A Micro Project report on

IOT Traffic Signal Monitoring & Controller System

Submitted to the CMR Institute of Technology in partial fulfillment of the requirement for the award of the Laboratory of

IOT with Cloud Computing Lab

Of

III-B.Tech. II-Semester

in

Computer Science and Engineering Department

Submitted by

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Kandlakoya,Medchal Road,Hyderabad

2023-2024

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CERTIFICATE

This is to certify that a Micro Project entitled with: **"IOT Traffic Signal Monitoring & Controller System"** is being

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In partial fulfillment of the requirement for award of the **IOT with Cloud Computing Lab** of III-B.Tech II- Semester in CSE towards a record of a bonafide work carried out under our guidance and supervision.

Signature of Faculty **Signature of HOD**

ACKNOWLEDGEMENT

We are extremely grateful to **Dr. M. Janga Reddy**, **Director**, **Dr. B. Satyanarayana**, **Principal** and **Mr. A. Prakash**, **Head of Department**, Dept of Computer Science and Engineering, CMR Institute of Technology for their inspiration and valuable guidance during entire duration.

We are extremely thankful to our IOT with Cloud Computing Lab faculty incharge **Mr.N.Praveen Kumar, Assistant professor**, Computer Science and Engineering department, CMR Institute of Technology for his constant guidance, encouragement and moral support throughout the project.

We express our thanks to all staff members and friends for all the help and coordination extended in bringing out this Project successfully in time.

Finally, we are very much thankful to our parents and relatives who guided directlyor indirectly for successful completion of the project.

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Abstract

IoT is an emerging research paradigm and apparently the discovery of its body of knowledge is still in an infancy stage, with a key feature to create a smart environment together with quick response to support certain decisions and/or operations of human, IoT-based systems have been proposed in several applications. The project is aimed at designing a density based dynamic traffic signal system where the timing of signal will change automatically on sensing the traffic density at any junction. Traffic congestion is a severe problem in most cities across the world and therefore it is time to shift more manual mode or fixed timer mode to an automated system with decision making capabilities. The increase in numbers of cars on streets is not the only reason for the traffic problems to appear; there is lack of planning to deal with this amount of cars. For example, it is very common for someone to wait a traffic light to become green even if there is no car in the street. This might intensify traffic jam, which would require manual control by policemen. In this context, modern societies can rely on traffic management system to minimize traffic congestion and its negative effects. Traffic management systems are composed of a set of application and management tools to improve the overall traffic efficiency and safety of the transportation systems. Smart Traffic Light Control System that works dynamically based on the concentration of vehicles in a specific region. The system is intelligent in that it can automatically adjust the time delay between light changes whenever issues arise.

Introduction

In cities, where the number of vehicles continuously increases faster than the available traffic infrastructure to support them, congestion is a difficult issue to deal with and it becomes even worse in case of car accidents. It brings down the productivity of individual and thereby the society as lots of work hour is wasted in the signals. High volume of vehicles, the inadequate infrastructure and the irrational distribution of the signaling system are main reasons for this chaotic congestions. This problem affects many aspects of the modern society. In the traditional traffic management system, ineffective traffic lights with predefined timers are used, along with manual control by police officers. Without taking an account of real-time traffic data for consideration, it can happen that a “green light” is granted to an empty lane while a lot of cars are lined up at a “red light” on the other lanes because the same time interval of green lights are granted to every lane. Smart Traffic Light Control System that works dynamically based on the concentration of vehicles in a specific region. The proposed system is quite advantageous with the use of local workstations consisting regional processing units that receive data from each vehicle pertaining to a specific regional radius. In this case, each IR Sensor acts as an eye, which transmits traffic data. The communication is established between IR Sensor and traffic signal over Arduino connection, so IR Sensor are like mouth and ear of sender and receiver consecutively. For example, traffic data can be collected and sent out persistently, which is nearly impossible when manual communication is applied. It indirectly also adds to the increase in pollution level as engines remain on in most cases, a huge volume of natural resources in forms of petrol and diesel is consumed without any fruitful outcome. Therefore, in order to get rid of these problems or at least reduce them to significant level, newer schemes need to be implemented by bringing in sensor based automation technique in this field of traffic signaling system.

