DENSITY BASED TRAFFIC LIGHT CONTROL USING ARDUINO

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ABSTRACT

Traffic congestion is a severe problem in many major cities across the world and it has become a nightmare for the commuters in these cities. Traffic can be controlled in several main junctions by incorporating either automatic traffic light control or traffic police. But conventional traffic light system is based on fixed time concept allotted to each side of the junction which cannot be varied as per varying traffic density. At some times, priority of traffic light needs to be changed based on more number of vehicles waiting in same road, VIPs vehicles and Ambulance vehicles etc. We propose to design and develop a density based traffic signal system. The signal changes automatically on sensing the traffic density at the junction. The prototype model was developed using IR sensors and Arduino. We use Arduino to write programming according to our requirements due to its simplicity and economy and IR sensors is used to measure the traffic density in a particular road. IR sensors may have limitations that it will work in normal light also. As a result, traffic light works in improper way. In future, it may be improved by using some suitable sensors. IR sensors are arranged on each road in accurate manner to detect traffic density properly; these sensors always sense the traffic on that particular road. All these sensors are interfaced to the arduino. Based on these sensors, controller detects the traffic and controls the traffic system. The controls of traffic light depend on number of vehicles available in the road.

Keyword: - *Arduino , IR sensors, Traffic light*

1. INTRODUCTION

In modern life we have to face with many problems one of which is traffic congestion becoming more serious day after day. It is said that the high volume of vehicles, the inadequate infrastructure and the irrational distribution of the development are main reasons for increasing traffic jam[1]. The major cause leading to traffic congestion is the high number of vehicle which was caused by the population and the development of economy. Due to the massive growth in urbanization and traffic congestion, automatic based traffic light controller is needed to reduce the traffic delay and travel time especially in developing countries. Traffic congestion is now considered to be one of the biggest problems in the urban environments. Traffic problems will be also much more widely increasing as an expected result of the growing number of transportation means and current low-quality infrastructure of the roads [2] . In addition, many studies and statistics were generated in developing countries that proved that most of the road accidents are because of the very narrow roads and because of the destructive increase in the transportation means. This idea of controlling the traffic light efficiently in real time has attracted many researchers to work in this field [3] with the goal of creating automatic tool that can estimate the traffic congestion and based on this Variable, the traffic signal can be varied.

2. COMPONENTS USED

2.1 ARDUINO

Arduino is an open-source project that created microcontroller based kits for building digital devices and interactive objects that can sense and control physical devices. The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named Processing which also supports the languages C and C++. The first Arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. The hardware design specifications are openly available, allowing the Arduino boards to be produced by anyone. Adafruit Industries estimated in mid-2011 that over 300,000 official Arduino had been commercially produced, and in 2013 that 700,000 official boards were in users' hands.

