AN INDUSTRY ORIENTED MINI PROJECT REPORT

On

DENSITY BASED TRAFFIC LIGHT SIGNAL CONTROL SYSTEM

Submitted to

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD

In partial fulfilment of the requirement for the award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS & COMMUNICATION ENGINEERING

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INSTITUTE OF TECHNOLOGY & MANAGEMENT

(AN AUTONOMOUS INSTITUTION)

(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)

NAAC Accredited Institution with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

August,2024

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Date:01 August 2024

CERTIFICATE

This is to certify that the project work entitled "**DENSITY BASED TRAFFIC LIGHT SIGNAL CONTROL SYSTEM**" work done by **B. SRIKANTH (217Y1A04I3), M. SRIRAM (217Y1A04I4), K. UMESH (217Y104J0)** student of Department of Electronics and Communication Engineering, is a record of bonafide work carried out by the members during a period from January, 2024 to July, 2024 under the supervision of **Dr. P. SUDHAKARA REDDY.** This project is done as a fulfilment of obtaining Bachelor of Technology degree to be awarded by Jawaharlal Nehru Technological University Hyderabad, Hyderabad**.**

The matter embodied in this project report has not been submitted by us to any other university for the award of any other degree.

B. SRIKANTH M. SRIRAM K. UMESH

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Date: (Dr .P.SUDHAKARA REDDY)

The Viva-Voce Examination of above student, has been held on……………………

Head of the Department **External Examiner**

Principal

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ABSTRACT

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. Present day traffic signaling system is fixed time based which may render inefficient if one lane is operational than the others. To optimize this problem, we have made a framework for an intelligent traffic control system.

Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time We, therefore propose here a mechanism in which the time period of green light and red light is assigned on the basis of the density of the traffic present at that time. This is achieved by using PIR (proximity Infrared sensors). Once the density is calculated, the glowing time of green light is assigned by the help of the microcontroller (Arduino).The sensors which are present on sides of the road will detect the presence of the vehicles and sends the information to the microcontroller (Arduino) where it will decide how long a flank will be open or when to change over the signal lights. In subsequent sections, we have elaborated the procedure of this framework.

CHAPTER 1

INTRODUCTION

In today's high-speed life, traffic congestion becomes a serious issue in our day-to-day activities. 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 these chaotic congestions. 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.

1.1 Problem Statement

This is our third-year project, which will draw attention of all the faculties. So, I want to make a project through which everyone can relate to it. Also, in our day-to-day life I am always observing at the crossing of roads that in some lane there are lot of traffic compared to others lane but all the signals in our country is timing based. So, we cannot manage our time. Also due to timing based the lighter dense roads are sometimes empty due to which many people start crossing the road but due green signal in that lane vehicle moves at high speed which increases the risk of accident. So, the best solution of these problem is to make traffic control system which control the whole traffic by density

1.2 Problem Definition

In many urban areas, traffic congestion is a significant problem that leads to delays, increased fuel consumption, and environmental pollution. Traditional traffic light systems, which operate on fixed timers, do not account for the varying traffic volumes on different roads. As a result, vehicles may be forced to wait at red lights even when the cross-traffic is minimal or non-existent. Conversely, heavy traffic on a busy road might not receive enough green light time, exacerbating congestion and causing longer queues.

A density-based traffic light signal control system addresses these inefficiencies by using real-time traffic data to adjust the signal timings at intersections. This system can dynamically alter the duration of traffic lights based on the current traffic conditions, ensuring that green lights are allocated more efficiently. By optimizing the signal timings according to the actual vehicle density, the system aims to reduce unnecessary waiting times, decrease congestion, improve traffic flow, and lower fuel consumption and emissions.

1.3 Research Objectives

The research objectives for a mini-project on a density-based traffic light signal system should be specific and focused on addressing the key challenges and goals of such a system. Here are some research objectives you can consider

System Development and Integration: To design and develop a prototype of a density-based traffic light signal system that can efficiently manage traffic at intersections

Data Collection and Analysis: To collect real-time traffic data using sensors or cameras at selected intersections. To analyze the collected data to determine traffic density patterns and trends

Density-Based Traffic Control Algorithms: To research and implement traffic control algorithms that use real-time traffic density data to optimize traffic signal timings. To evaluate the performance of different density-based control algorithms in terms of traffic flow efficiency and congestion reduction

Sensor Technology Evaluation: To assess the suitability and accuracy of various sensor technologies (e.g., cameras, infrared sensors, radar) for collecting traffic density data.

Communication Infrastructure: To develop a communication infrastructure that allows traffic signals to receive and transmit data to effectively coordinate signal changes based on traffic density.

1.4 Project Scope and Direction

The scope of our mini project involves the development of a density-based traffic light signal system aimed at addressing the persistent issue of traffic congestion and improving traffic flow within a defined area. The project's primary objective is to design and implement a system capable of dynamically adjusting traffic light signals based on real-time traffic density data.

To achieve this, we will employ a comprehensive system architecture that includes both hardware and software components. Sensors, such as cameras, infrared sensors, or ultrasonic sensors, will be strategically deployed to collect data on traffic density. This data will then be processed in real-time, using sophisticated algorithms and logic to determine the optimal timing for traffic light signal changes. In addition to the core system functionality, we will develop a user interface that allows traffic authorities or operators to monitor the system's operation and make manual adjustments if necessary. The project's success will be measured through rigorous testing and validation processes, encompassing various traffic scenarios and patterns.

1.4.1 Impact, Significance and contributions

Improved Traffic Flow: By dynamically adjusting traffic signal timings based on real-time traffic conditions, the system can significantly reduce congestion, traffic jams, and delays. This leads to smoother traffic flow and shorter commute times for drivers. Reduced Fuel Consumption and Emissions: Efficient traffic flow means less time spent idling at red lights, which can reduce fuel consumption and lower emissions, contributing to improved air quality and reduced environmental impact. Public Satisfaction: When traffic flows smoothly and efficiently, it tends to increase public satisfaction with urban transportation systems and local government.

