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Dynamic Traffic Light Switching based on Traffic Density

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ABSTRACT

In recent years, the amount of traffic on the roads has risendramatically. The signals in the new Traffic Light system differaccording to preset time intervals. They do not change according to the amount of traffic. Waiting times are longer and fuel consumption is higher due to fixed time intervals. Furthermore, emergency vehicles are not prioritised in these traffic networks. Emergency vehicles will find it difficult to cross the traffic signal during peak hours. We suggest a system that allows for dynamic switching between traffic lights as well as emergency vehicle preemption to increase traffic lightcontrol performance. A microcontroller with an infrared sensor is used to monitor traffic lights. A microphone is also built into themicrocontroller to identify emergency vehicles. As a result, traffic signal optimization improves the flow of traffic.

KEYWORDS

Arduino Mega 2560,IR Sensors,LEDs (Traffic Lights).

Introduction

Road traffic is a complicated phenomenon in which a variety of entities (pedestrians, cars, trucks, buses, tramps, bicycles, and so on) communicate with one another by using shared facilities. Due to infrastructure constraints and an increase in the number of vehicles, traffic management and control is a difficult job that necessitates the use of dedicated algorithms as well as accurate traffic data (both historical and current). The details on thenumber of vehicles and their forms helps in the reduction of travel time and pollution. Precise traffic data enables us to not only boost traffic control efficiency, but also to adjust management policies to evolving circumstances and predictedinfrastructure bottlenecks.

In recent years, it has been observed that urbanisation isaccelerating at a rapid rate. People are migrating from rural areas to urban areas in order to take advantage of different resources that they may not have access to in rural areas. As we all know, metropolitan areas have more industries than rural areas, which means that there are more jobs in urban areas than in rural areas. Other amenities, such as medical services and education, also draw rural residents to urban areas. When the number of people in cities increases, so does the demand for vehicles to carry them from one location to another. One of the key causes of traffic congestion is the increase in the number of people and automobiles in urban areas. People who work in the same city arrive at work at about the same time and return home at approximately the same time. As a result, traffic congestion has become a major issue in major cities. On the highways,traffic lights are used to manage traffic and prevent accidents, although there have been several problems with traffic lights that have been found. One of them is that often the road on one side is clear, but the traffic lights on that side are orange, while the traffic lights on the other side of the road are red, meaning that there is heavy traffic trapped between the two lanes. This issue wastes time and increases traffic congestion. Another concern is that emergency vehicles, such as ambulances, cannot beidentified by traffic lights, causing these vehicles to wait for the green signal, which may be risky for the patient in theambulance. Because of the specific fixed time period of thetraffic signals, the ambulance's arrival at the hospital may be delayed. We have developed a proposal called dynamic traffic light controller that can be used to alleviate the above-mentioned traffic light problem. Our plan would include features that will monitor the strength of the ambulance horn, allowing theambulance to cross the road without waiting for a traffic signal. Another feature is that traffic lights will be able to sense vehicle interference on the road and will turn traffic lights on and off based on that detection.

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Existing Work

Owing to the rise of population and technology in this modern age, traffic is growing day by day. This causes massive traffic congestion in a variety of areas. The new traffic light system operates on a fixed time interval between green and red signals. Traffic signals run at the same time regardless of whether or not the lane is congested; in some situations, even though there is no traffic, people must wait. This is due to the fact that the traffic light stays red for the remainder of the preset time frame. It lacks emergency vehicle preemption, which can trigger serious issues for those in need.

Disadvantages

- A fixed time period for traffic signals wastes time and increases fuel consumption, resulting in air pollution.
- Because the emergency vehicle is trapped in traffic, it takes a lot longer to get to the hospital and save people's lives, and sometimes it's too late.

Proposed Work

The traffic light in our proposed system responds dynamically to the identification of traffic in a specific lane. Commuters do not have to wait for the time interval to end. When a lane's traffic is cleared, the signal in that lane is shifted to another lane, reducing commuters' waiting time in other lanes. As a result, traffic on the other lanes is reduced. When an emergency vehicle crosses a lane, the controller detects it and switches the green signal to that lane. This will allow the emergency vehicle to quickly pass through the traffic signal without having to wait in traffic. The switching is made in a matter of seconds, ensuring that the emergency vehicle is not delayed.