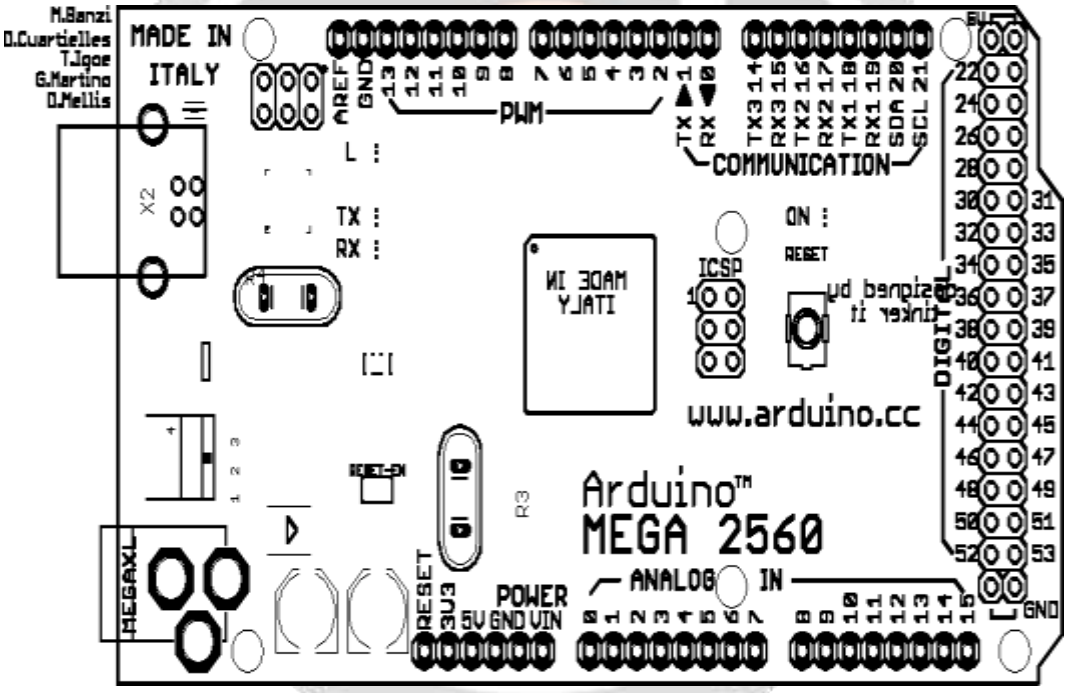


Fig -1 Arduino Board

TABLE 1: Arduino specification

Microcontroller	Arduino mega 2560
Digital I/O pins	54
Analog input pins	16
Flash memory	256KB
SRAM	8KB
EEPROM	4KB
Clock Speed	16 MHz

2.2 LED

A light-emitting diode (LED) is a two-lead semiconductor light source as shown in figure2.It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. An LED is often small in area (less than 1 mm^2) and integrated optical components may be used to shape its radiation pattern. Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity, and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness. Early LEDs were often used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of seven-segment displays, and were commonly seen in digital clocks. Recent developments in LEDs permit them to be used in environmental and task lighting. LEDs have many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Light-emitting diodes are now used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, camera flashes and lighted wallpaper. As of 2016, LEDs powerful enough for room lighting remain somewhat more expensive, and require more precise current and heat management, than compact fluorescent lamp sources of comparable output. They are, however, significantly more energy efficient and, arguably, have less environmental concerns linked to their disposal. The wavelength range of different colour LEDS are given in the table below.

Table -1: LED specification

Color	Wavelength range (nm)	Typical efficiency coefficient	Typical efficiency (lm/W)
Red	$620 < \lambda < 645$	0.39	72
Red-orange	$610 < \lambda < 620$	0.29	98
Green	$520 < \lambda < 550$	0.15	93

3. SELECTION OF SENSOR

3.1 Proximity sensor:

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target. The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Some know this process as "thermo sensation". Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object. Proximity sensors are commonly used on smart phones to detect (and skip) accidental touch screen taps when held to the ear during a call. They are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing. This is common in large steam turbines, compressors, and motors that use sleeve-type bearings. A proximity sensor adjusted to a very short range is often used as a touch switch. The main disadvantages are that a significant part of the measurement is external (i.e.) no metallic part intrusion within 3-inch spherical radius" of the sensor. Hence IR sensors are used to detect the density of traffic.

3.1 IR sensor:

IR Transmitter:

IR transmitter looks like an LED. This IR transmitter always emits IR rays from it. The operating voltage of this IR transmitter is 2 to 3V. These IR (infra red) rays are invisible to the human eye. But we can view these IR rays through camera. Infrared is an invisible radiant energy, electromagnetic radiation with longer wavelengths than those of visible light, extending from the nominal red edge of the visible spectrum at 700 nanometers (frequency 430 THz) to 1000000 nm (300 GHz) (although people can see infrared up to at least 1050 nm in experiments). Most of the thermal radiation emitted by objects near room temperature is infrared. Infrared radiation is used in industrial, scientific, and medical applications. Night-vision devices using active near-infrared illumination allow people or animals to be observed without the observer being detected. Infrared astronomy uses sensor-equipped telescopes to penetrate dusty regions of space such as molecular clouds, detect objects such as planets, and to view highly red-shifted objects from the early days of the universe. Infrared thermal-imaging cameras are used to detect heat loss in insulated systems, to observe changing blood flow in the skin, and to detect overheating of electrical apparatuses.

IR Receiver (Photodiode):

A photodiode is a semiconductor device that converts light into current. The current is generated when photons are absorbed in the photodiode. A small amount of current is also produced when no light is present. Photodiodes may contain optical filters, built-in lenses, and may have large or small surface areas. Photodiodes usually have a slower response time as their surface area increases. The common, traditional solar cell used to generate electric solar power is a large area photodiode. Photodiodes are similar to regular semiconductor diodes except that they may be either exposed (to detect vacuum UV or X-rays) or packaged with a window or optical fiber connection to allow light to reach the sensitive part of the device. Many diodes designed for use specifically as a photodiode use a PIN junction rather than a p–n junction, to increase the speed of response. A photodiode is designed to operate in reverse bias.