Enhanced Safety: The system can reduce the likelihood of accidents caused by congestion, gridlock, and unsafe traffic patterns. By optimizing traffic flow and minimizing stop-and-go traffic, it contributes to a safer road environment for both drivers and pedestrians.Adaptability: The system can adapt to changing traffic patterns, road closures, special events, and accidents. This adaptability makes it well-suited for managing complex and dynamic traffic situations in urban areas.

Emergency Vehicle Priority: The system can prioritize emergency vehicles, such as ambulances and firetrucks, by quickly recognizing their approach and changing signals to give them the right of way. This can save lives and reduce response times during emergencies.Efficient Resource Allocation: By reducing the need for law enforcement or traffic management personnel to manually adjust signal timings, the system optimizes resource allocation and reduces operational costs.

Data Insights: The system generates and collects a wealth of traffic data, which can be valuable for traffic analysis, city planning, and transportation policy decisions. It provides insights into traffic patterns, peak hours, and the impact of changes in the road network. Reduced Travel Time: Commuters benefit from reduced travel times, leading to increased productivity and improved quality of life. This can also reduce stress associated with daily commuting. Environmental Benefits: Lower fuel consumption and reduced emissions contribute to a greener and more sustainable urban environment. This aligns with sustainability goals and efforts to combat climate change.

Improved Livability: Reduced congestion and traffic-related stress can improve the quality of life for residents in urban areas. It makes cities more attractive places to live and work.Economic Impact: A more efficient transportation system can have positive economic effects by reducing transportation costs for businesses and making cities more accessible.Accessibility for Vulnerable Populations: Improved traffic management, including pedestrian and cyclist safety measures, can enhance accessibility for individuals with disabilities and other vulnerable populations.

1.5 Overview

The Density-Based Traffic Light Signal System project is a cutting-edge urban traffic management initiative aimed at enhancing the efficiency, safety, and environmental sustainability of transportation networks in urban areas. This project leverages advanced technology, data analysis, and real-time control to dynamically adjust traffic signal timings based on the actual traffic conditions at key intersections and road segments.

CHAPTER 2

LITERATURE SURVEY

I have done research on traditional traffic signal control methods, including fixed-time and actuated signal control. Studied on the limitations of traditional methods in adapting to dynamic traffic conditions and congestion.

2.1 Traffic Management and Control:

Adaptive Traffic Signal Systems: Literature on the development and implementation of adaptive traffic signal systems that adjust signal timings based on real-time traffic data. Evaluation of the effectiveness of adaptive systems in improving traffic flow and safety.

Sensor Technologies: Exploration of different sensor technologies used for data collection in traffic signal systems, such as cameras, inductive loop sensors, microwave sensors, and infrared sensors. Comparative studies on the accuracy and reliability of various sensor types.

2.2 Real-Time Data Analysis:

Research on algorithms and data analysis techniques for processing and interpreting real-time traffic data. Studies on the use of machine learning and artificial intelligence for predictive modeling and traffic forecasting.

Case Studies and Field Trials:

Detailed case studies of real-world implementations of density-based traffic signal systems in various cities.

Assessment of the impact on traffic flow, congestion reduction, and safety improvements.

Environmental and Energy Impacts:

Studies on the environmental benefits of adaptive traffic signal systems, including reductions in fuel consumption and greenhouse gas emissions.

Analysis of energy-efficient technologies used in these systems.

Smart Cities and Urban Mobility:

Exploration of the role of adaptive traffic signal systems in the broader context of smart city initiatives and urban mobility planning.

Studies on the integration of traffic management with public transit and sustainable transportation modes.

CHAPTER 3

TRAFFIC LIGHT SIGNAL SYSTEM

3.1 Introduction

In today's high-speed life, traffic congestion becomes a serious issue in our day-to-day activities. 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 these chaotic congestions

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.

3.2 Objective of the project:

Our project aims at reducing traffic congestion and unwanted long-time delay during the traffic light switch overs especially when the traffic is very low.It is designed to be implemented in places nearing the junctions where the traffic signals are placed, in order to reduce the congestion in these junctions.

It keeps a track of the vehicles in each road and accordingly adjusts the time for each traffic light signals.The higher the number of vehicles on the road the longer will be the time delay allotted for that corresponding traffic light signal.

The higher the number of vehicles on the road the longer will be the time delay allotted for that corresponding traffic light signal.

3.3 Motivation of the Project

This is our third-year project, which will draw attention of all the faculties. So, I want to make a project through which everyone can relate to it. Also, in our day-to-day life I am always observing at the crossing of roads that in some lane there are lot of traffic compared to others lane but all the signals in our country is timing based. So, we cannot manage our time. Also due to timing based the lighter dense roads are sometimes empty due to which many people start crossing the road but due green signal in that lane vehicle moves at high speed which increases the risk of accident.So, the best solution of these problem is to make traffic control system which control the whole traffic by density. From this we got the motivation to work on this project.

At the starting of the project, we were not able to visualize it practically, but slowly we are getting information from the Internet and taking help of some of our faculties of our college to implement it practically. Any random person won't be able to visualize our efforts put in the completion of the project because after completion it looks a bit easy.These algorithms are not faster compared to modern days face-recognition algorithms. Traditional algorithms can't be trained only by taking a single picture of a person.

3.4 Present Traffic Signaling System

Under present scenario, traffic control is achieved by the use of a system of hand signs by traffic police personnel, traffic signals, and markings. A comparable and matching education program is needed, through driver-licensing authorities, to assure that those who operate motor vehicles understand the rules of the road and the actions that they are required or advised to take when a particular control device is present. Each traffic control device is governed by standards of design and usage; for example, stop signs always have a red background and are octagonal in shape.

Design standards allow the motorist to quickly and consistently perceive the sign in the visual field along the road. Standard use of colours and shape aids in this identification and in deciding on the appropriate course of action. Under current circumstances, traffic lights are set on in the different directions with fixed time delay, following a particular cycle while switching from one signal to other creating unwanted and wasteful congestion on one lane while the other lanes remain vacant.

