile application, to provide real-time updates on the system status and emergency vehicle locations. And also, LCD display is also provided. Allow manual intervention by authorized personnel for special cases.

Power Management:

Implement an efficient power management system

to ensure the continuous operation of the IoT devices, sensors, and servo motors. Utilize low-power modes when the system is idle to conserve energy. By integrating these components and functionalities, the proposed system ensures a responsive and adaptive road infrastructure that enhances emergency vehicle response times, contributing toa safer and more efficient urban environment.

OBJECTIVES:

- **Efficient Emergency Response**
  Develop an automatic road divider system that seamlessly and rapidly creates a clear path for ambulances, ensuring swift and unhindered passage during emergency situations. The system should minimize response time and enhance overall emergency medical services.
- **Real-time Traffic Adaptability**

  Implement advanced sensors and communication technologies to enable the automatic road divider to dynamically adapt to real-time traffic conditions. The system should be capable of identifying congestion, altering the road divider configuration accordingly, and prioritizing ambulance access without causing disruptions to regular traffic flow.
- **Safety and Reliability**
  Ensure the automatic road divider is designed with the highest safety standards, minimizing the risk of accidents or damage to vehicles. Additionally, focus on reliability to guarantee consistent and dependable performance, even in adverse weather conditions or challenging environments.
- **Integration with Traffic Management Systems**

  Integrate the automatic road divider with existing traffic management systems to facilitate seamless coordination with traffic lights, road signs, and other infrastructure elements. This integration should optimize the overall traffic flow while prioritizing ambulance movement. User-friendly Interface

Develop a user-friendly interface for emergency responders to interact with the automatic road divider system. This interface should allow ambulance drivers to request priority access, provide essential information, and receive real-time feedback on the status of the road divider adjustments.

- **Cost-effectiveness**

Optimize the design and implementation of the automatic road divider to be cost-effective, considering both initial deployment and long-term maintenance. Aim to strike a balance between performance and afford ability to encourage widespread adoption in urban areas.

- **Regulatory Compliance**

  Ensure that the automatic road divider system complies with local traffic regulations and standards. Collaborate with relevant authorities to obtain necessary approvals and certifications, promoting the lawful and widespread deployment of the technology.
- **Continuous Improvement and Adaptability**
  Establish a framework for continuous improvement, incorporating feedback from emergency responders, traffic management authorities, and the community. Design the automatic road divider system to be adaptable and upgradeable, allowing for future enhancements and technology advancements.

PROBLEM STATEMENT:

In urban environments, the efficient and timely movement of emergency vehicles, particularly ambulances, faces significant challenges due to congested traffic conditions. The existing traffic management systems lack a dedicated and adaptive solution that ensures swift and unimpeded passage for emergency vehicles, compromising the effectiveness of emergency

response services. Additionally, the lack of a standardized, IoT-integrated automatic road divider system specifically designed for ambulance priority exacerbates the difficulties faced by emergency responders.

The current infrastructure fails to dynamically adapt to real-time emergency scenarios, resulting in delayed response times and potential life-threatening consequences for patients in need of immediate medical attention. There is a critical need for a comprehensive, IoT-based automatic road divider system that can seamlessly integrate with existing traffic management frameworks, prioritize ambulance movement, and enhance overall emergency response capabilities.

This problem statement highlights the necessity for an innovative solution that addresses the following key challenges:

- **Traffic Congestion**: The inability of current traffic management systems to efficiently handle emergency situations, leading to delayed ambulance response times in congested urban areas.
- **Lack of Ambulance Priority Infrastructure**: The absence of dedicated and adaptive road divider systems that prioritize ambulance movement, hindering the ability of emergency vehicles to navigate through traffic seamlessly.
- **Real-time Adaptability**: The current road infrastructure does not dynamically adjust to real-time traffic conditions, hindering the timely response of emergency vehicles and potentially jeopardizing patient outcomes.
- **Integration with IoT**: The absence of a standardized, IoT-integrated solution for automatic road dividers tailored specifically for ambulance priority, limiting the potential for seamless coordination between emergency vehicles and traffic management system

METHODOLOGY

Designing a smart movable road divider involves integrating several components to ensure effectiveness, safety, and efficiency. Here's a methodology you could follow:

Define Objectives and Requirements:

Clearly outline the purpose of the smart movable road divider. Is it for managing traffic flow, enhancing safety, or facilitating road maintenance?