Hardware and Software Requirements

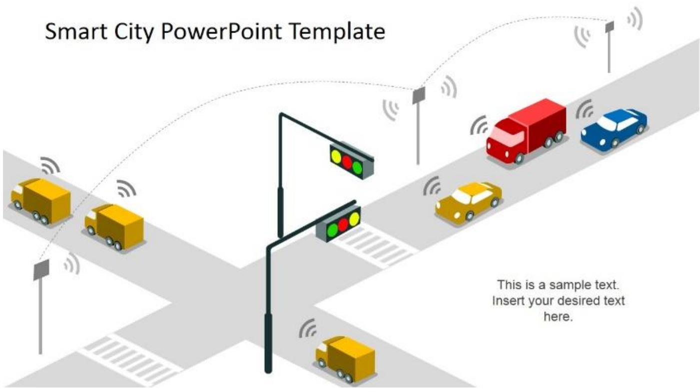
The design and implementation of a Density-Based Traffic Signal Control System require a combination of both hardware and software components. Each component plays a crucial role in ensuring the system functions efficiently and adapts to real-time traffic conditions.

Components Required:

- **Arduino UNO (or any compatible board):** Serves as the central microcontroller that processes data from the sensors and controls the traffic lights.
- **IR Sensor module:** Detect the presence and density of vehicles in each lane approaching the intersection.
- **LEDs (for traffic signals):** Represent the traffic signals for each lane.
- **Breadboard and jumper wires:** Facilitate the connection of all electronic components.
- **Power supply for Arduino:** Provide necessary electrical power to the Arduino and other components.

Software Components:

- **Arduino IDE:** Used for programming the Arduino board.
- **C/C++ Code:** Written to interface with the sensors, process data, and control the LEDs based on traffic conditions.
- **Traffic Signal Control Algorithm:** Core logic that determines the traffic light timings based on vehicle density data from the IR sensors.



Objectives of the project

The objective of our traffic signal monitoring system project is to design and implement a Density-Based Traffic Signal Control System utilizing Arduino and IR Sensors to efficiently manage traffic flow based on vehicle density. This system aims to

- **Enhance Traffic Flow:**

Optimize traffic signal timings to reduce congestion and improve traffic flow at intersections and minimize waiting times for vehicles, leading to a smoother and more efficient traffic management system.

- **Improve Road Safety:**

Reduce the likelihood of accidents by providing real-time traffic updates and adaptive signal control.

- **Real-Time Data Collection:**

Collect real-time traffic data using IR sensors and other devices to monitor vehicle density and traffic patterns. Ensure accurate and timely data collection for analysis and decision-making.

- **Reduce Environmental Impact:**

Decrease vehicle idling time at intersections, thereby reducing fuel consumption and emissions. Promote environmentally friendly traffic management practices through efficient signal control.

- **Scalable and Cost-Effective Solution:**

Utilize cost-effective hardware (IR sensors, Arduino, traffic signal LEDs) to create an affordable solution for traffic monitoring.

Design

The design of the Density-Based Traffic Signal Control System integrates multiple components to create an intelligent traffic management solution. By leveraging the capabilities of Arduino, infrared (IR) sensors, and LEDs, the system dynamically adjusts traffic signal timings based on real-time vehicle density. This adaptive approach aims to enhance traffic efficiency, reduce waiting times, and improve overall road safety.

System Architecture:

The system architecture involves a setup where IR sensors are installed at each lane approaching the intersection. These sensors continuously monitor the lanes, detecting the presence and count of vehicles. The data collected by the IR sensors is sent to the Arduino, which processes this information using a pre-programmed algorithm.

1. **Sensor Data Collection:**
    - IR sensors detect the presence of vehicles at the intersection and send signals to the Arduino board.
2. **Data Processing:**
    - The Arduino board processes the sensor data to determine the traffic density at the intersection.
3. **Traffic Signal Control:**
    - Based on the traffic density, the Arduino board controls the traffic signal LEDs to manage the flow of traffic.

