Traffix : Efficient Traffic Control using IoT

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Abstract— This paper aims to alleviate traffic congestion brought on by antiquated, ineffective traffic management systems that are based on a predefined countdown. Long red light delays are the result of these traditional systems, which have a predefined countdown regardless of the actual traffic on a given road. Our system makes sure that time set for the traffic lights reflects the traffic density in real time, which ensures efficient use of time. In order to do this, we first compute the traffic density, which is ascertained by combining image processing methods along with the use of ultrasonic sensors. The Raspberry Pi then processes this data and then manages the time set for the traffic light. Furthermore, the use of SQL Alchemy ensures that this processed information is stored to the cloud, where it may be utilized in events of sensor failure or system malfunction.

Index Terms—*Image Processing, Raspberry Pi, Traffic Congestion, Ultrasonic sensors*

I. INTRODUCTION

India is the second most populated country in the world, second only to China. In addition, India is a developing nation with the population growing exponentially every year. According to the latest United Nations data the current population of India is estimated to be 1.4 billion which is equivalent to 17.76% of the total world population where 36.3 % of the population is based in urban areas. India has the second largest road network in the world with 4.2 million km. Interestingly, even though the increase in road length has kept pace with the rising population, it has not managed to keep pace with the increasing number of motor vehicles. This has led to inefficient management of traffic.

The traffic management system today depends highly on traffic lights which have a predefined countdown which is between 30 seconds to 120 seconds. These traffic lights work like clockwork with the light changing after a fixed period of time. This system works in the same way irrespective of how much traffic is actually in that lane. For example, at a four cross junction if there are no vehicles in one lane the green time allotted to that particular lane will remain the same while the vehicles in other lanes wait resulting in time delays and wastage.

This ends us leading to road rage, accidents, excess burning of fuel and ultimately more air pollution. To minimize this the proposed system makes use of dynamic allotment of time to manage traffic in each lane at a traffic junction. The amount of time allotted to each lane depends on the traffic in that lane. For example,These enhancements aim to mitigate existing limitations and make traffic management more adaptable, accurate, and efficient.

II. LITERATURE REVIEW

[1] The system uses an RSU (Road Side Unit) to provide drivers with real-time traffic congestion information. Each vehicle has an RFID tag, and each traffic signal has a RSU and RFID scanner. The RFID scanner scans the tag and sends data to a database system. An HTML5-based mobile app alerts users of traffic and distance, reducing waiting times. However, sudden traffic changes due to accidents could cause problems, as drivers assume previous information is correct.

[2] The existing manual traffic system has drawbacks, including the need for physical presence and static time allocation. To address these, a model using image processing and algorithms like Gaussian filtering, Canny edge detection, and time allocation is proposed. This algorithm determines vehicle density on each lane, allocates time to signals with the highest density, and reduces waiting time. However, continuous image processing could cause inaccurate results and does not prioritize emergency vehicles or accidental situations.

[3] The system uses RFID technology to create a green corridor for emergency vehicles, dynamically updating traffic signals based on an oncoming vehicle. The scanner retrieves information from an RFID tag attached to the vehicle, alerting traffic signals and turning green. This system allows ambulances to progressively shift lanes, reducing congestion. However, delays and inaccurate scanners can hinder effective communication.

[4] The Adaptive Neuro Fuzzy Inference System (ANFIS) is used to improve traffic conditions by analyzing inputs like waiting time and vehicle density. The system uses the least-square method and backpropagation gradient descent techniques. Images captured using camera sensors are processed using ThingSpeak. Two models are used: daytime and nighttime vehicle detection. Daytime detection uses optical flow and background subtraction, while nighttime detection using Ostu's image thresholding. The learning model dynamically allocates signal timing based on queue length and waiting time. However, the inputs are preprocessed, making the output uninterpretable.