- **Research Existing Solutions:**

  Study existing movable road divider designs and technologies to gather insights into what workswell and what can be improved.

- **Conceptual Design:**

  Brainstorm design concepts that meet the defined objectives and requirements.

- **Feasibility Study:**

  Conduct a feasibility study to evaluate the technical, economic, and operational viability of eachdesign concept.

- **Prototype Development:**

  Develop a prototype based on the selected design concept.

- **Testing and Validation:**

  Conduct thorough testing of the prototype under various conditions, including different road surfaces, weather conditions, and traffic scenarios.

SYSTEM REQUIREMENT SPECIFICATION

SOFTWARE REQUIREMENTS

Arduino IDE

Arduino IDE is a open source software. Arduino IDE is used to write and upload code to the arduino board. A program for Arduino may be written in any programming language for a compiler that produces binary machine code for the target processor. The Arduino IDE supports the languages C and C++ using special rules of code structuring.

Blynk Mobile App

Blynk app allows to quickly build interfaces for controlling and monitoring hardware projects. In our project we are using blynk to monitor our road divider. It can control hardware remotely, it can display sensor data, it can store data, visualize data.

Blynk Web-app to configure Blynk

Blynk is an IOT platform for iOS or Android smartphones that is used to control Arduino via the Internet.

HARDWARE REQUIREMENTS

ESP32

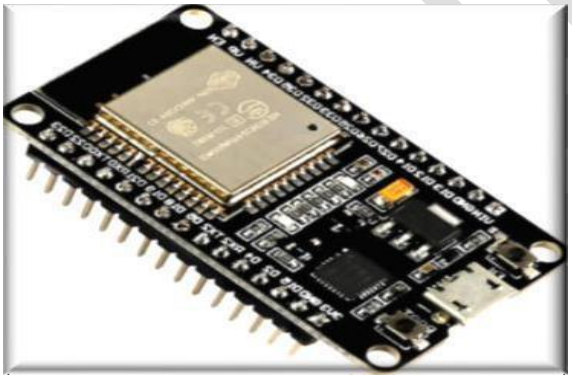


Fig. 4.2.1

ESP 32 is a microcontroller board. Our whole project is controlled by Esp 32. It helps in functioning the sensor and motors. Wi-Fi and Bluetooth connectivity is available for embedded devices.

Servo Motor

Fig. 4.2.2

Servo motor is a rotatory actuator. It is used to rotate dividers according to instructions. We are using the rotatory motion of the motor to move the road divider accordingly. It allows for precise control of angular or linear position, velocity and acceleration.

IR Sensor

IR sensor is infrared Sensor.IR is used to detect the motion happening on the road. In our project we have used the sensor as detecting the vehicles passing by the divider. The divider starts moving accordingly to the amount of vehicles on the road.

Fig. 4.2.3

Jumper Wires

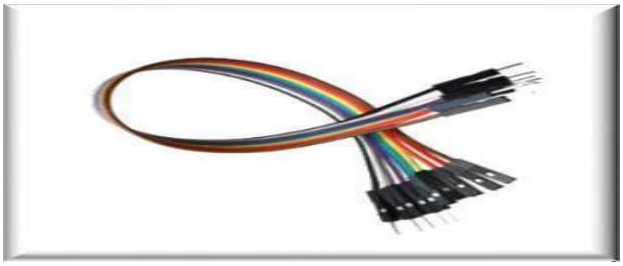


Fig. 4.2.4

A jump wire is an electrical wire with a connector or pin at each end. It is used to interconnect the components of a breadboard or test circuit. A jump wire is also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable, which is normally used tointerconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering Breadboard

