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Dynamic Traffic Control System with Emergency Vehicle Detection

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Abstract

The project's goal is to create a density-based dynamic traffic light system in which the timing of the signal changes autonomously based on the density of traffic at any given junction. Traffic congestion is a major issue in most places around the globe, so it is time to transition from a more manual or set timer method to an automatic system with decision-making capabilities. The current traffic signaling system is time-based, which can make it wasteful if one route is more active than the others. This technology detects vehicle weight and generate signal using piezoelectric sensors. The traffic density is then computed based on the number of cars present, and traffic signals are changed to ensure improved traffic flow. The system utilizes density-based traffic management techniques and incorporates ambulance detection to facilitate the smooth movement of emergency vehicles on the road. When an ambulance is detected in the vicinity, the system automatically gives priority to the ambulance by adjusting traffic signals and clearing the path for the vehicle. The system has the potential to significantly reduce traffic congestion and improve emergency vehicle response times, thereby saving precious lives.

Keywords: Autonomously, congestion, transition, vicinity, vehicle detection, traffic control

INTRODUCTION

Today's fast-paced society has made traffic congestion a significant problem in our everyday lives. Because so much time is lost in signalling, it lowers productivity on both an individual and society level. These disorganized traffic jams are mostly caused by an excessive number of cars, poor infrastructure, and an erroneous signalling system distribution. The initiative's objective is to improve traffic efficiency.

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In order to build an intelligent traffic control system, IR sensors were first used as a replacement for traditional systems. To determine the volume of traffic in each lane, Infrared sensors were employed [1]. To address the issue of emergency vehicles becoming stopped in traffic, the system includes Acoustic sensors (transmitter and receiver) installed on poles on each side of the road. As the emergency vehicles pass nearby, it activates and receives the signal [2].

In order to enhance traffic density measurement. Piezoelectric sensors installed in the road are used in this project to detect automobile movement, and a microcontroller is used to determine when to turn

on each lane's green light. This reduces the open time for the lane with little traffic and increases the open time for the lane with heavy traffic [3]. Later on, people employed FPGA technology to assess traffic density in this project, and they also built a unique system for traffic violations.

Infrared sensors are installed ahead of each road's halting line. During a red light, the sensor sends a low signal if all of the cars are in front of the marked line. When a rule is breached, the sensor activates the camera module, which takes a photo of the offending vehicle and submits it to the traffic road authority for further action [4]. Further advancement in this system calculates the time based on the vehicle density measurement, deft edge identification, and digital image processing. The reaction speed, vehicle management, automation, reliability, and overall efficiency of this powerful traffic control system are noticeably better than those of the existing systems [5].

The acoustic sensors were set up to gather the siren sounds and transmit them to the Road Side Unit in order to detect emergency vehicles. To identify emergency vehicles, the Road Side Unit has an Arduino UNO frequency measuring controller. The emergency vehicle is located by the controller using the frequencies of its siren [6]. The use of RFID technology for tracking emergency vehicles can greatly improve response times during emergencies. By attaching RFID tags to emergency vehicles and placing RFID readers along the road, the system can detect the presence of the vehicle and trigger an alert to notify emergency personnel. This research will focus on the system design for RFID tags on emergency vehicles and RFID readers on the road to detect their presence and trigger an alert using Arduino technology [7-10].

LITERATURE SURVEY

Density Measurement using IR Sensor

Here they are using IR sensors Arduino as a micro-controller replacing system to design an intelligent traffic control system. IR sensor contains IR transmitter IR receiver (photodiode) in itself. These IR transmitter and IR receiver will be mounted on same sides of the road at a particular distance. As the vehicle passes through these IR sensors, the IR sensor will detect the vehicle & will send the information to the microcontroller. The microcontroller will count the number of vehicles, and provides glowing time to LED according to the density of vehicles. If the density is higher, LED will glow for higher time than average or vice versa. [1]. Density Measurement using IR Sensor is shown in model in Figure 1.

