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Intelligent Traffic Control System with Priority to Emergency Vehicles

Arshiya [1], Azra Khan [2], Pavithra M [3], Shefali Shankar [4], Mamatha V [5]
[1, 2, 3, 4] *Student,* [5] *Professor, Dept. of Computer Science and Engineering, BIT, Bengaluru*

Abstract: ***In static road dividers the number of lanes on either side of the road is fixed and cannot be extended. This can be a major problem during peak traffic hours. The situation is abysmal when emergency vehicles are required to wait for other vehicles to give way at traffic intersections. This causes large time delays and may affect the emergency case. These traffic issues faced by emergency vehicles and daily commuters can be avoided by using this proposed traffic control system based on image processing and IoT. As a result, this project successfully analyzes and implements an Intelligent traffic control system with priority given to emergency vehicles.***

Keywords: Raspberry Pi, Traffic Density, Moveable Divider, Image Processing, RGB LED

I. INTRODUCTION

With the increase in urbanization in metropolitan cities, there has been a tremendous increase in the number of vehicles on the roads. Though the number of vehicles using the roads has increased, the static road infrastructure is unable to cope with the congestion. The widening of existing roads is limited as the total available space within the city is restricted. The effect of extending existing roads results in additional traffic that continues to increase congestion. This calls for better utilization of existing resources like the number of lanes or width of the road available. This paper discusses implementation of movable traffic dividers to reduce the traffic congestion. The project aims to use image processing techniques to detect real-time traffic congestion along with an IoT module for the movement of the road dividers. The road divider would move automatically to the side having less traffic, thereby providing more space for traffic flow on the traffic dense side of the road. Using the movement of the divider, an extra path can also be formed to facilitate speedy movement of emergency vehicles.

II. AIM AND OBJECTIVES

The main aim of this project is to reduce the traffic congestion by using a movable road divider system which can be embedded in the road. This system aims to save the commuters time and fuel by decongesting traffic dense roads.
The objective is to automate movement of the divider based on the traffic density and to also make a path for the Ambulance in case of Emergency to avoid delays due to traffic. The goal is to move the divider using Image Processing and IoT techniques and to also implement a TCP app for Ambulances.

III. PROPOSED SYSTEM

In this proposed system, Raspberry Pi is the microcontroller to which all other peripheral devices are connected. A web camera captures the live traffic image. This image is processed using image processing techniques. Traffic density is calculated for this image by counting the number of vehicles on both sides of the road. The vehicle count on both sides of the road is compared to determine which side has higher traffic density. The divider then moves towards the side having lower traffic density. This adds additional space on the traffic dense side of the road and helps relieve traffic congestion. Traffic lights are also turned green for the traffic dense side of the road to further reduce congestion. The Raspberry Pi controls the divider movement via the DC motor. Ultrasonic sensors are present on the divider for object detection. If any object is detected in the proximity of the divider, the Raspberry Pi sends a signal to the buzzer, which makes an alarm sound. This indicates that an object is impeding the divider's movement. The Raspberry Pi then prevents the divider from moving further. The divider will not move until the obstacle in its proximity is cleared. A TCP mobile application is used to send commands to indicate the arrival of the ambulance to the Raspberry Pi. The command indicates which side of the road the ambulance is arriving from. RGB LEDs present on the divider glow when the ambulance arrives and the divider starts moving. On the arrival of Ambulance, the RGB LEDs turn red indicating that the path(lane) created is only for the Ambulance movement. This informs the commuters that the divider is moving to make an extra lane only for the arriving ambulance. The traffic signal is turned green so that the Ambulance can cross all the traffic signals smoothly. Once the ambulance crosses the traffic signal, the divider is reset to its original position in the center of the road.

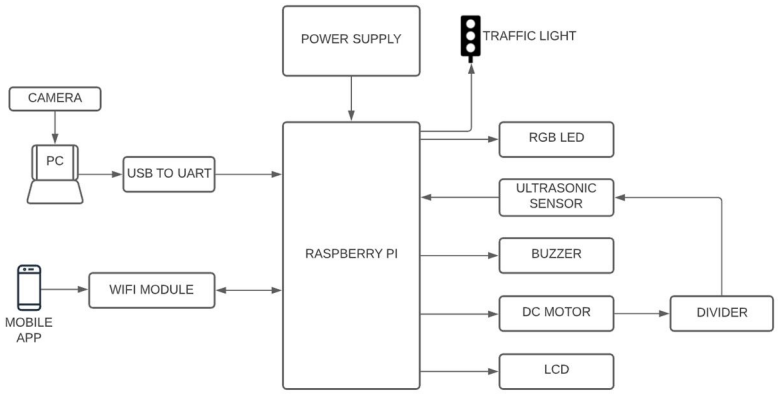

Fig 1. Architecture of Proposed System

IV. LITERATURE SURVEYS

A. Traffic Control System with Priority to Emergency Vehicles

This paper was published in the year 2018 by R Vani, N Thendral, JC Kavitha, NPG Bhavani. The project detects vehicles using imaging processing. Traffic density is found based on the processed traffic image frames and traffic signals are changed accordingly. Emergency vehicles are detected through their flashing red lights.