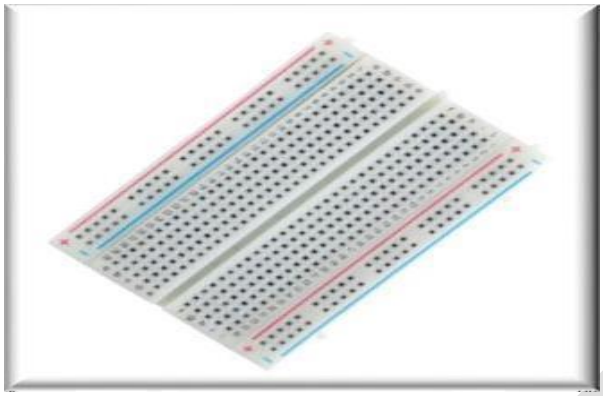


Fig. 4.2.5

Breadboard is a base for constructing electronic projects and prototyping electronics. It is used for building temporary circuits. It is useful for designers because it allows components to connect and operate easily.

LED Indication

Fig. 4.2.6

LEDs are used as visual indicators to notify drivers about lane changes or altered traffic patterns. They provide clear visual cues to guide drivers through the modified road layout.

SYSTEM DESIGN

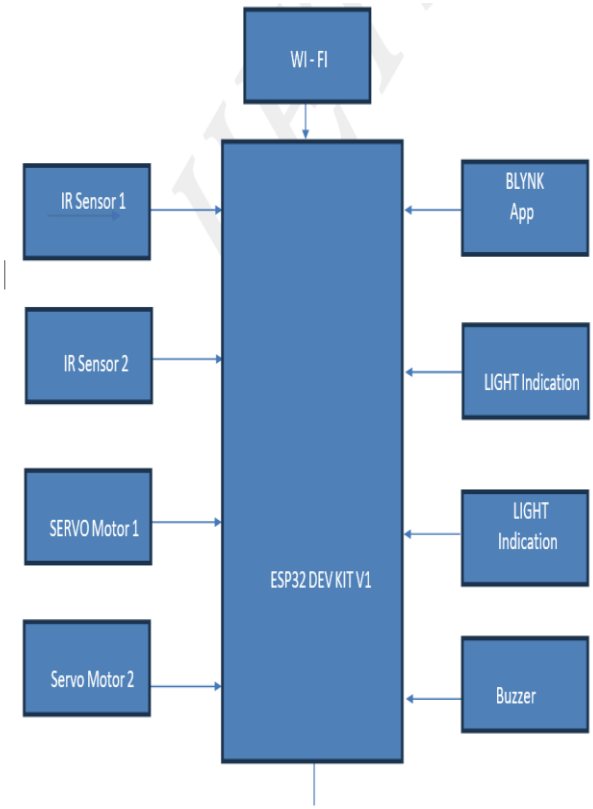


Fig. 5.1 Block Diagram Power Supply

MODULES

In these modules has been developed that consists of an IR sensor, Servo motor, Blynk, Arduino.

A. IR sensor is infrared Sensor.IR is used to detect the motion happening on the road. In our project we have used the sensor as detecting the vehicles passing by the divider. The divider starts moving accordingly to the amount of vehicles on the road.

B. Servo motor is a rotatory actuator. It is used to rotate dividers according to instructions. We are using the rotatory motion of the motor to move the road divider accordingly. It allows for precise control of angular or linear position, velocity and acceleration.