The system we propose identify the density of traffic on individual lanes and thereby regulate the timing of the signals' timing. IR sensors count the obstructions and provide an idea about the traffic density on a particular lane and feed this response to a controller unit which will make the necessary decisions as and when required.

3.5 Block Diagram

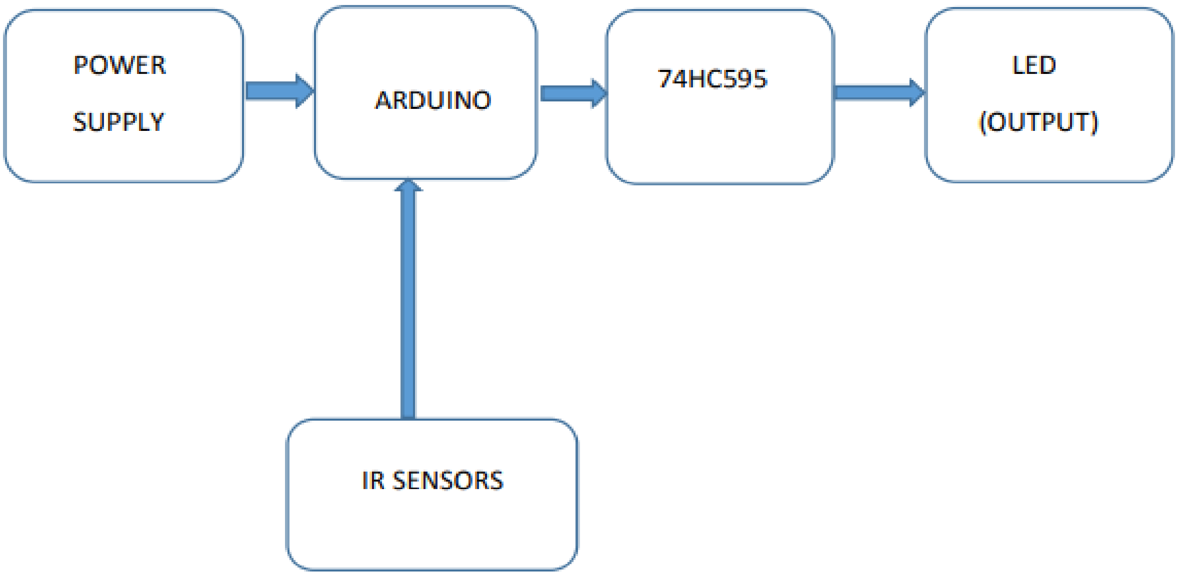

Fig 3.1

- At starting, ac power is converted to dc by using rectifier and then given to Arduino.
- IR sensors are also connected to Arduino directly.
- IC 74HC595 is connected to Leds and Arduino to control the whole circuit in a proper way.

- Leds are connected between resistance and IC 74HC595 and then through resistance one terminal of the leds go to ground.

3.6 COMPONENTS

3.6.1 List of Components:

1.ARDUINO UNO
2.LEDS
(Green--------4
Red--------4)
3.VOLTAGE DIVIDER
4.IR SENSORS (6)
5.CONNECTING WIRES
(As required)

3.6.2 Power Supply

A power supply is an electrical device that supplies electric power to an electrical load. The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power. All power supplies have a power input connection, which receives energy in the form of electric current from a source, and one or more power output connections that deliver current to the load.

In this project, we are providing 9V DC supply to the circuit through 12-0-12V transformer by using Rectifier.

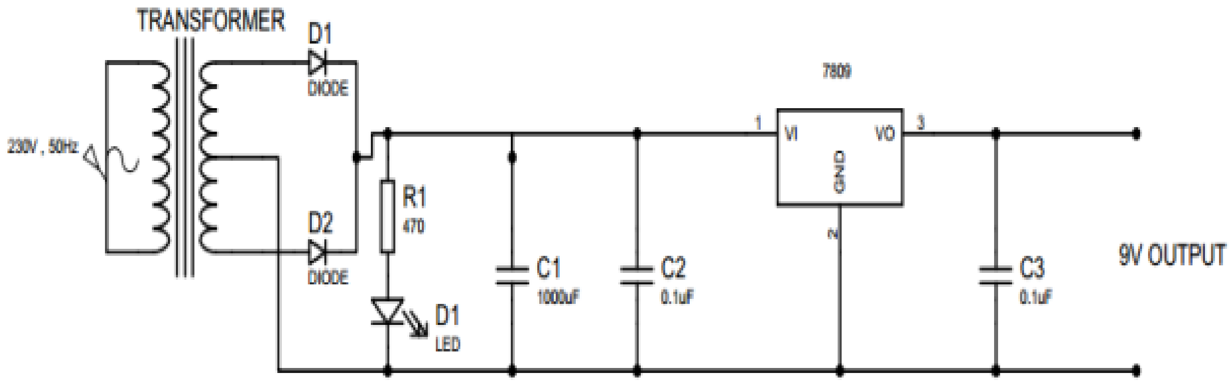

Fig 3.2

In our project we are using two capacitors of 0.1 microfarad, one capacitor of 1000microfarad, two diodes, one resistor of 470-ohm, one red led and one 7809 voltage regulator for getting 9V DC power supply. In this circuit red led is just for indication purpose. Rectifier is getting 12V AC supply from step down transformer and giving output of 9V DC with the help of voltage regulator. The detailed function of rectifier is mentioned below.