B. Implementation of Movable Road Divider using Internet of Things (IoT)

This Paper published in 2018 by Hemlata Dalmia, Kareddy Damini and Aravind Goud Nakka, proposes a system to reduce the response time to emergency vehicles by providing RFID tags. Using this the cloud detects the ambulance arrival and triggers the divider to move. Continuous monitoring of the traffic is done, and intensity of traffic is uploaded to the cloud. The road divider is moved based on LOW, MEDIUM and HIGH traffic intensity.

C. Movable Road Divider

This paper was published in 2019 by Rohit Mohit, Abhijeet Kaname, Pankaj Kamble and Prashant Kabutare. This project identifies the status of each car using IR transceivers and sends this data to the microcontroller. When the car comes near the artificial road divider, the proximity sensor senses the car and conveys this to the microcontroller. The microcontroller uses the H-bridge for the forward and reverse movement of the divider.

D. Controlling of Traffic Using Movable Road Dividers

This paper was published in the year 2018 by S. Jyothirmayee, G. Vamshi Krishna, J. Nanditha, B. Shashank Yadav. The paper proposes a module consisting of a microcontroller and an ultrasonic sensor for measuring the traffic density, along with two dividers: Normal and Extended. When the signal turns red, the traffic density is measured. If the traffic density is high, then the extended divider comes up and the normal divider goes to ground position. If the traffic density is normal, then no type of action is taken.

V. DRAWBACKS OF THE EXISTING SYSTEM

Most existing systems are not efficient and are expensive to build and maintain. Static systems require space to widen roads in order to reduce traffic density. This is not always possible due to limited space available for expansion. Hence, these systems are not scalable. Zipper Machine systems are bulky and consume lots of time to move the dividers. They cannot detect traffic density automatically and require Manual intervention. Most existing systems do not make provisions for emergency vehicles. Hence, these vehicles would get caught up in the traffic congestion and reach their destinations late.