TABLE 3: Photodiode specification

PARAMETERS	**VALUES**
Wavelength	1250~1600
Dark current	0.4 nA (typ),1.0 nA (max)
Capacitance(PF)	0.7(typ),0.9 (max)
Input power(MW)	2.0 (max)
Cut off frequency	2.0 GHZ
Operating voltage	-5.0 v
Reverse voltage	20 v
Rise/fall time	0.3ns

4. BLOCK DIAGARAM:

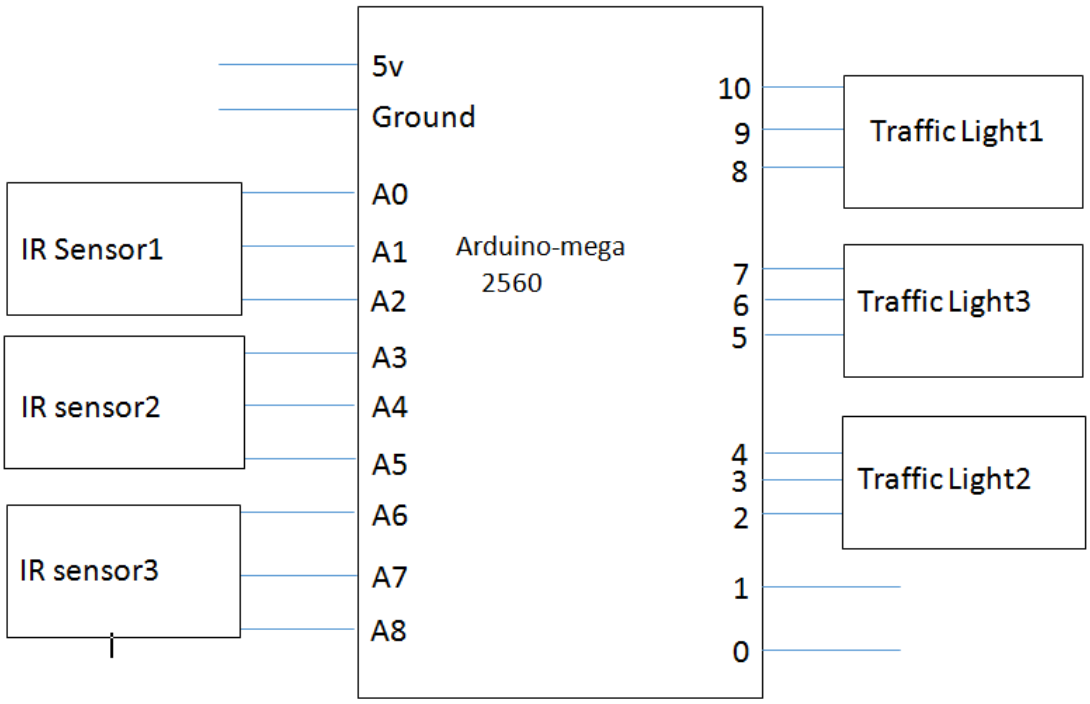


Figure 2: Block diagram

As shown in figure 2, it can be seen that the main heart of this traffic system is Arduino. IR (sensors) receivers are connected to the analog pins of the Arduino (i.e.) A0-A8 and traffic lights are connected to digital pins (i.e.) 0-10. If there is traffic on the road, then that particular sensor output becomes low. By receiving these IR sensor outputs, coding is written to control the traffic system. Low output from these sensors will activate the green signal on that particular road side and other road sides are made to be red and yellow depending on the density of the road. The sensors are monitored for specified time interval.

4.1 OPERATION:

- Connect the adaptor to the Arduino board.
- Switch on the supply.
- Load the program to the Arduino2560 microcontroller.
- Connect three IR sensors on each road.
- Connect LEDs to the digital pins of the Arduino.
- Arrange all the LED's same as traffic lights.
- Now if any obstacle(vehicles) is placed in front of any IR sensor, then the system allows the traffic of that particular path by glowing GREEN light.
- Set some delay time for the next signal to glow based on the sensor output.