3.6.3 ARDUINO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

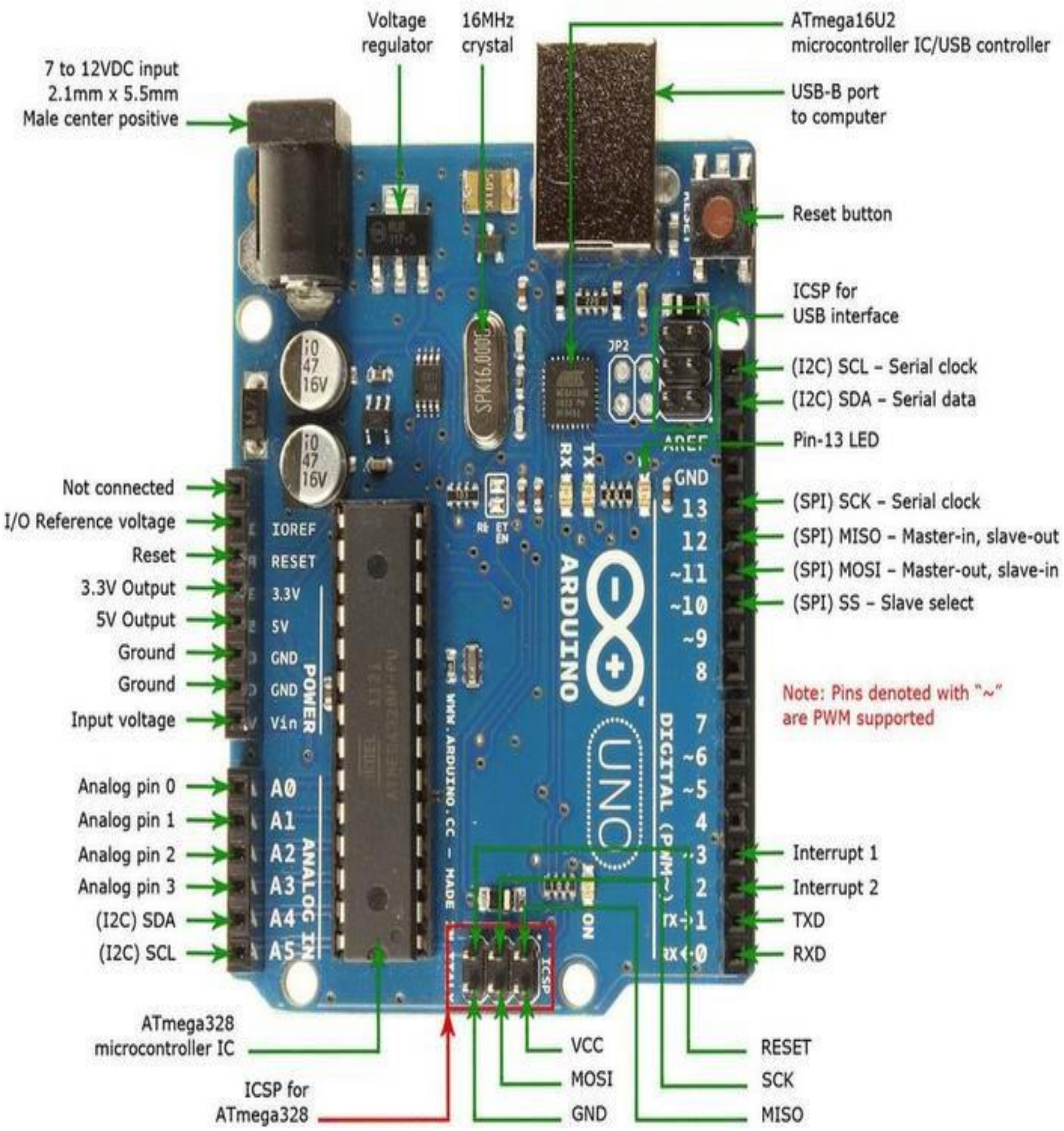

Fig 3.3

General Pin functions:

- **LED**: There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- **VIN**: The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

- **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- **3V3**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND**: Ground pins.
- **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset**: Typically used to add a reset button to shields which block the one on the board.

TECHNICAL SPECIFICATIONS:

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- 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
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

3.6.4 IR SENSORS

An infrared sensor is an electronic device, which emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes , that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED.

- LM358 IC 2 IR transmitter and receiver pair
- Resistors of the range of kilo ohms.
- Variable resistors.
- LED (Light Emitting Diode)

In this project, the transmitter section includes an IR sensor, which transmits continuous IR rays to be received by an IR receiver module. An IR output terminal of the receiver varies depending upon its receiving of IR rays. Since this variation cannot be analysed as such, therefore this output can be fed to a comparator circuit. Here an operational amplifier (op-amp) of LM 339 is used as comparator circuit.

When the IR receiver does not receive a signal, the potential at the inverting input goes higher than that non-inverting input of the comparator IC (LM339). Thus the output of the comparator goes low, but the LED does not glow. When the IR receiver module receives signal to the potential at the inverting input goes low. Thus the output of the comparator (LM 339) goes high and the LED starts glowing.

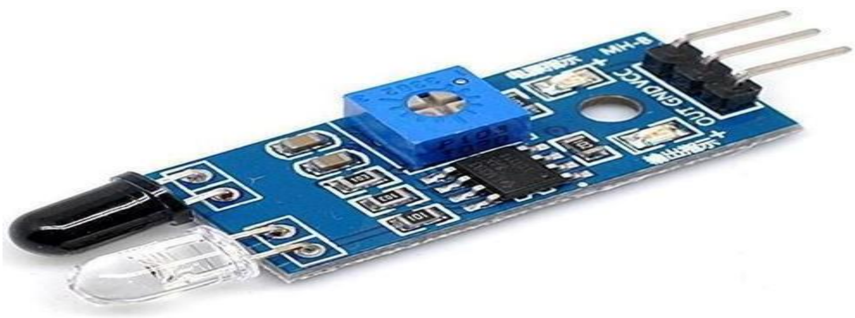

Fig 3.4

IR Obstacle Detection Module Pin Outs:

The drawing and table below identify the function of module pin outs, controls and indicators.