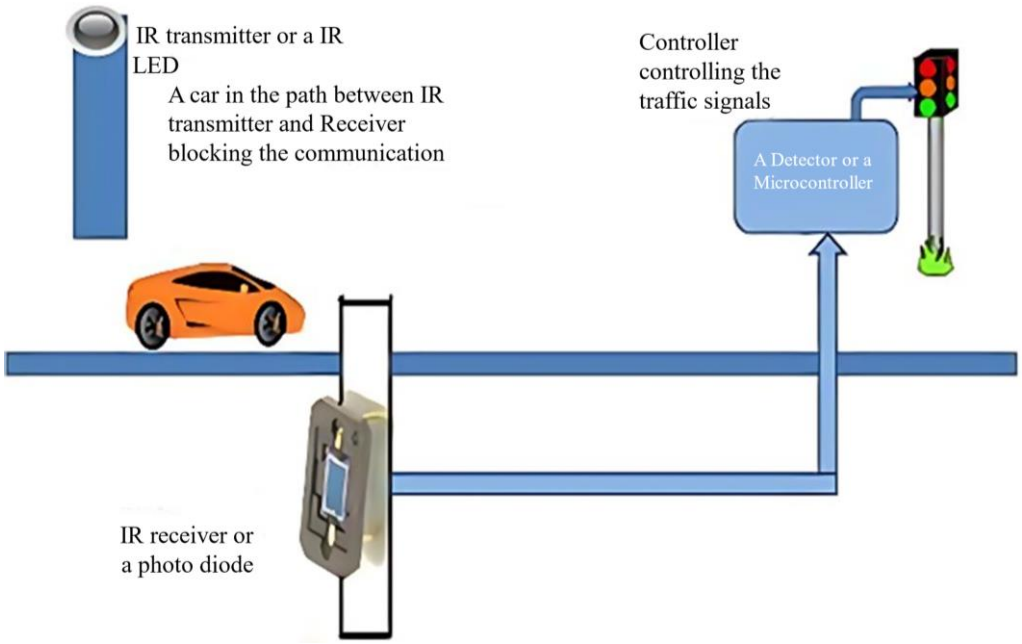

Figure 1. Density measurement using ir sensor.

Density Calculation using Image Processing

In this method, the time is allocated according to the measure of the vehicle density using canny edge detection with digital image processing. This imposing traffic control system offers great improvement in response time, vehicle management, automation, reliability and overall efficiency over the existing systems. There are many different distinct techniques to govern vehicle records like counting the overall variety of pixels and calculating the reliability of vehicles. They have used the Canny Edge detection method, which is used as powerful method to extract the specified vehicle facts from the CCTV footage. [2]. Density Calculation using Image Processing is shown in Figure 2.

Density Measurement using Piezoelectric Material

The proposed roadway vitality reaper is a pressure based framework, which produces vitality under pressure drive, and the created control is a heartbeat control enlisted with every pressure cycle [4].

A traffic light that will reduce congestion at crosswalks by detecting vehicle movement with the aid of piezoelectric sensors, extending the green light period for lanes with heavy traffic while shortening it for lanes with light movement, and reducing the open time for lanes with light movement [5]. Density Measurement using Piezoelectric Material is shown in Figure 3.

METHODOLOGY

System Structure Overview

Using the suggested system, we may identify automobiles by detecting pressure and vibration (piezoelectric sensor) (pressure sensor). It is simple to embed in the road surface in order to detect vibration. The vehicle will be detected by the piezoelectric vibration and electrical production, which will then relay the information to the microcontroller.

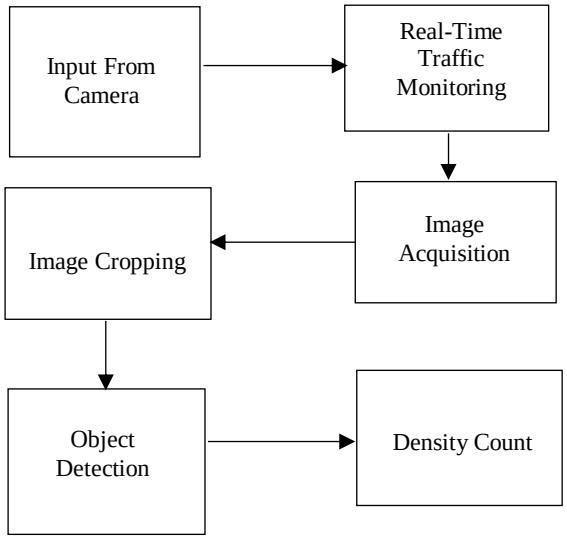

Figure 2. Density calculation using image Processing

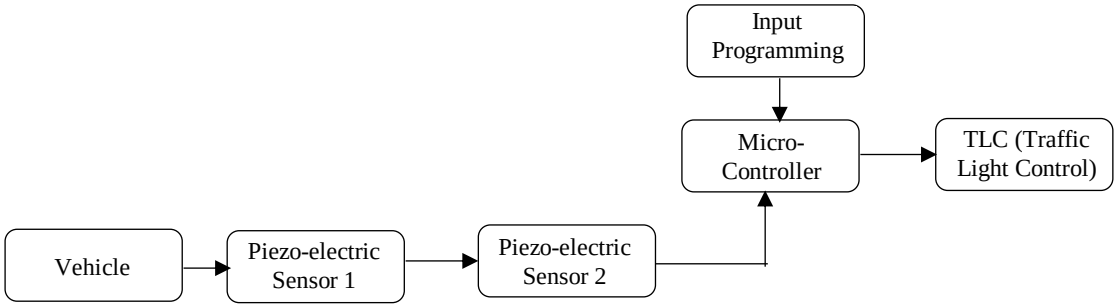

Figure 3. Density measurement using piezoelectric material.