System Design (Phase 1)

As shown in (fig.1), this block diagram illustrates the overall configuration of a traffic light control system:-

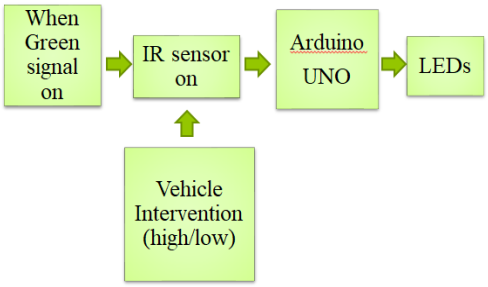

Fig.1. Block diagram of the proposed System

The model is based on the concept of adjusting traffic signals based on the density of traffic passing through a specific section of road. The density of the area covered by the sensors is tested by four sensors mounted on four sides of a four-way lane.

We're using infrared sensors to build a smart traffic control device. IR sensors will be mounted at a specific distance on either side of the road to determine the density of traffic on each side. An IR transmitter and an IR receiver are included in each of the IR sensors.

The IR transmitter is in charge of transmitting the IR rays, while the receiver is in charge of receiving them. The Aurdino, a microcontroller, is in charge of the entire device. IR sensors, resistors, and LEDs are all connected to the Arduino.

The IR sensor will detect the vehicle as it moves through these IR sensors and send the information to the Arduino. The total number of IR sensors needed is four, and the number of LEDs required is twelve. The obstacle that crosses the IR Beam is detected by these IR sensor modules. Each IR sensor communicates with the Arduino board located in each lane of the road.

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The road is about 8 to 10 feet wide in each lane. As a result, the IR Sensors' range is set to detect any vehicle that comes within 8 to 10 feet only. Each road side has four 10-foot-wide lanes, and each IR obstacle Sensor Modules Set includes four IR sensors and an Arduino Uno board to detect vehicles passing through these lanes.

The IR Obstacle module has three pins: two for powering up the module, which is 5V DC, and the third for output. The Arduino Uno Board is attached to this module. The module's output pin is connected to the Board's analogue pin 2. Each lane of the road has an IR module mounted. The IR Obstacle module's working theory is that an IR transmitter fires an IR beam at an object, which is reflected back when a vehicle passes in front of it. The IR Receiver senses the beam that is reflected back. By changing the variable on the IR Obstacle Module, you can change the detection range.

It's worth noting that the number of IR Sensors mounted for each lane of the road corresponds to the number of lanes. As a result, if four vehicles arrive on the road at the same time, an IR sensor is mounted in each lane to detect only the vehicles in that lane and send a signal to the main controller.

System Design (Phase 2)

In this step of our project, we have defined how the traffic light system detects emergency vehicles, as shown in the diagram below (fig.2.).

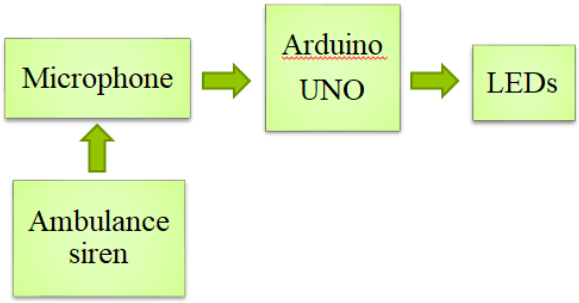

Fig.2. Block diagram of detection of EV

People's use of cars is increasingly growing as a result of rapid population growth, resulting in high-density traffic and longer vehicle wait times. Ambulances, fire trucks, and VIP cars are all expected to arrive at their destination as soon as possible. The primary limitation is time, which is consumed by the vehicle's high-density traffic signal. When ambulances enter the signal, this method focuses on having a smart way to manage traffic. This project is being carried out on the Arduino UNO platform.

