TRAFFIC SIGNAL MONITORING AND CONTROL USING RADIO FREQUENCY IDENTIFICATION

A PROJECT REPORT

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ABSTRACT

Traffic signal monitoring and control using RFID uses the radio frequency to monitor the traffic signal by linking the RFID to the Arduino. The project is very useful in monitoring different systems and the components used are Arduino Uno , RFID card reader, RFID card, LED's and buzzer. A circuit of three traffic lights has been designed for this project. The three LED's used are Red,Yellow and Green. This is done to bring out a real time scenario of a traffic signal intersection. The three LED's are powered by Arduino Uno using jumper wires from the Arduino board to the breadboard where the LED's are placed accordingly to represent a traffic signal intersection..The project works on Arduino control which is already coded inside the Arduino to detect the RFID card when it passes through the sensor. The project is designed to read the radio frequency signal from the card and initiate the alarm and the change in lights when the frequency interprets the sensor and triggers the lights and alarms to go on.Initially the lights are programmed to change the colors periodically((i.e)just like traffic lights) and when the RFID card is detected by RFID card reader, it changes the light to a particular colour(i.e)green in this case and the alarm also goes on.

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LIST OF ABBREVIATIONS

AVR	Advanced Virtual RISC
ASK	Amplitude Shift Keying
A_{REF}	Analog Reference
EEPROM	Electrically Erasable Programmable Read Only Memory
GPRS	General Packet Radio Service
GHz	Giga Hertz
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GNU	GNU's Not Unix
Gnd	Ground
IR	Infra Red
I/O	Input/Output
IDE	Integrated Development Environment
I^2C	Inter Integrated Circuit
IoT	Internet of Things
IRQ	Interrupt Request
KHz	Kilo Hertz
KB	Kilo Bytes
LED	Light Emitting Diode
mA	milli Amps

MISO	Master In Slave Out
MOSI	Master Out Slave In
MHz	Mega Hertz
PIC	Programmable Integrated Circuit
PWM	Pulse Width Modulation
RFID	Radio Frequency Identification
RTLS	Real Time Location Systems
R_x	Receiver
RS232	Recommended Standard 232
RISC	Reduced Instruction Set Computer
RST	Reset
SCK	Serial Clock
SDA	Serial Data
SPI	Serial Peripheral Interface
SS	Slave Select
SRAM	Static Read Only Memory
T_x	Transmitter
TTL	Transistor Transistor Logic
TWI	Two Wire Interface
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus
V_{in}	Input Voltage

CHAPTER 1

INTRODUCTION

1.1 POPULATION SURVEY

Overpopulation is one of the biggest problems in the world today. The earth population in 1800 was 1 billion and only 2 centuries later, the global population was 6 billion, and half of which lives in the cities. By the 20th century, it increased to 47%.

1.2 TRAFFIC CONGESTION

This urban population is the vital reason for traffic problems and eventually, increase in number of humans means increase in number of vehicles on the road. There is phenomenal growth in vehicle population in the recent years. With the growth in urbanization, industrialization and population, there has been a tremendous growth in vehicle traffic on the road. Approximately, one million vehicles were licensed last year. Due to the rapid increase in vehicles, the traffic problems have increased in the last few years.

Traffic congestion is a major issue of transportation system in most of all the cities of developing countries. The traffic management is a critical issue in many metropolitan cities. This is especially true for countries where population is increasing at higher rate. As a result, many of the arterial roads and intersections are operating over the capacity and average journey speeds are lower than 10 Km/h at the peak hour. With the increasing number of population in the metropolitan areas, already existing problem of poor traffic congestion has grown to an alarming event. This problem has to be properly analyzed and the appropriate measures have to be taken.

1.3 EXISTING TRAFFIC CONTROL SYSTEM

Traffic lights were developed since 1912. They are the signaling devices, which are used to control the traffic flows at road intersections, pedestrian crossings, railway crossings and other locations. Traffic lights consist of three universal colored lights system: Red, Yellow and Green. The green light allows traffic to proceed in the indicated direction, the yellow light warns vehicles to prepare for a short stop which indicates the intermediate period between start and stop and the red signal stops any traffic from proceeding. The current traffic system has fixed delay slots for the signal light transition and does not consider the emergency vehicles on its way. Ambulance service is one of the main service which is worst affected because of this traffic jam.