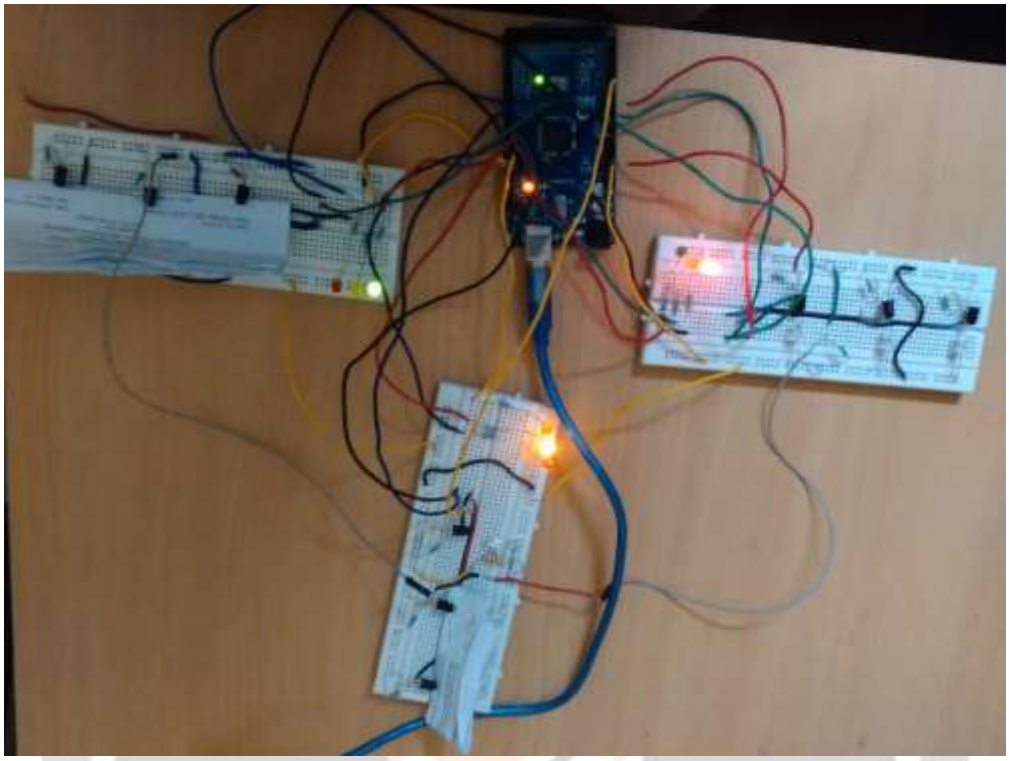
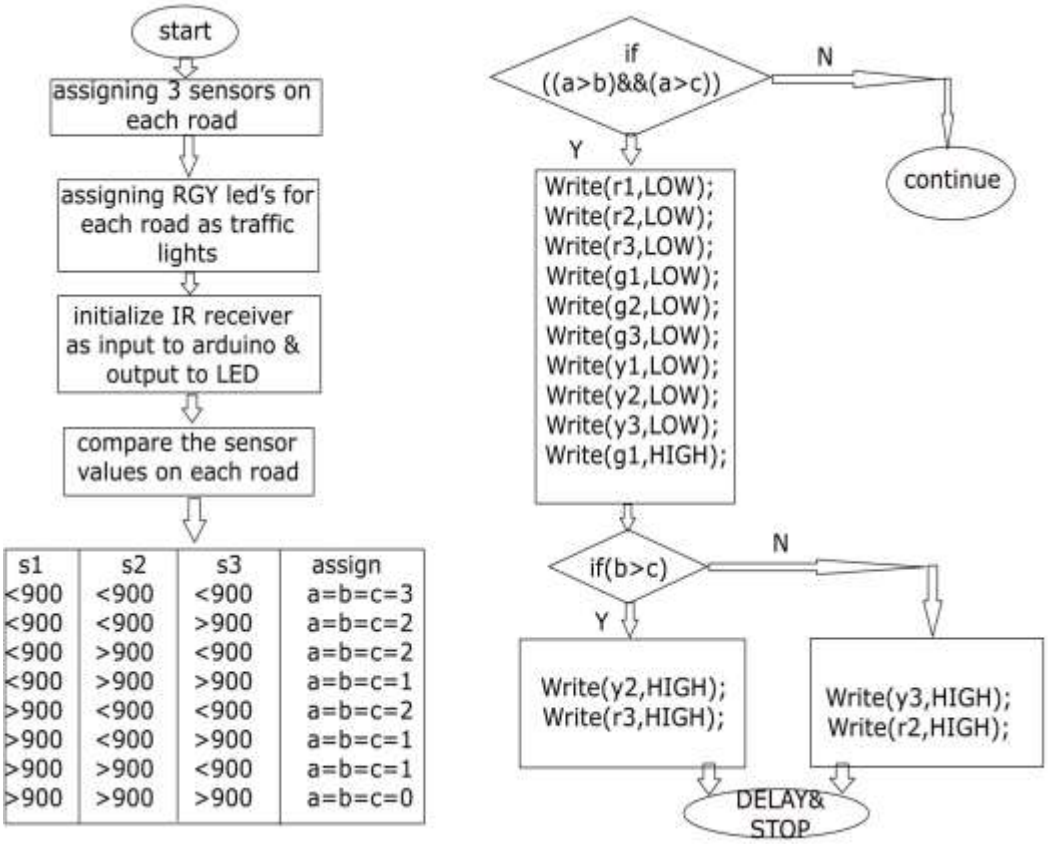