We've explained how the traffic light system detects emergency vehicles in this phase of our project. This concept was created specifically for the ambulance so that it would not be caught in the traffic jam.

The Arduino UNO, microphone, and buzzer are all part of our design. Arduino is used to attach the microphone and buzzer. The strength of the horn of the ambulance present in the traffic jam can be sensed by the microphone. The Arduino will activate the microphone, and the microcontroller will adjust the traffic light from red to green, allowing the ambulance to continue. The detected lane's traffic light turns green when the buzzer sound is detected using the circuit's microphone. All other lanes will be red at that period. This design will assist ambulances in arriving at the hospital on time and keeping patients healthy.

Interfacing Devices

Arduino Uno

The Arduino UNO is a microcontroller board supported by the Microchip ATmega328P. The board has a variety of digital and analog pins that can be used to connect to expansion boards and other circuits. The board has 14 digital pins and 6 analog input pins, and it is programmed using Arduino IDE and a USB type B cable. It accepts voltages

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between 7 and 20 volts. It can be operated by a USB cable or an external 9 volt battery.
In Italian, the word "uno" means "one". It was chosen to commemorate the release of Arduino Software (IDE) 1.0. The Uno board and Arduino Program (IDE) version 1.0 were the reference versions of Arduino, which have since beensuperseded by newer updates.

- **Arduino Pin Functions**

LED: A built-in LED is powered by digital pin 13. The LED is turned on when the pin is HIGH, and it is turned off when the pin is LOW.

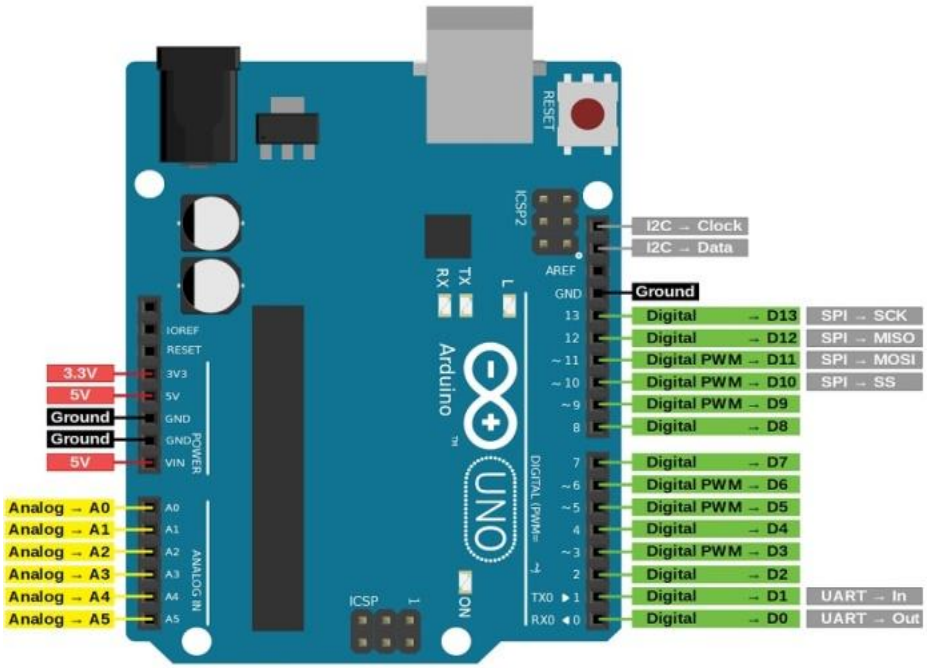

Fig.3.PIN Diagram

VIN:When using an external power source, VIN is the input voltage to the Arduino uno board. This pin may be used to supply voltage or to access voltage if it is supplied through the power jack.

This pin receives a controlled 5V from the board's regulator. The DC power jack (7 - 20V), the USB connector (5V), or the board's VIN pin can all be used to power the board (7-20V). Using the 5V or 3.3V pins to supply voltage by-passes the regulator and may harm the board.