Fig 2. Road Zipper reducing traffic congestion

VI. METHODOLOGY

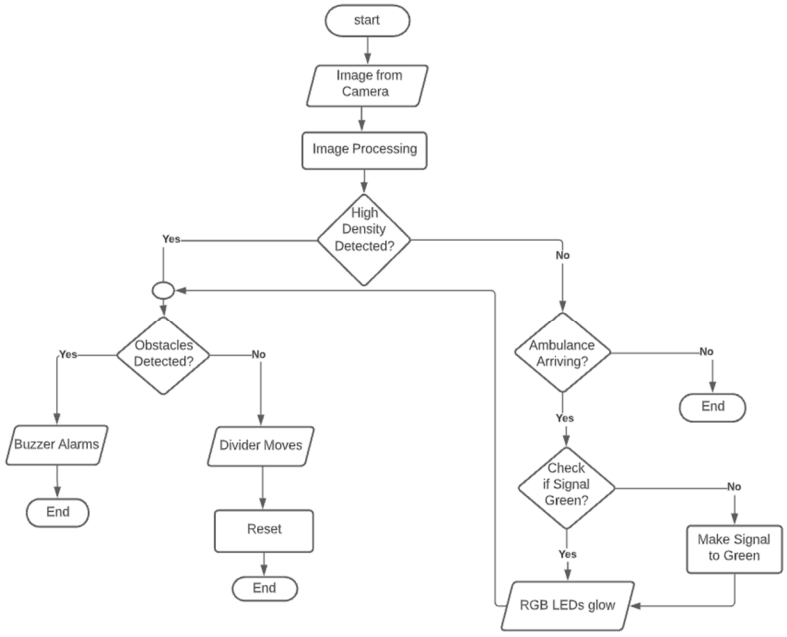

Fig 3. System Flowchart

A. Traffic Density System

1) *Image Capture and Processing:* The first step is to train the model to detect only vehicles. This is done using a COCO vehicle dataset and YOLO algorithm. Once the model, a live traffic image is captured. This is done with the help of a web camera placed having a top down view. The captured image is then sent to a computer system for image processing. The image is processed using CNN. The image is first divided into two halves along the divider. It is then converted to grayscale followed by background subtraction. Vehicles are detected and marked using Blobs. A bounding box is drawn around the detected vehicles for easy identification. The detected vehicles are counted on each side of the divider. If the vehicle counts are above a certain threshold, the divider moves towards the side having lower vehicle count.
2) *Divider Movement:* The traffic density (vehicle count) detected is sent to the Raspberry Pi. The Raspberry Pi sends a signal to the DC motor to move the divider towards the side having lower traffic density. Here we use the concept of an artificial movable road divider. The DC motor is attached to the divider and connected to the Raspberry Pi via the H-Bridge. The H-Bridge is used to control the movement of the DC motor. The Raspberry Pi also sends a signal to turn the traffic lights to green for the side having higher traffic density. This helps in reducing the traffic congestion. Ultrasonic sensors are present on the sides of the road divider. They detect the presence of objects in the proximity of the divider. If objects are detected, the ultrasonic sensor sends a signal to the Raspberry Pi. The Raspberry Pi then prevents the divider from moving and sends a signal to the buzzer. The buzzer makes an alarm sound to alert the presence of an object blocking the divider's movement. The divider is reset to its original position once the traffic congestion is reduced. No action takes place if the traffic density is normal, or below a certain threshold.

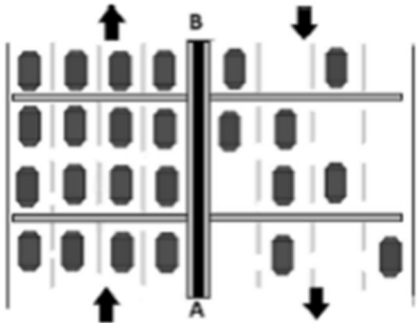

Fig 4. High Traffic on Left side of road

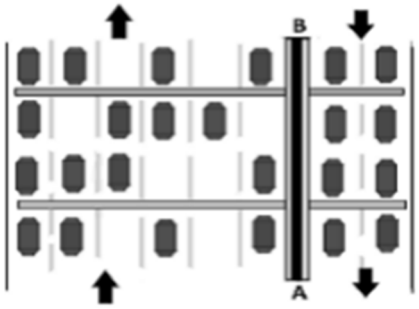

Fig 5. Divider moves to the right to reduce traffic density on the left side of the road

B. Ambulance System

In case of emergency vehicles, the divider movement is instigated through a mobile device connected to a Wi-Fi module. A TCP app is used to send commands from the mobile device, present in the ambulance, to indicate its arrival to the Raspberry Pi. The TCP app connects to the Raspberry Pi using a registered IP address and a port number. This connection is similar to a TCP socket connection. The Raspberry Pi then signals the road divider to move to create a traffic free path (lane) for the ambulance. This is done with the help of the H-Bridge. The signal is sent from the Raspberry Pi to the H-Bridge. The H-Bridge then controls the movement of the DC motor. The DC motor will be attached to the road divider. So, the divider will move along with the DC motor. It also signals the RGB LEDs, present on either side of the road, to glow, indicating the movement of the road dividers and direction of ambulance arrival to the commuters. The microcontroller then turns the traffic light green so that the Ambulance can pass through the junction quickly. The system is reset once the ambulance passes through the junction.

VII. RESULTS

A. Image Captured from Camera

Live traffic image is captured by the web camera placed at a high viewpoint and fed into a Computing system as input. This is the traffic image which will be processed.

Fig 6. Captured Traffic image

B. Vehicle Detection and Counting

Vehicles are identified and counted on the left and right side of the road using YOLO and CNN. The vehicle count(traffic density) on both sides of the road is compared, and the divider moves towards the side having lower vehicle count.