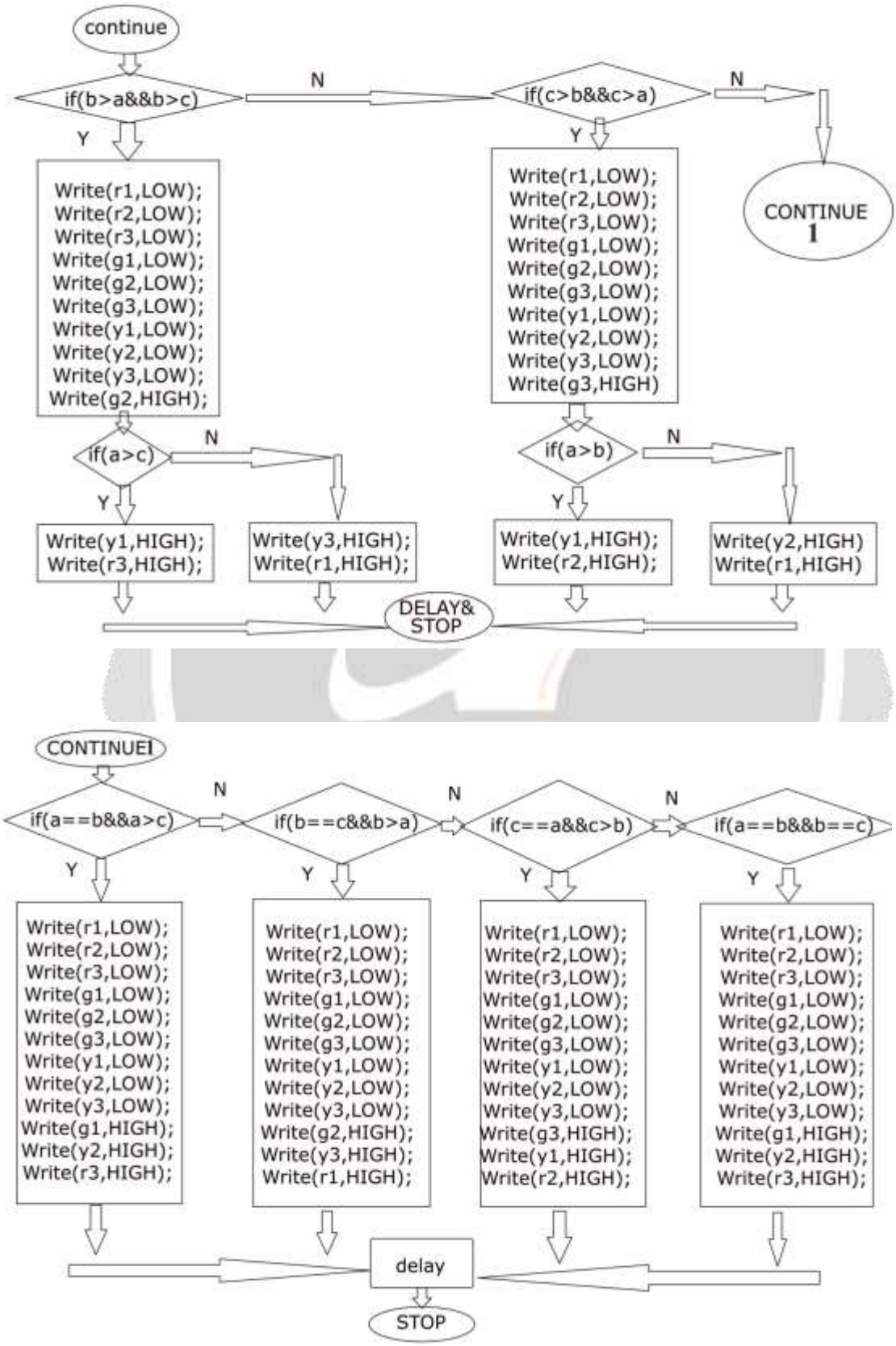