3V3: The on-board regulator generates a 3.3 volt supply. The overall existing draw is 50 milliamperes.
GND: GND stands for field pins.

IOREF: The voltage reference for the microcontroller is given by this pin on the Arduino/uno board. The IOREF pin voltage can be read by a properly calibrated shield, which can then pick the appropriate power source or allow voltage translators on the outputs to operate with 5V or 3.3V.

Reset: This is widely used to add a reset button to shields that block the board's reset button.

- **Technical Specifications**

  - Microcontroller: Microchip ATmega328P
  - Operating Voltage: 5 Volts

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- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 Ma
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz

- **IR Sensor**

An infrared sensor is an electronic system that emits infrared light in order to detect certain aspects of the environment. An infrared sensor can detect motion as well as measure the heat of an object. Almost all objects emit some form of thermalradiation in the infrared spectrum. These are radiations that are invisible to the naked eye but can be identified by an infrared sensor. The emitter is a simple infrared LED (Light Emitting Diode), and the detector is a simple infrared photodiode that detects infrared light of the same wavelength as the IR LED.

- LM358 IC 2 IR transmitter and receiver pair.
- Resistors of the range ofkilo ohms.
- Variable resistors.

Fig.4.IR Sensor

- **IR Sensor Pin Functions**

Pin, Control Indicator	Description
VCC	3.3 to 5 Vdc supply input
Ground	Ground input
OUT	Output that goes low when obstacle is in range
Power LED	Illuminates when power is applied
Obstacle LED	Illuminates when obstacle is detected
Distance adjust	Adjust detection distance. CCW decreases distance. CW increases distance
IR Emitter	Infrared emitter LED
IR Receiver	Infrared receiver that receives signal transmitted by infrared emitter.

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Leds

When an electric current passes through it in the forwarddirection, the LED emits light. The recombination of charge carriers occurs in the LED. The N-side electron and the P-side hole combine to produce energy in the form of heat and light. The light is radiated through the junction of the diode, which is made of colourless semiconductor material. The transmitter portion of this project includes an IR sensor that emits continuous IR rays that are received by an IR receiver module. The receiver's IR output terminal varies depending on how well it receives IR rays.

Fig.5.LEDs

Resistors

A resistor is a two-terminal passive electrical component that acts as a circuit element by implementing electricalresistance. Resistors are used in electronic circuits for avariety of purposes, including reducing current flow,adjusting signal levels, dividing voltages, biassing activecomponents, and terminating transmission lines. Each end of a resistor has two terminals, one for each connection.

A resistor's electrical resistance is measured in ohms. The Greek capital-omega symbol for an ohm is: The resistance between two points where 1 volt (1V) of applied potential energy pushes 1 ampere (1A) of current is the (somewhat roundabout) meaning of 1.

Fig.6. Resistors

Ky-038 Microphone Sound Sensor

The module has two outputs for sound detection: AO stands for analogue output, which is the microphone's real-time output voltage signal. When the sound intensity exceeds a certain level, the high and low signals are output. The sensor's thresholdsensitivity can be changed using the potentiometer.

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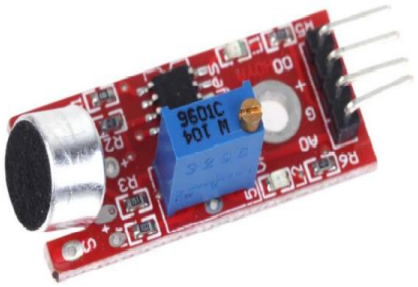

Fig.7. KY-038 Microphone Sound Sensor

Buzzer

Buzzers are made up of a DC power supply and electronic transducers that work together. They're commonly used in timers, alarm clocks, electronic toys, computers, telephones, and other items that require sound generation. Active and passive buzzers are the two forms of buzzers. The sound is created by an active buzzer. If the buzzer needs more current than the Arduino digital pin can supply, it is needed to use a mosfet to raise the current. In the case of the passive buzzer, you'll need to send a sound signal to control the speed. To give the sound signal, you'll need to use the pwm pin.