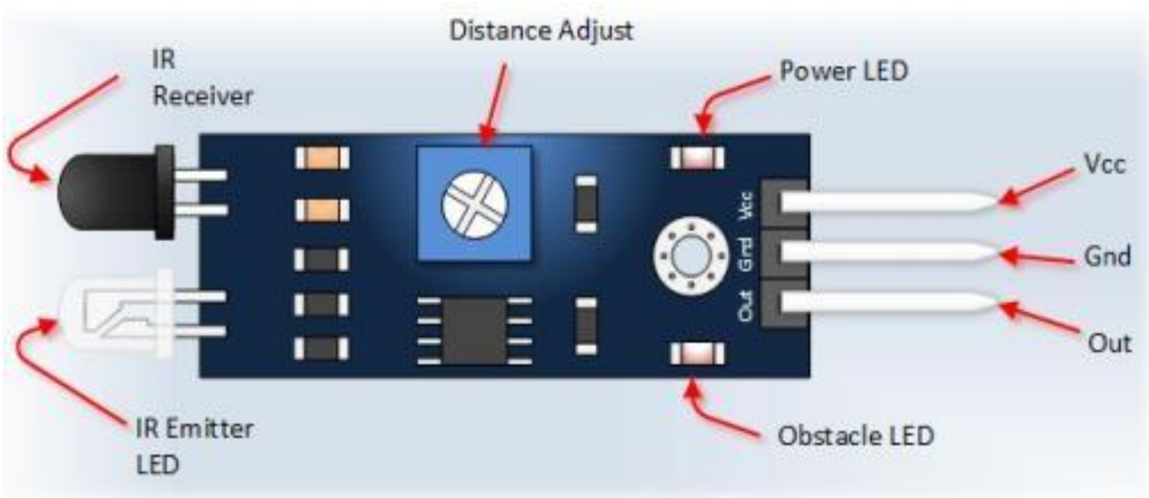

Fig 3.5

Pin, Control Indicator	Description
Vcc	3.3 to 5 Vdc Supply Input
Gnd	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.

CHAPTER 4

WORKING OF THE SYSTEM

4.1 Circuit Diagram

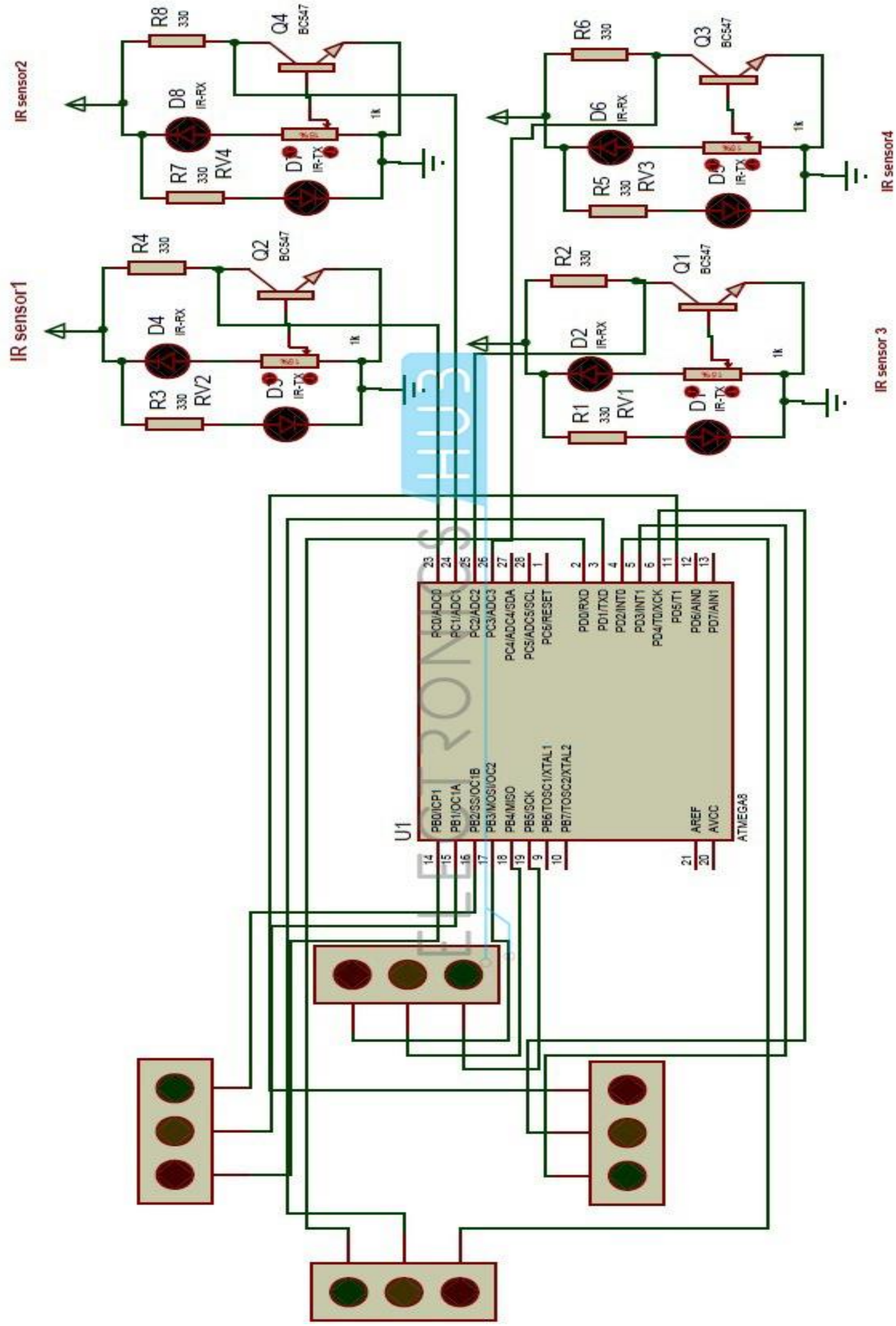

Fig 4.1

4.2 WORKING

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 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 10 seconds of green light and other signal will be red. After 10 seconds the signal 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) and R (red) glow in following sequence.

- G1-R2-R3-R4
- R1-G2-R3-R4
- R1-R2-G3-R4
- R1-R2-R3-G4

i.e., timing-based traffic signal will be automatically implemented when all the signals having same condition

When condition changes, Let us suppose when first side traffic signal is green and at that time third side traffic signal's IR sensor receiving data then after first traffic signal it will automatically shifts towards third traffic signal without moving to second traffic signal.