[5] The system estimates traffic congestion using LabView and ThingSpeak. It works in four stages: first, using analog sensors and laser cameras to calculate vehicle numbers and types. Data pre-processing is done using an analog-to-digital converter and Raspberry Pi. Traffic congestion ratio is calculated based on road parameters and transmitted to the cloud. ThingSpeak provides a detailed view of congestion levels. The system has high complexity, time for data pre-processing, and potential for inaccurate results with cheaper camera alternatives.

[6] The Harris algorithm detects parked vehicles by identifying static and dynamic corners in an environment. Camera monitoring areas extend vertically, creating one-dimensional vectors for each frame. This system offers real-time insights and in-depth statistical analysis of lane occupancy. However, it has limitations like vehicle discrimination, false positives, and lack of detailed vehicle attributes. Its suitability depends on specific application requirements and trade-offs between simplicity and precision.

III. METHODOLOGY

A. BLOCK DIAGRAM

As shown in Fig 1. The block diagram shows the "brain" of the entire system which is responsible for computing all results to give an output is the Raspberry Pi. It processes the data received from the ultrasonic sensors and camera. Ultrasonic Sensors (HCSR04) are responsible for detecting the traffic on the given lane. Raspberry Pi Camera Module captures and determines the traffic on a given lane using image processing. RFID Scanners are responsible for identifying vehicles with RFID Tags and displaying them on an LCD Display. Sqlalchemy is a database that will store all this information.

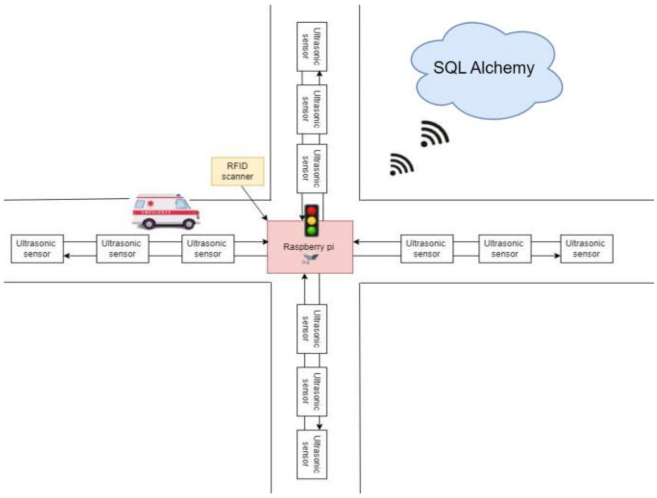

Fig. 1 Block Diagram

B. WORKING

The main purpose of the smart traffic management system is to allocate traffic light times according to the level of traffic on the track. To calculate the traffic level in each lane, the road is divided into three equally spaced sections.

Each section has an ultrasonic sensor that detects the presence of vehicles in that area. The ultrasonic sensor detects the presence of an obstacle by finding the distance taken for a transmitted signal to be received. In addition, a camera will be placed at the intersection which will periodically take pictures of the road. Using image processing techniques, we can determine the traffic in the area, the average of this empty road is compared with the limited images of the real road. Based on the number of vehicles in the area, the traffic level is classified as low or high.

Ultrasonic sensors and image processing techniques results are sent to the Raspberry Pi, and based on the received inputs, the Pi calculates the traffic level and allocates time for traffic indicators accordingly. These Values processed by the Raspberry Pi are forwarded to a database (Sqlalchemy) where they can be stored as a database useful for analyzing traffic density in a certain area.In addition, the Raspberry Pi compares the values provided by the ultrasonic sensors and the image processing results to ensure the same traffic level in both cases. If the readings appear to be very different on several occasions, the values recorded by the database provide sufficient information to allocate times to the traffic lights without the use of sensors. It does not give exact results, but the times allocated to the traffic lights are based on historical traffic levels calculated over a long period of time.So the above mentioned system is said to have a failsafe system so that it can be used even in fail situations

The system uses RFID technology to allow the passage of emergency vehicles on four cross four junctions using RFID scanners and tags.The RFID scanner will be placed at the center of the junction and RFID tags will be installed in each emergency vehicle. As the emergency vehicle approaches the traffic signal, it is detected and that particular junction is kept open for longer to allow the vehicle to pass.