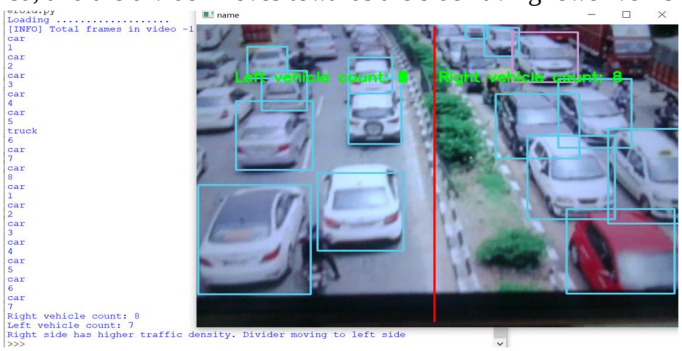

Fig 7. Processed Traffic image

C. Hardware Design

Fig 8 shows the hardware components present in the proposed system. Two DC Motors are present centrally beneath the divider. This is connected to the Raspberry Pi via the H-Bridge and controls the movement of the divider present above it (shown by Fig 9). LM317 voltage regulator is used to control the voltage supply to the H-Bridge and LEDs. LCD displays the current action performed by the system. It is connected to the Raspberry Pi. Ultrasonic sensors, present on the divider for object detection, are connected directly to the Raspberry Pi. A buzzer, connected to Raspberry Pi, alarms when an input signal is received from Raspberry Pi in case an object is detected by Ultrasonic sensors. RGB LEDs, present on the divider, glow to indicate divider movement during ambulance arrival. They are connected to Raspberry Pi via 4-Channel Relays. Two additional LEDs depict red and green traffic lights. They glow depending on the signal from the Raspberry Pi.

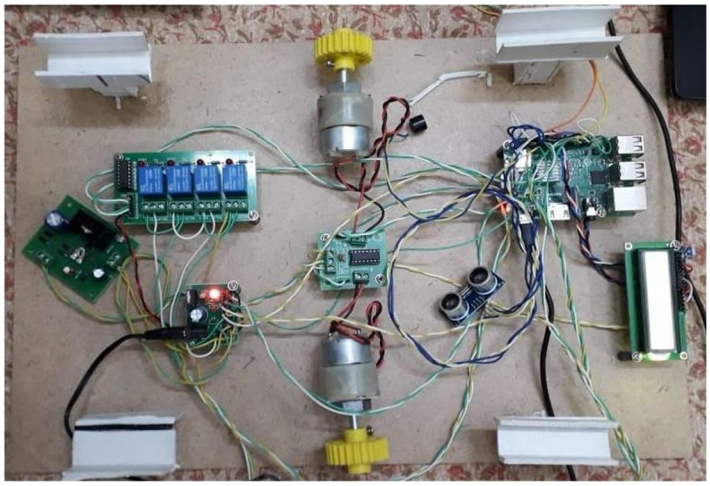

Fig 8. Hardware Components

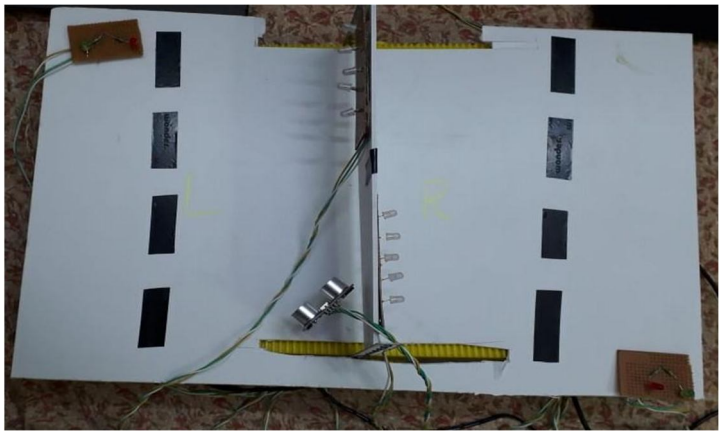

Fig 9. Movable road divider present in the middle of road with RGB LEDs and Ultrasonic sensor

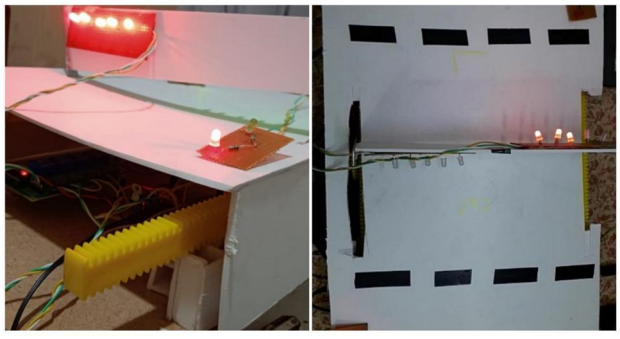

Fig 10. LEDs present on divider glow indicating Ambulance arrival

Fig 11. LCD Display

VIII. FUTURE SCOPE

The proposed system can be further enhanced and used in spontaneous traffic monitoring and mapping traffic free routes for emergency vehicles. The movable road divider technique can be applied in parking lots for space optimization by moving parking dividers/barricades automatically based on vehicle size. The system can also be further enhanced to identify vehicles that disobey traffic rules and to detect stolen vehicles using image processing techniques.