System Design

The suggested system is broken up into many control sections. The various sections are performing a different job.

An Integrated Piezoelectric generator's Basic Operation

Piezoelectricity is the electricity produced when certain materials, like crystals, are mechanically stressed (Quartz). When a force is applied to a crystal, minute adjustments in the lattice's structure lead to the development of an electric dipole, which generates a voltage across the crystal's faces. A modest quantity of charge that can be utilised to power an external circuit is made accessible by this voltage.

Density Calculation Piezoelectric Generator's

The automobile will be detected by the piezoelectric's vibration and voltage, and the information will be sent to the microcontroller. In which the maximum amount of weight that can be pushed onto the piezo is specified, allowing the density that each sort of vehicle can cover to be easily calculated.

Control Room Section

The microcontroller will tally the number of cars and give the LED a lighting time based on the vehicle density. The LED will shine longer than average in the lane or road with the higher density, and vice versa. The piezo-electric sensor and LEDs are connected via a microcontroller, which houses the full embedded system.

Emergency Vehicle

When an emergency vehicle is dispatched, an RFID tag is attached to the vehicle. RFID reader is placed along the road. The RFID reader is connected to the Arduino. When an emergency vehicle passes by an RFID reader, the reader detects the presence of the RFID tag and sends the identification number to the Arduino. The Arduino receives the identification number and determines which lane the emergency vehicle is in. The Arduino then gives green signals to the traffic signals in that lane, allowing the emergency vehicle to pass through without any delay.

System Flow Chart

System Flow chart of proposed system is shown in Figure 4.

Block Diagram

Block Diagram of proposed system is shown in Figure 5.

Circuit Diagram

Circuit Diagram in the form of 2D model is shown in Figure 6.

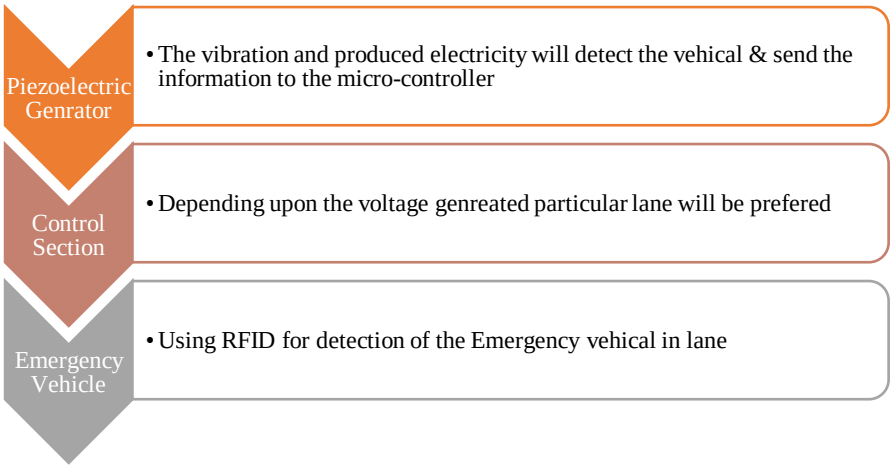

Figure 4.

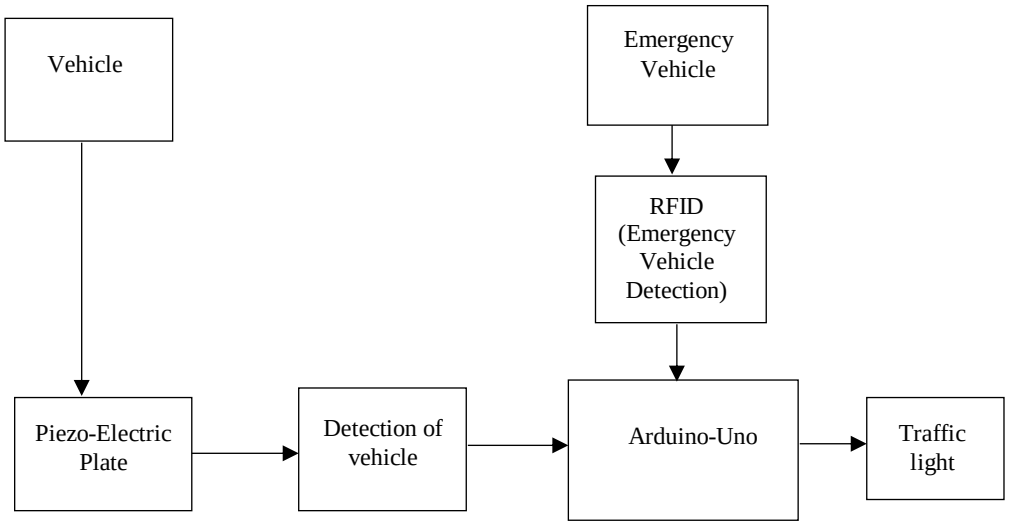

Figure 5. Block Diagram as per proposed system.