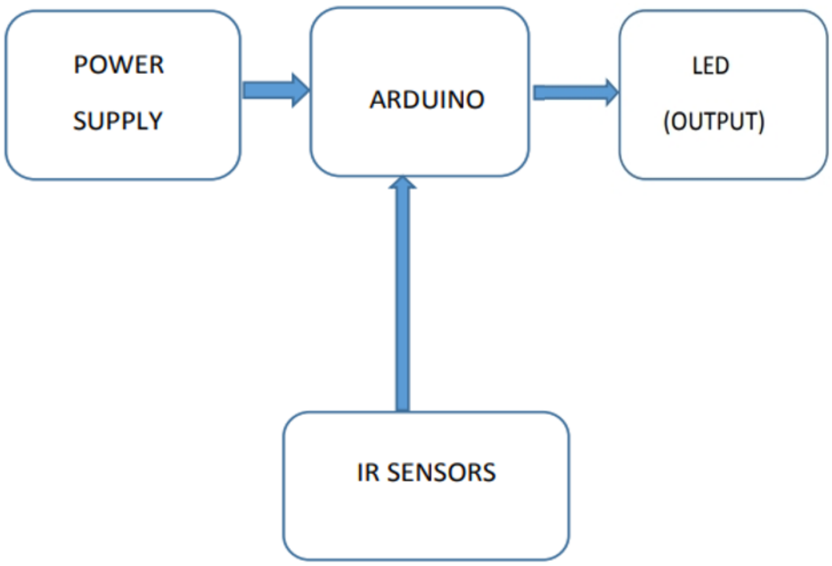
System Operation:

- **Placement of IR Sensors:**
    - IR sensors are placed at specific points on each lane approaching the intersection. These sensors detect the presence and count of vehicles.
- **Data Collection:**
    - The IR sensors continuously monitor the lanes and send data about vehicle density to the Arduino.
- **Signal Control Logic:**
    - The Arduino processes the input from the IR sensors using a programmed algorithm to determine the vehicle density on each lane.
    - Based on the density, the Arduino decides the duration for which each traffic light (Red, Yellow and Green) should be on for each lane.
    - The logic prioritizes lanes with higher vehicle density, ensuring that lanes with more vehicles get a green signal for a longer duration.
- **Traffic Light Control:**
    - The Arduino controls the LEDs connected to each lane. The LEDs represent the traffic signals, turning Red, Yellow, or Green based on the Arduino’s decisions.
    - When a vehicle is detected by the IR sensor, the Arduino board updates the traffic signal status accordingly.
    - The system can be programmed to adjust signal timings dynamically based

on real-time traffic conditions.

System Flowchart:

1. **Initialize System**:
    - Start the Arduino and initialize the IR sensors and LEDs.
2. **Read Sensor Data**:
    - Continuously read the data from the IR sensors to get the vehicle density on each lane.
3. **Process Data**:
    - Process the vehicle density for each lane.
4. **Determine Signal Timings**:
    - Use the density data to determine the optimal green light duration for each lane.
5. **Control Traffic Lights**:
    - Turn on the green light for the lane with the highest density.After the green light duration ends, turn on the yellow light for a short interval. Finally, turn on the red light and move to the next lane based on the density.
6. **Repeat**:
    - Continuously repeat the process to ensure real-time traffic management.



Documentation

Working of the circuit:

The model works on the principle of changing of Traffic signals based on the density through an assigned section of the road. There are four sensors placed at four sides of a four way road which checks the density of the area covered by the sensors. Here we are using IR sensors to design an intelligent traffic control system. In order to measure the density of traffic on each side, IR sensors will be kept on either sides of the road at a specific distance. Each of the IR sensors consists of an IR transmitter and an IR receiver. Just as the name suggests, the IR transmitter transmits the IR rays and the receiver is responsible to receive the rays. The whole system is controlled by the microcontroller which is the Aurdino. Arduino is interfaced with Serial to parallel IC(74HC595) and IR sensors .As the vehicle passes through these IR sensors, the IR sensor will detect the vehicle & will send the information to the Arduino. The total no of IR sensors required are 4 and Led's 12. Three sets of LEDs via Green, Yellow and Red are used to indicate the GO state, Ready to Go state and WAIT state.
The traffic signal will be tuned with a default timing of 5 seconds of green light and all other signal will be red. After 5 seconds two signals will be yellow for 5 seconds and another two will be red. This condition will be followed till all the IR sensors receiving the signals or all the IR sensors are not getting signals. The LEDs G (green), Y (yellow) and R (red) glow in following sequence.