IX. CONCLUSION

Traditional methods of decongesting traffic, such widening of roads, are limited due to restricted space in cities and cannot cope with the tremendous increase in traffic. This proposed intelligent traffic system helps to reduce traffic jams and provide road clearance for the emergency vehicles. The system uses image processing techniques to move the divider according to traffic density. This system is highly scalable and can be implemented even in narrow roads and bridges. Thus, the proposed system overcomes the demerits of other Traffic management systems and has high scope for future enhancements.

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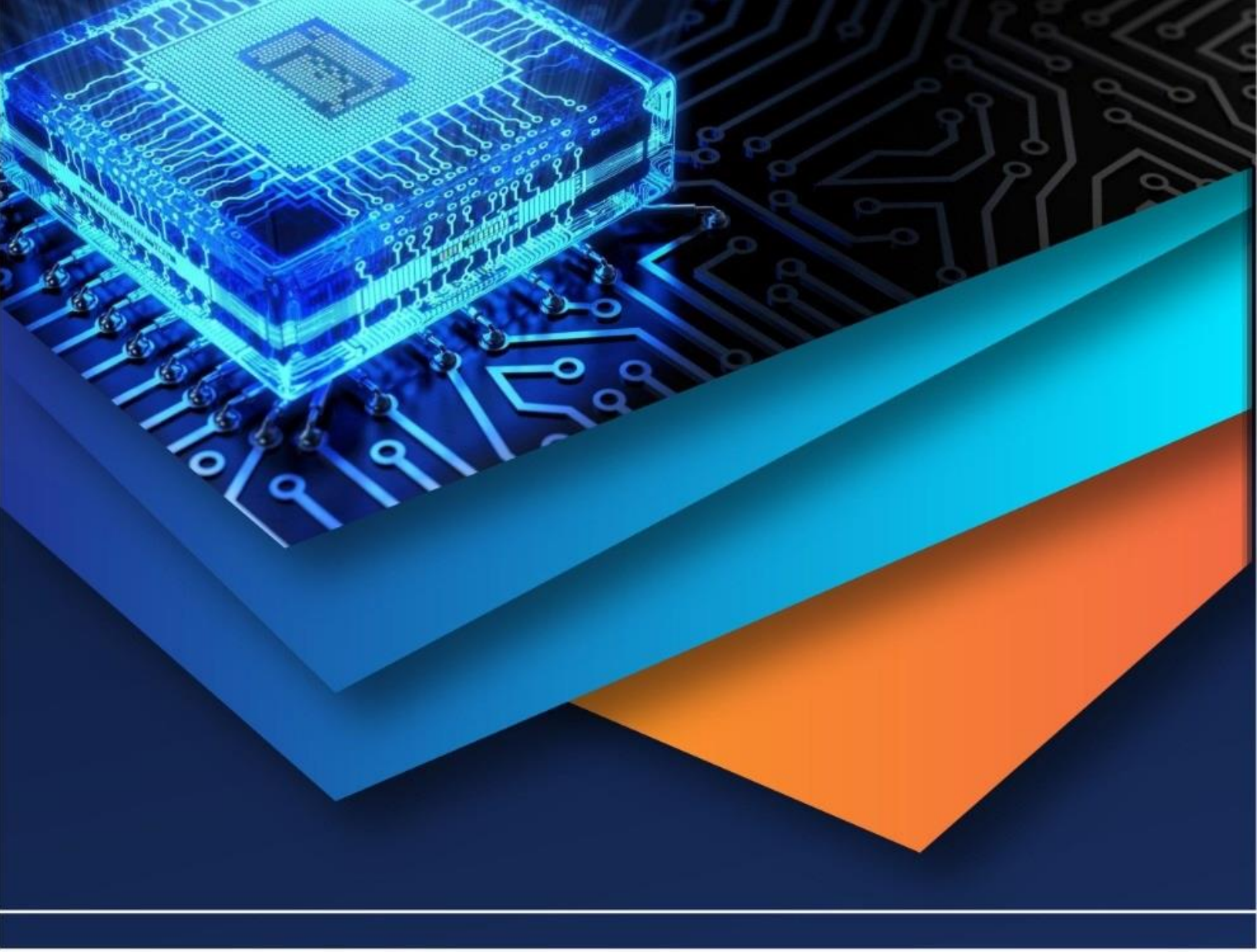

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