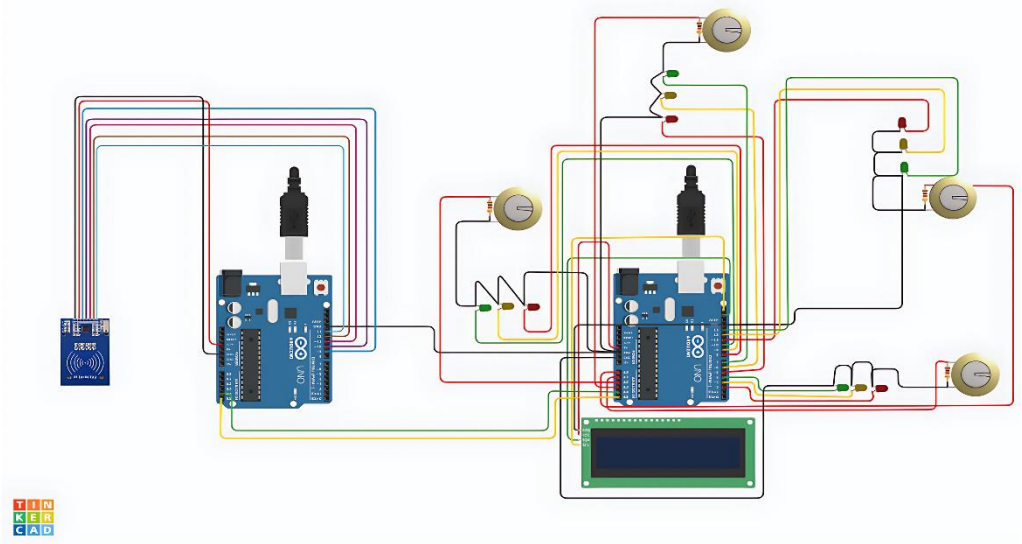

Figure 6. Circuit Diagram in the form of 2D model.

RESULTS

We were able to address the problem of traffic congestion in this project by developing a smart traffic light system. Piezoelectric sensors are used in the system's architecture to track moving vehicles and modify the green signal timing accordingly. Additionally, this technology gives emergency vehicles priority by collecting data from RFID sensors and sending it to the traffic signal control module. Our solution proved more effective than the traditional traffic control system.

when a particular lane (lane 2 on T0 second, where T0 is one of 10–25) detects the presence of an emergency vehicle. Green light timing for that lane (lane 2) will be extended by 30 seconds.

The timing for granting the green light will now be T0< T< T0+30 for that specific lane (here lane 2). The latest version of the truth table has been displayed in Figure 7.

If an emergency vehicle is spotted in a lane (i.e., lane 2) with a high red signal or when the green signal in another lane (i.e., lane 3) is high. Then the green signal of the lane with the emergency vehicle (here lane 2) will activate for 30 seconds before returning to the preceding lane (lane 3).

Traffic Timing	0<T<=5			5<T<=10			10<T<25			25<T<=30			30<T<=55			55<T<=60			60<T<=65			65<T<=70		
Traffic LEDs	R	Y	G	R	Y	G	R	Y	G	R	Y	G	R	Y	G	R	Y	G	R	Y	G	R	Y	G
Lane 1(Count <5)	0	0	1	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
Lane 2(5<Count<10)	1	0	0	1	0	0	0	0	1	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0
Lane 3(Count>10)	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0	0	1	0	0
Lane 4(Count <5)	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	1	0

Figure 7. Latest version of the truth table.

CONCLUSION

We get to the conclusion that this approach is useful for signal intelligence and traffic density. The adaptability of sensor architecture tends to expand with the current developments in sensor management. There is a huge need for gadgets that are more durable, useful, and power-efficient. The creation of a practical model to estimate traffic density and carry out the signalling procedure based on it is the main objective of this project. The operating of the sensor today seems to be less complicated despite the sensor's increased capability and internal complexity. The efficacy and simplicity of this tactic will raise people's standard of living. In future Artificial Intelligence would be used with this method.

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