Arduino IDE Source code:

The Arduino code is structured to continuously monitor the IR sensors and adjust the traffic signals based on the detected vehicle density.

```
# define left_ir 13
# define down_ir 12
# define right_ir 11
# define up_ir 10

# define left_red 9
# define left_yellow 8
# define left_green 7

# define down_red 6
```

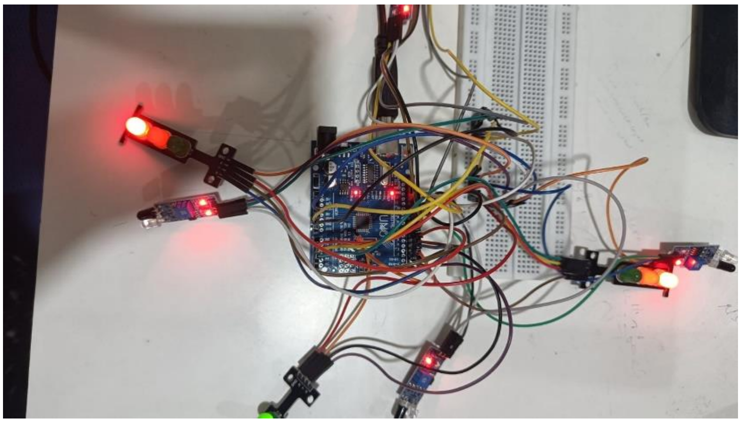
```
# define down_yellow 5
# define down_green 4

# define right_red 3
# define right_yellow 2
# define right_green 1

# define up_red A1
# define up_yellow A2
# define up_green A3

void setup() {
  pinMode(left_ir, INPUT);
  pinMode(down_ir, INPUT);
  pinMode(right_ir, INPUT);
  pinMode(up_ir, INPUT);

  pinMode(left_red, OUTPUT);
  pinMode(left_yellow, OUTPUT);
  pinMode(left_green, OUTPUT);

  pinMode(down_red, OUTPUT);
  pinMode(down_yellow, OUTPUT);
  pinMode(down_green, OUTPUT);

  pinMode(right_red, OUTPUT);
  pinMode(right_yellow, OUTPUT);
  pinMode(right_green, OUTPUT);

  pinMode(up_red, OUTPUT);
  pinMode(up_yellow, OUTPUT);
  pinMode(up_green, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  all_reds_high();
  default_traffic();
}

void all_reds_high() {
  digitalWrite(left_red, HIGH);
  digitalWrite(right_red, HIGH);
  digitalWrite(up_red, HIGH);
  digitalWrite(down_red, HIGH);
}

void default_traffic() {
  if (digitalRead(left_ir)) { Serial.println("left ir read"); set_lane_lights(left_red, left_yellow,
left_green, 3000, 5000); }
```

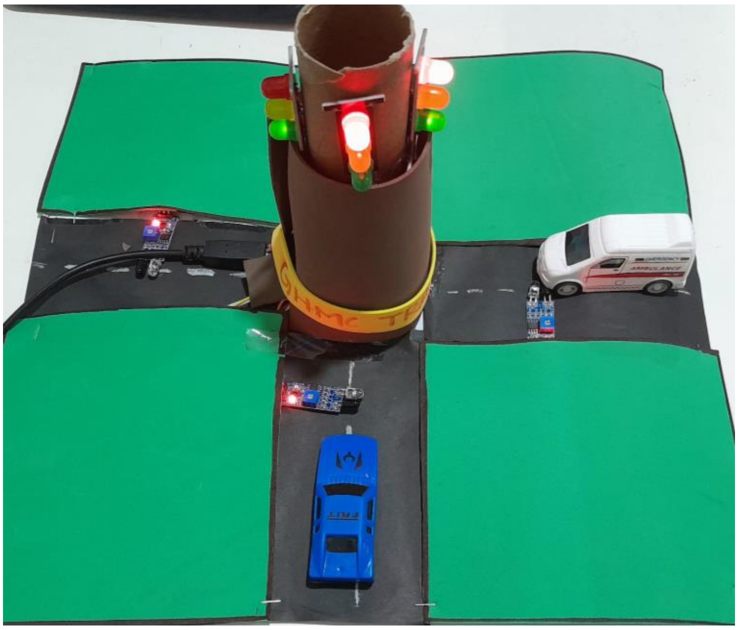
```
  else { Serial.println("left ir read"); set_lane_lights(left_red, left_yellow, left_green, 2000, 10000); }

  if (digitalRead(down_ir)) { set_lane_lights(down_red, down_yellow, down_green, 3000, 5000); }
  else { set_lane_lights(down_red, down_yellow, down_green, 2000, 10000); }

  if (digitalRead(right_ir)) { set_lane_lights(right_red, right_yellow, right_green, 3000, 5000); }
  else { set_lane_lights(right_red, right_yellow, right_green, 2000, 10000); }

  if (digitalRead(up_ir)) { set_lane_lights(up_red, up_yellow, up_green, 3000, 5000); }
  else { set_lane_lights(up_red, up_yellow, up_green, 2000, 10000); }
}

void set_lane_lights(int red, int yellow, int green, int second_timer, int third_timer) {
  digitalWrite(red, LOW);
  digitalWrite(yellow, HIGH);
  delay(second_timer);
  digitalWrite(yellow, LOW);
  digitalWrite(green, HIGH);
  delay(third_timer);
  digitalWrite(green, LOW);
  digitalWrite(red,HIGH);
}
```