A buzzer or beeper is an electronic signalling system that is commonly used in cars, home appliances such as microwave ovens, and game shows. It typically consists of a number of switches or sensors connected to a control device that decides whether and which button was pressed, or whether a preset time has elapsed, and generally illuminates a light on the appropriate button or control panel, as well as sounding an alert in the form of a continuous or intermittent buzzing or beeping tone.Originally, this device used an electromechanical mechanism that was similar to an electric bell but didn't have the metal gong (which makes the ringing noise).

Fig.8. Buzzer

Rocker Switch

To attach or break a circuit, rocker switches have a button for action that which can be pressed on either end. They are often used as ON/OFF switches. The word "rocker switch" comes from the switch's rocking motion when the button is pressed. A seesaw turn is another name for it.

A rocker switch can accommodate maximum current through three different ratings: 10A, 16A, and 20 A. For example, It is possible to reduce the portion of 16 A rated rocker switch that protrudes from the panel surface from 25 mm 32 mm to 17 mm 24 mm, and even further to 15 mm 21 mm. Sealed Forms, Illuminated Types, and Resettable Types also are available.

Fig.9. Rocker Switch

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Software Requirements

- **Arduino IDE**

The Arduino IDE is a java-based cross-platform framework that originated from the IDE for the processing programming language. It is intended for beginners who are not known well with software development, to learn to program. It comes with a code editor that has features such assyntax highlighting, brace matching, and automatic indentation, also the ability to compile and upload program to the board with a single click. Arduino programs are written in C or C++ programing languages.

The arduino IDE includes a software library named "wiring" from the first wiring project, which simplifies different input/output operations.

A led and a load resistor are normally connected between pin 13 and ground on most Arduino boards, which serves as a useful function for several basic tests. When the user clicks the "upload to i/o board" button, a replica of the code is written in atemporary file with an extra header at the top and a very basic main() function at the bottom, making it a legitimate c++ program. Arduino is open-source hardware. Several devices having Arduino-compatible that have been released commerciallyhave used "-duino" name variant instead of the "Arduino".

Result

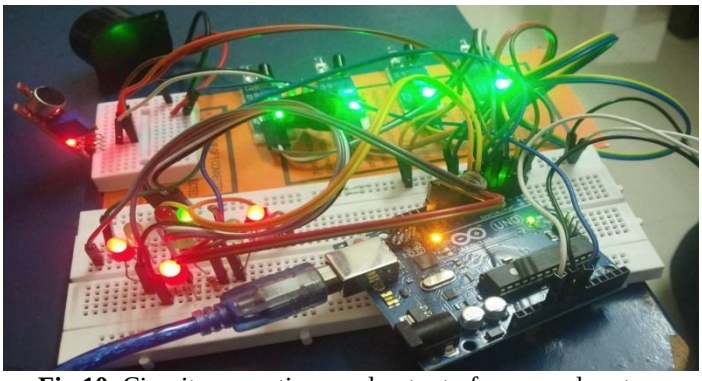

Fig.10. Circuit connections and output of proposed system

As shown above, the circuit connections are made. When the IR sensor detects no interference, dynamic LED switching occurs, and a buzzer sound is generated alongwith the green light switching when an ambulance siren is detected. Our paper is designed to ensure efficient time management during peak hours, especially in metropolitan areas.

Conclusion

By dynamically switching signals based on traffic in the lanes, this paper eliminates waiting time and traffic during peak and non-peak hours. It offers a solution to the present emergency vehicle crisis. Except in congested areas, the emergency vehicle quickly passes the signal. As a consequence, the traffic light controlling system has become more efficient.

It has been discovered that the proposed intelligent system is more effective than the existing traditional controller in terms of waiting time and emergency operation. Furthermore, the system features a simple architecture, a quick response time, user-friendly,cost-effective, and also has room for development.

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Future Scope

This traffic light controlling system can be further developed to implement it in ajunction of eight lanes. It can also be featured for tracking the one who violates the traffic signal by using image processing.

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