IV. RESULTS

These sensors can be used to determine the presence of an obstacle, which in our case is vehicles. Each track has three equally spaced sensors placed vertically on the divider. A total of 12 ultrasonic sensors are used for the four paths. These sensors are connected to the Raspberry Pi using jumper cables and the Raspberry Pi processes the data collected by the sensors.

Fig. 2 HC-SR04 ultrasonic sensor

In addition to the ultrasonic sensors, the system also makes use of the Raspberry Pi camera module as shown in Fig 3 to capture images of each lane. Each lane has one camera to capture images of the lane. In total four cameras are used for the four paths. The Pi then determines the level of traffic and distributes the time to the light LEDs, which are red, yellow and green LEDs.

Fig 3. Raspberry Pi Camera Module

The system also uses RFID tags and scanners to allow for the passage of emergency vehicles through the junction. A RFID scanner is placed at the center of the junction and each emergency vehicle has an RFID tag. Fig 4 shows the setup of the prototype housing the camera module, the Raspberry pi, the ultrasonic sensors and the traffic light indicators. Every time the Raspberry Pi finds the level of traffic it updates the values to the database (Sqlalchemy).

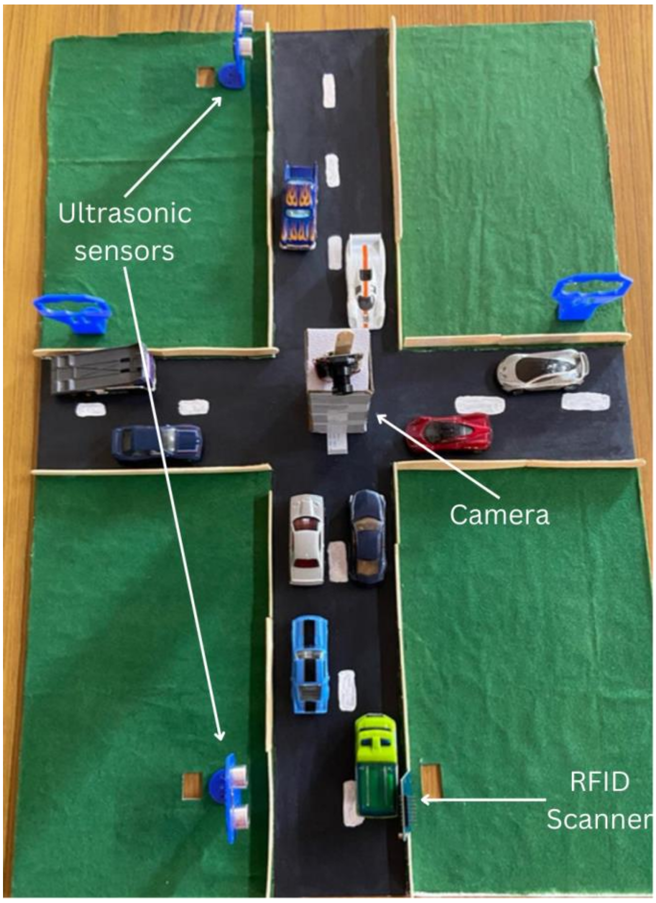

Fig 4. Four way traffic junction prototype

V. CONCLUSION

Huge traffic jams brought on by the widely used traditionally configured system are reduced by this system setup. Additionally, the technique lessens the workload of policemen who could have to control traffic when there are unforeseen circumstances or when the traffic lights are not working. Additionally, it makes it possible for traffic lights to run constantly with fewer chances of failing. Put simply, the technology offers an easy-to-use yet efficient remedy for ineffective traffic management systems.

VI. FUTURE WORK

This project still has room for improvement and can be extended by displaying traffic information in an application that is public. In addition, the system can be made more efficient by using a higher resolution camera or by replacing the HC-SR04 ultrasonic sensors with industrial grade sensors that serve the same purpose. Additional changes can also be made to the system, which will allow obtaining the height of emergency vehicles in any situation.

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