Result/Output

The implementation of the Density-Based Traffic Signal Control System yielded positive outcomes in terms of traffic management and efficiency. The system successfully adjusted traffic signal timings based on vehicle density. Lanes with higher vehicle density received longer green light durations, effectively reducing congestion during peak traffic hours.

Below is the Density-Based Traffic Signal Control System prototype.





Conclusion

The Density-Based Traffic Signal Control System represents a significant advancement in urban traffic management by integrating modern technology to address the dynamic nature of traffic conditions. By utilizing an Arduino microcontroller and infrared (IR) sensors, this system effectively monitors vehicle density in real-time and adjusts traffic signal timings to optimize traffic flow, reduce waiting times, and enhance road safety.

The project's hardware components, including the Arduino UNO, IR sensors, LEDs, and power supply, work seamlessly with the software components, such as the control algorithms and sensor processing code, to create an intelligent and responsive traffic management solution. This integration ensures that the traffic signals adapt dynamically to real-time traffic conditions, prioritizing lanes with higher vehicle density and minimizing congestion.

There is exigent need of efficient traffic management system in our country, as India meets with 384 road accidents every day. To reduce this congestion and unwanted time delay in traffic an advanced system is designed here in this project. We have successfully implemented the prototype at laboratory scale with remarkable outcome. As a prototype was implemented to demonstrate the feasibility of the proposed model, the results of the prototype demonstration showed good accuracy in vehicle detection and a low relative error in road occupancy estimation. The successful implementation of this system offers numerous benefits, including reduced fuel consumption and emissions due to decreased idle times, improved traffic efficiency, and enhanced safety for all road users. Moreover, the project demonstrates the potential of smart traffic control systems to contribute to environmental sustainability and better urban living conditions.

Thus, the proposed model can help citizens to save their time, especially during peak hours. Hence, the traffic congestion due to accidents or any such unusual incidents can be avoided. Overall, the Density-Based Traffic Signal Control System is a promising step towards smarter and more efficient urban traffic management, paving the way for further innovations and improvements in the field.

Future Enhancement

As part of future advancements, the traffic check post may be connected by **wireless transmitters** by which the crossings ahead may be an anticipation of the traffic that is approaching. This may be achieved the connecting the sensor network with GPS connectivity and short wave radio transmission signals. This will act as a feed forward system making the signaling system even more smooth and congestion free. We will also update this system with modern technology so that when a vehicle try to move even during red signal it will turn on an alarm to warn the driver of the vehicle and will send the alert to the traffic warden with the picture.

Integration with IoT, Connect the system to the Internet of Things (IoT) to enable remote monitoring and management of traffic signals. Provides real-time updates and control, allowing for more efficient traffic management and quick responses to changing traffic conditions or emergencies.

Solar Power Integration, Incorporate solar panels to power the system, reducing reliance on conventional power sources. Promotes sustainability by utilizing renewable energy, potentially lowering operational costs.

Emergency Vehicle Priority System, Implement a priority system for emergency vehicles, allowing them to communicate with traffic signals to receive green lights during emergencies. Ensures faster response times for emergency services, improving public safety.

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