- G1-R2-R3-R4
- R1-R2-G3-R4

Similarly, Let green light is On in the fourth traffic signal for 10 seconds and during that time second traffic signal's IR sensor receiving data then after green light it will take 4 seconds delay for light or we can say that the delay for pedestrians to walk in order to ensure their safety and then it will automatically shifts towards second traffic signal.

- R1-R2-R3-G4
- R1-G2-R3-R4

Just taking into consideration the above conditions further and let us suppose after second signal again forth signal's IR sensor receiving data then after 10 seconds and 4 seconds delay signal is green for forth lane.

- R1-G2-R3-R4
- R1-R2-R3-G4

NOTE:

The working of the project is divided into three steps:

- If there is traffic at all the signals, then the system will work normally by controlling the signals one by one.
- If there is no traffic near a signal, then the system will skip this signal and will move on to the next one. For example, if there is no vehicle at signal 2, 3 and currently the system is allowing vehicles at signal 1 to pass. Then after signal 1, the system will move on to signal 4 skipping signal 2 and 3.
- If there is no traffic at all the 4 signals, then also the system will work normally by controlling the signals one by one

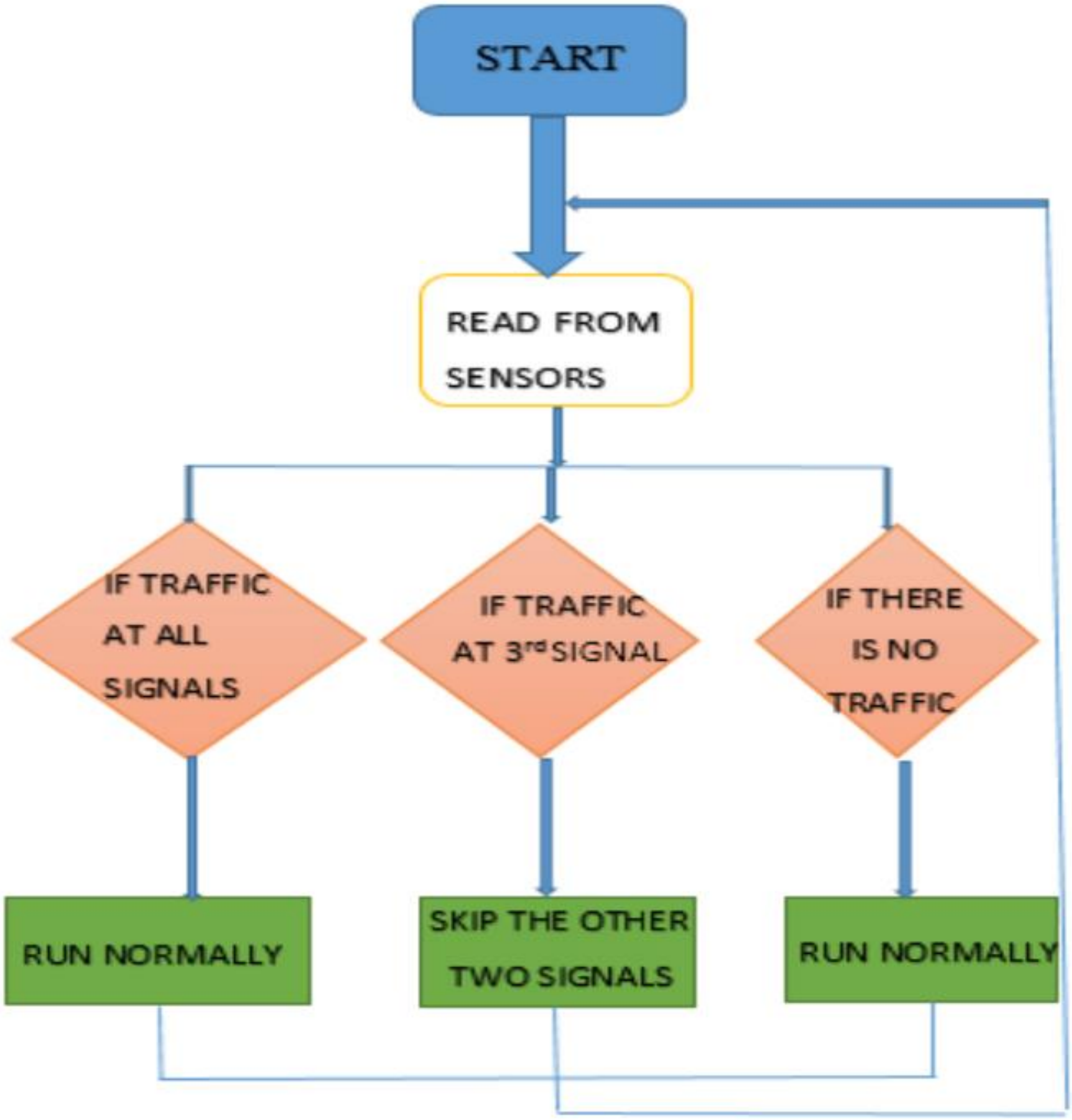

Fig 4.2

In this way we can control the heavy traffic of any particular lane in peak timing like office hour.

But, it has some very big drawbacks in which one of the drawback is the lane in which traffic is low have to wait for long time.