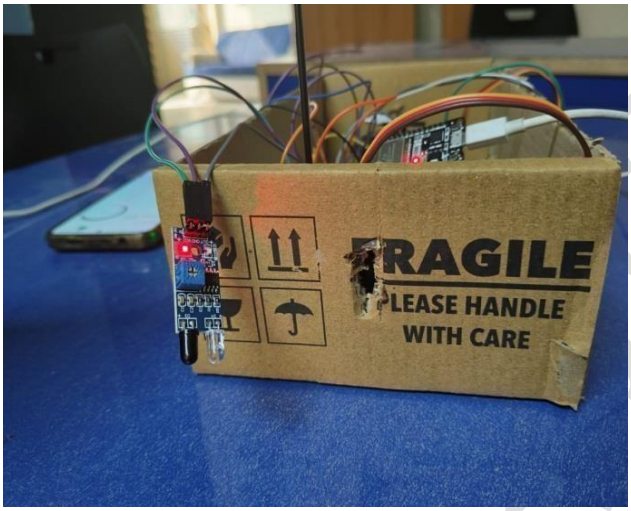
C. Blynk app allows to quickly build interfaces for controlling and monitoring hardware projects. In our project we are using blynk to monitor our road divider. It can control

hardware remotely, it can display sensor data, it can store data, visualize data.

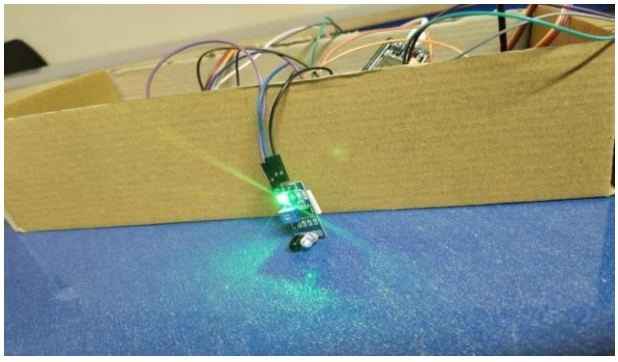
D. Arduino IDE is a open source software. Arduino IDE is used to write and upload code to the arduino board. A program for Arduino may be written in any programming language for a compiler that produces binary machine code for the target processor.

IMPLEMENTATION

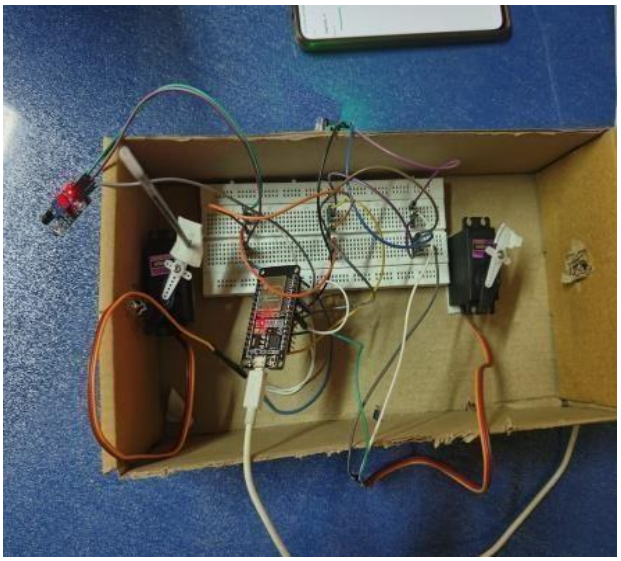
The model has been set using the demo box. We have connected the servo motor to the esp32 using the help of jumper wires and the bread board. There are 2 sensors outside the box for motion detection.



IR sensor 1 shows red light which indicates the which opening of the road divider once vehicle is dividerdetected.



IR sensor 2 shows green light indicates the closing of the road once vehicle is passed.