Figure 2: Prototype model

4.2Flowchart:



s1	s2	s3	assign
<900	<900	<900	a=b=c=3
<900	<900	>900	a=b=c=2
<900	>900	<900	a=b=c=2
<900	>900	>900	a=b=c=1
>900	<900	<900	a=b=c=2
>900	<900	>900	a=b=c=1
>900	>900	<900	a=b=c=1
>900	>900	>900	a=b=c=0


continue
if(b>a&&b>c)
N
if(c>b&&c>a)
N
Y
Y
Write(r1,LOW);
Write(r2,LOW);
Write(r3,LOW);
Write(g1,LOW);
Write(g2,LOW);
Write(g3,LOW);
Write(y1,LOW);
Write(y2,LOW);
Write(y3,LOW);
Write(g2,HIGH);
CONTINUE
1
Write(r1,LOW);
Write(r2,LOW);
Write(r3,LOW);
Write(g1,LOW);
Write(g2,LOW);
Write(g3,LOW);
Write(y1,LOW);
Write(y2,LOW);
Write(y3,LOW);
Write(g3,HIGH)
if(a>c)
N
if(a>b)
N
Y
Y
Write(y1,HIGH);
Write(r3,HIGH);
Write(y3,HIGH);
Write(r1,HIGH);
Write(y1,HIGH);
Write(r2,HIGH);
Write(y2,HIGH)
Write(r1,HIGH)
DELAY&
STOP
CONTINUE1
if(a==b&&a>c)
N
if(b==c&&b>a)
N
if(c==a&&c>b)
N
if(a==b&&b==c)
Y
Y
Y
Y
Write(r1,LOW);
Write(r2,LOW);
Write(r3,LOW);
Write(g1,LOW);
Write(g2,LOW);
Write(g3,LOW);
Write(y1,LOW);
Write(y2,LOW);
Write(y3,LOW);
Write(g1,HIGH);
Write(y2,HIGH);
Write(r3,HIGH);
Write(r1,LOW);
Write(r2,LOW);
Write(r3,LOW);
Write(g1,LOW);
Write(g2,LOW);
Write(g3,LOW);
Write(y1,LOW);
Write(y2,LOW);
Write(y3,LOW);
Write(g2,HIGH);
Write(y3,HIGH);
Write(r1,HIGH);
Write(r1,LOW);
Write(r2,LOW);
Write(r3,LOW);
Write(g1,LOW);
Write(g2,LOW);
Write(g3,LOW);
Write(y1,LOW);
Write(y2,LOW);
Write(y3,LOW);
Write(g3,HIGH);
Write(y1,HIGH);
Write(r2,HIGH);
Write(r1,LOW);
Write(r2,LOW);
Write(r3,LOW);
Write(g1,LOW);
Write(g2,LOW);
Write(g3,LOW);
Write(y1,LOW);
Write(y2,LOW);
Write(y3,LOW);
Write(g1,HIGH);
Write(y2,HIGH);
Write(r3,HIGH);
delay
STOP

5. CONCLUSIONS

Density of the road is calculated using IR sensors. IR sensors are used to detect the number of vehicles based on the IR sensor, the traffic light is operated.IR sensors are less cost and more effective. This project can be extended by using Sound sensors(if the noise from other vehicles are eliminated), priority can be given to the sound sensor than the IR sensor and this will indicate the presence of ambulance and fire engine.

6. REFERENCES

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