4.3 CIRCUIT ON BOARD

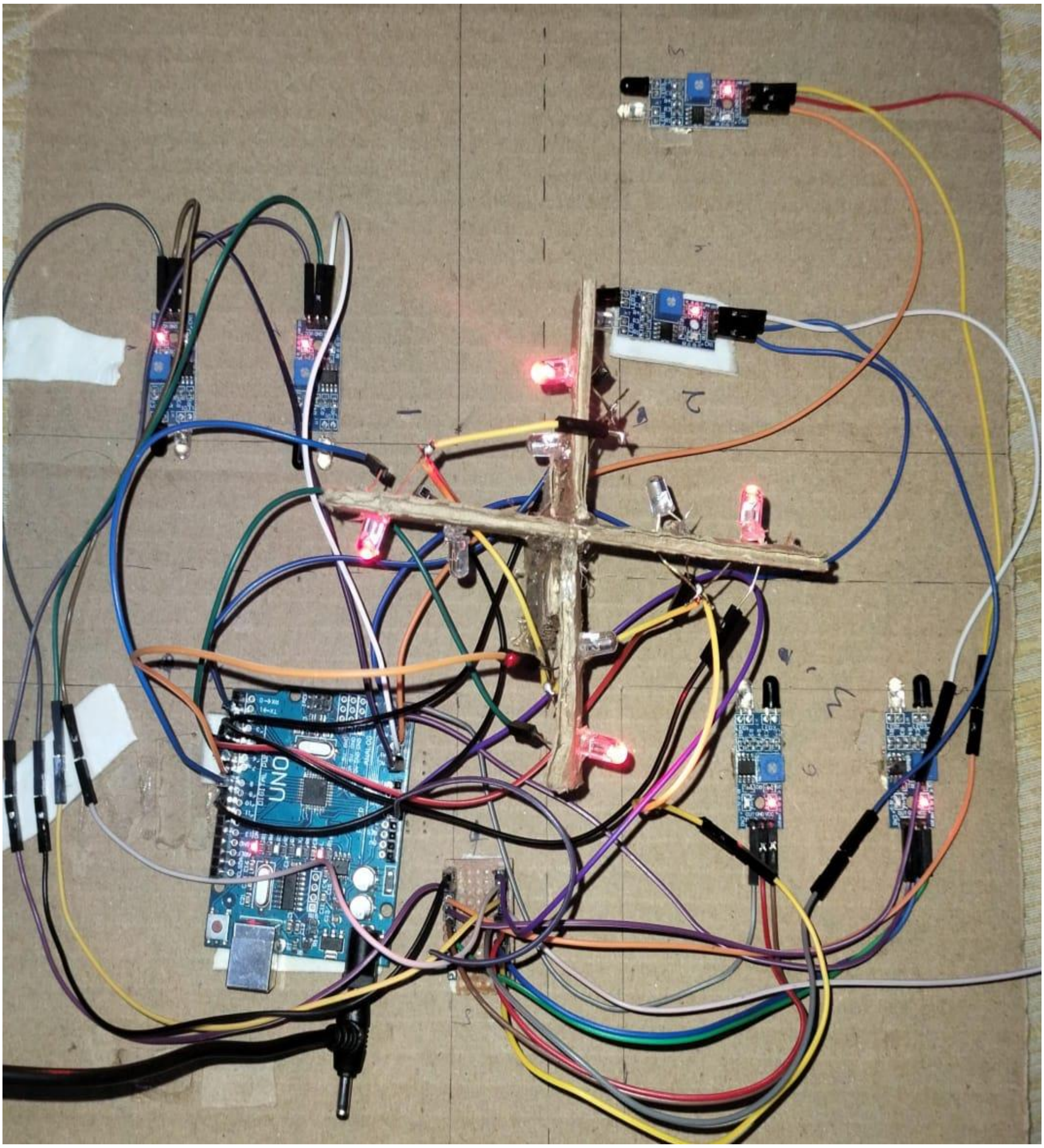

Fig 4.3

4.4 RESULT

The project is an output of 1 year of research and implementation. The circuits when implemented separately works as per the desired output however during integrating all, output fluctuates and shows different response every time. This could be a problem of loose connections of the wires or internal wiring of the bread board used. This project lists down the results realized from the practical work and examines whether ideas / solution approaches recommended in research are met by the practical implementation. For this project the main communication is by using IR technology

From the series of experiments, we have conducted the following results were

obtained:

- Traffic can be cleared without any irregularities
- Time can be shared evenly for all intersections
- Effective time management