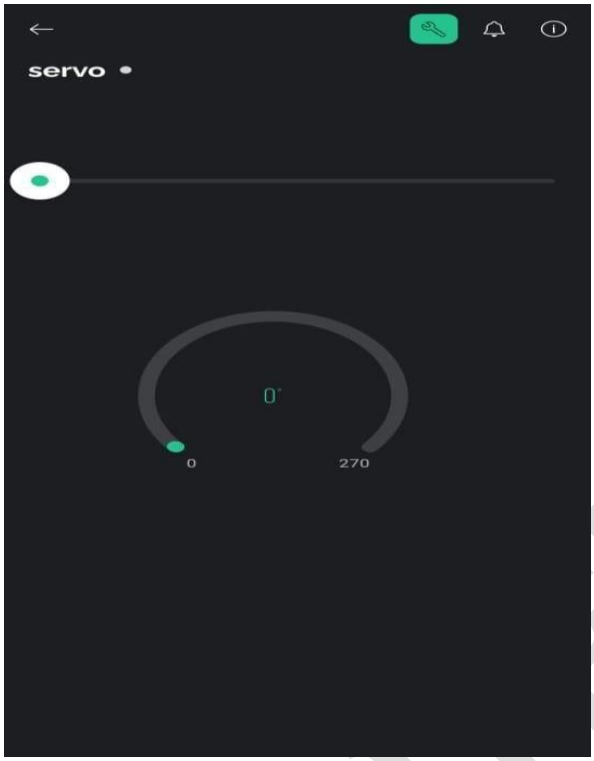
The divider is moved based on the density of the traffic using IR sensors. If the density of thetraffic is high on one side, the divider is moved to the other side. Then the density of traffic is stored in cloud which is possible through IOT.

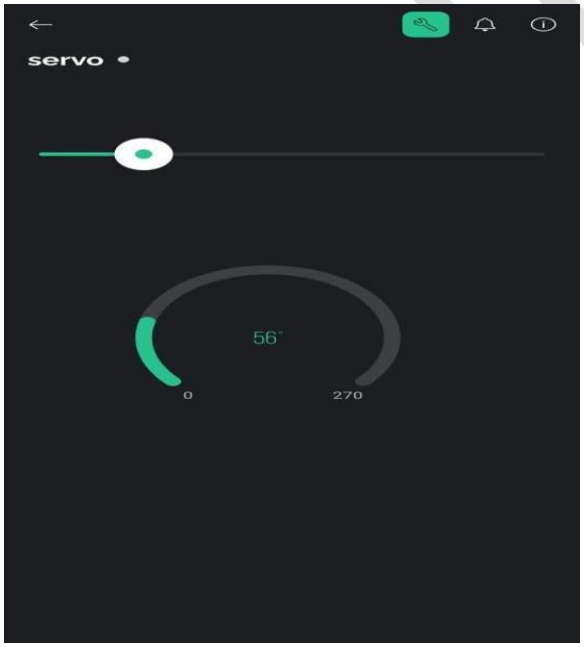
RESULTS

The experiment was done on smart divider by prioritizing emergency vehicles and obtained the following results. When the ambulance is passed the sensors will automatically detect the ambulance and give alert the public and after the delay of few seconds divider will start moving to the either side of the road.

RESULTS

When the divider has to be moved manually, the in charge can move the divider using the Blynk app. The divider can be moved short distance each time according to the requirement.





CONCLUSION

In the current urban landscape, emergency services often face challenges in navigating through traffic congestion, leading to delays that can have severe consequences for those in need of urgent medical attention. The Smart Road Divider Project addresses this issue by introducing a sophisticated infrastructure that integrates IoT devices, sensors, and smart algorithms to create an adaptable road system.

The core functionality of the project revolves around the implementation of intelligent road dividers that can dynamically adjust their positioning to create an unimpeded pathway for approaching emergency vehicles. These dividers are equipped with advanced sensors that constantly monitor traffic conditions, identifying the presence of emergency vehicles through real- time data analysis.

The project aims to establish seamless communication between the road infrastructure and emergency vehicles, ensuring that the dynamic road division mechanism responds rapidly and accurately to the changing conditions on the road. This collaborative approach between technology and emergency services seeks to significantly reduce response times, potentially saving lives in critical situations.

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