CHAPTER-5

SOURCE CODE

5.1 CODE SELETION

```
#include <Arduino.h>

// Define constants for IR sensor pins and LED pins
const int irSensors[] = {A0, A1, A2, A3, A4, A5}; // Analog pins for IR sensors
const int redLEDs[] = {2, 4, 6, 8}; // Pins for red LEDs
const int greenLEDs[] = {3, 5, 7, 9}; // Pins for green LEDs

// Define constants for sensor threshold and maximum green light duration
const int sensorThreshold = 500; // Adjust based on IR sensor output
const int maxTime = 25; // Maximum green light duration in seconds
const int minGreenTime = 5; // Minimum green light duration for each lane in case of no
traffic

// Initialize vehicle counts for each lane
int vehicleCounts[4] = {0, 0, 0, 0}; // Vehicle counts for each lane

// Initialize variables to control the timing of the green light
unsigned long greenLightStartTime = 0;
int greenLightDuration = 0;
bool greenLightActive = false;
int currentLane = 0;
int lanesWithTraffic[4];
int laneCount = 0;

void setup()
```

```
{
    // Initialize Serial communication
    Serial.begin(9600);

    // Initialize IR sensor pins as inputs
    for (int i = 0; i < 6; i++)
    {
        pinMode(irSensors[i], INPUT);
    }

    // Initialize LED pins as outputs
    for (int i = 0; i < 4; i++)
    {
        pinMode(redLEDs[i], OUTPUT);
        pinMode(greenLEDs[i], OUTPUT);
    }

    // Set all red LEDs to HIGH initially
    for (int i = 0; i < 4; i++)
    {
        digitalWrite(redLEDs[i], HIGH);
        digitalWrite(greenLEDs[i], LOW);
    }
}

void loop()
{
        // Reset vehicle counts
        for (int i = 0; i < 4; i++)
        {
            vehicleCounts[i] = 0;
        }
```

```
// Read IR sensor values and count vehicles
for (int i = 0; i < 6; i++)
{
        int sensorValue = analogRead(irSensors[i]);
        if (sensorValue < sensorThreshold)
        {
            if (i < 2)
            {
                // Lanes 1 and 2 have low traffic sensors
                vehicleCounts[0]++;
}
    else if (i < 4)
    {
        // Lanes 3 and 4 have high traffic sensors
        vehicleCounts[1]++;
    }
    else
    {
        // Lanes 5 and 6 have low traffic sensors
        vehicleCounts[2]++;
    }

}

}
```

```
// Determine the lanes with traffic
laneCount = 0;
for (int i = 0; i < 4; i++)
{
        if (vehicleCounts[i] > 0)
        {
              lanesWithTraffic[laneCount++] = i;
        }
}

// Determine green light duration based on traffic
if (laneCount == 0)
{
        // No traffic detected, cycle through each lane for minGreenTime
        greenLightDuration = minGreenTime;
        // Activate each lane for minGreenTime in a round-robin fashion
       for (int i = 0; i < 4; i++)
       {
              // Turn on the green light for the current lane
              digitalWrite(greenLEDs[i], HIGH);
              digitalWrite(redLEDs[i], LOW);

              // Set the duration for the current lane
              greenLightStartTime = millis();
              while (millis() - greenLightStartTime < minGreenTime * 1000)
              {
                    // Just wait
              }
```

```
                // Turn off the green light for the current lane
                digitalWrite(greenLEDs[i], LOW);
                digitalWrite(redLEDs[i], HIGH);
            }
    }
    else
    {
            // Calculate total traffic and duration per lane
            int totalVehicles = 0;


            for (int i = 0; i < laneCount; i++)
            {
                totalVehicles += vehicleCounts[lanesWithTraffic[i]];
            }

            // Determine the duration for each lane based on its vehicle count
            for (int i = 0; i < laneCount; i++)
            {
                int lane = lanesWithTraffic[i];
                int laneDuration = maxTime * (vehicleCounts[lane] /(float)totalVechicles);

                // Apply the duration
                digitalWrite(greenLEDs[lane], HIGH);
                digitalWrite(redLEDs[lane], LOW);

                // Set the duration for the lane
                greenLightDuration = laneDuration;

                // Wait until the duration for the current lane expires
                greenLightStartTime = millis();
```

```
                while (millis() - greenLightStartTime < greenLightDuration * 1000)
                {
                        // Just wait
                 }

                 // Turn off the green light for the current lane
                digitalWrite(greenLEDs[lane], LOW);
                digitalWrite(redLEDs[lane], HIGH);
        }
  }


  // Print data to the Serial Monitor

  Serial.print("Lane 1 Count: ");
  Serial.println(vehicleCounts[0]);
  Serial.print("Lane 2 Count: ");
  Serial.println(vehicleCounts[1]);
  Serial.print("Lane 3 Count: ");
  Serial.println(vehicleCounts[2]);
  Serial.print("Lane 4 Count: ");
  Serial.println(vehicleCounts[3]);
  Serial.print("Green Light Duration: ");
  Serial.println(greenLightDuration);
  Serial.println();

  // Add a delay to avoid flooding the Serial Monitor
  delay(5000);
}
```

CHAPTER-6

CONCLUSION & FUTURE SCOPE

6.1 CONCLUSION

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. With field application of this technology, the maddening chaos of traffic can be effectively channelized by distributing the time slots based on the merit of the vehicle load in certain lanes of multi junction crossing. We have successfully implemented the prototype at laboratory scale with remarkable outcome. The next step forward is to implement this schema is real life scenario for first hand results, before implementing it on the largest scale. We believe that this may bring a revolutionary change in traffic management system on its application in actual field environment

6.2 CHALLENGES, FUTURE SCOPE & ADVANCEMENTS

Public Opinion and Acceptance: Research on public perception and acceptance of adaptive traffic signal systems, as well as the impact on commuter behavior and satisfaction.

Future scope:

Smart Cities Integration: Integration of density-based traffic signal systems with broader smart city initiatives will become more common. These systems can play a central role in creating intelligent and connected urban environments, optimizing transportation, energy usage, and overall quality of life.

Sustainable Transportation: The integration of density-based systems with sustainable transportation modes, such as public transit, cycling, and pedestrian pathways, can help reduce congestion, promote eco-friendly transportation options, and improve the overall urban environment.

Environmental Impact Reduction: Density-based systems will play a crucial role in reducing greenhouse gas emissions and improving air quality. They can be further optimized to minimize energy consumption and encourage the use of electric or hybrid vehicles.Traffic Analytics and Predictive Modeling: Advanced analytics and predictive modeling can provide valuable insights into long-term traffic trends, enabling cities to plan infrastructure improvements, road expansions, and alternative transportation solutions effectively.

Interconnected Urban Infrastructure: Integration with other urban infrastructure, such as parking systems, traffic cameras, and street lighting, will create a more holistic approach to urban management.Cross-Border Traffic Management: In metropolitan areas with shared borders, collaborative efforts to implement density-based systems that span multiple jurisdictions can lead to seamless traffic flow across city boundaries.

Energy Efficiency: Continued advancements in energy-efficient technologies and renewable energy sources will help reduce the environmental footprint of these systems.Adaptive Traffic Synchronization: The development of adaptive traffic synchronization systems that can optimize signal timings across multiple intersections along a corridor will become more sophisticated, further reducing congestion.Public-Private Partnerships: Collaborations between public agencies and private companies will help fund and implement advanced traffic management systems, accelerating their deployment and development.

Advancements:

Though the prototype model worked very efficiently with remarkable outputs, the real-life situation is going to be way more challenging and demanding. Few of the challenges that should be taken into account are listed as follows

Low range IR sensors may not be an answer for long range signaling system. We may resort to ultrasound or radar techniques for big scale set-ups. Next is the influence of stray signals that may alter the reading of sensor receptors and lead to conveying false information to the microcontroller. Periodic checking of the accuracy and precision is a must for efficacious operation of this model prototype.

Safety first: it has to be absolutely made sure that no compromise is being made on safety issues, i.e. a secondary stand-by set-up that can switch over from automated to manual mode, should be provided in case of sensor or circuit malfunctions so that vehicular crowd does not go beyond control. 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 tries 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.

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