1.4 PROPOSED SYSTEM

Emergency occurs anywhere at any location, at any time, and in various ways. Even if each and every vehicle passing through the traffic has its own need, the priority must be given to the ambulance and other emergency vehicles so that the probability of risk gets reduced. Optimum utilization of the time after an accident is actually the golden hour. The crucial issue is the smooth movement of emergency vehicles such as ambulances, rescue vehicles, fire brigade, and police through the intersection of traffic during peak hours. The situation becomes worse when emergency vehicles have to wait along with other vehicles because of traffic congestion. The motivation for the project is due to the real-life scenes that most of us have witnessed.

With this objective in mind, the project aims at developing an intelligence ambulance system to utilize each and every second efficiently to save the life of a person. The ambulance once after reaching the accident spot decides the route to hospital based on the traffic signals in its path of travel. At the same time, the control of traffic lights may be enabled from the ambulance itself before few meters distance so that clearance in path may be achieved. With the certain modification in the existing traffic control system, the proposed project focuses on reducing the time delay in the most efficient and economical manner by optimal control of traffic to save a life.

The proposed system overcomes every problem that are faced in the existing system.

It uses RFID technology.

RFID stands for Radio Frequency Identification.

It is a form of wireless communication which uses radio waves to identify and track objects.

Identify objects without direct line-of-sight.

Identify many objects simultaneously.

Identify objects within a particular distance (i.e.) up to 3-4 feet within a frequency range of 125KHz to 134KHz.In the project RFID Reader and RFID tags are used for data collection.

CHAPTER 2

LITERATURE REVIEW

Prashanth Shetty (2017) presented a paper on **"Traffic Signal Control System with Ambulance Assistance"**, which was published in the IOSR Journal of Electronics and Communication. This system was designed to be operated when it received signal from emergency vehicles based on radio frequency transmission and used the programmable Arduino Atmega 328 micro controller to controls the LED's used in the traffic signals. The use of hazard LED in the system which helps the emergency vehicles to pass the traffic easily, which will reduce accidents which often happen at the traffic light intersections because other vehicles have to provide passage to emergency vehicle. This project is using the frequency of 434 MHz.

E.Geetha et. al. (2014) presented a paper on the topic **"Design of an Intelligent Auto Traffic Signal Controller with Emergency Override"** . The intelligent auto traffic signal control system tries to minimize the possibilities of traffic jams by clearing the road with higher density of vehicles and also provides the clearance for the emergency vehicle. The system is based on the optimization of traffic light controller in a city using the PIC 16F877A micro controller, IR sensors and Radio Frequency Identification (RFID) technology. Whenever the emergency vehicle enters the lane, RFID reader reads the unique identification code of the tag and sends it to micro controller. Micro controller gives the high priority to the lane with the emergency vehicle and clears that particular lane.

N. M. Z. Hashim & A. S. Jaafar (2013) presented a paper on **"Traffic Light**

Control System for Emergency Vehicles Using Radio Frequency" . In this paper, the system was designed to be operated when it received signal from emergency vehicles based on radio frequency (RF) transmission at the frequency of 434 MHz and used the Programmable Integrated Circuit (PIC) 16F877A micro controller to change the traffic light sequence to emergency mode and back to the normal sequence.

Bilal Ghazal & Khaled El Khatib (2016) presented a paper on **"Smart Traffic Light Control System"** . This system based on PIC micro controller is capable of estimating the traffic density using IR sensors posted on either side of the roads. Based on this information, the time dedicated for the green light will be extended to allow large flow of cars in case of traffic jam, or reduced to prevent unnecessary waiting time when no cars are present at the opposite route. The system is complemented by secure communication with the help of portable X Bee wireless system controller for the emergency vehicles stuck in the traffic and the controller triggers the traffic master controller to the emergency mode and provides an open path until the stuck emergency vehicle traverses the intersection.

S. Dhivya & M. Palani (2018) presented a paper on the topic **"IOT Based Traffic Signal Control for Ambulance"**, which was published in the International Journal of Pure and Applied Mathematics . This proposes an IoT based traffic light signal system to control the traffic lights from the ambulance and make clearance for its way to reach the hospital without any delay. The proposed architecture of the system consists of internet of things, raspberry Pi3, Arduino, timer, buzzer, etc. This system uses GPS and GSM modules. The emergency vehicle unit contains a controller siren, a GPS antenna and a GSM module. The received information is given to the controller GPS system inside the vehicle. The GPS system finds the present position of the vehicle (scope and the longitude) gives that information to the GSM module. The GSM module sends this information to the crisis number via the control unit, which is used to send location of the ambulance to reach the traffic signal to make prior arrangements to manage the crisis vehicle and provide a free approach to the emergency vehicle. At whatever point the crisis vehicle comes to near the development hail (around 100 m), the signal light will be made to green through RF signal.

K. Sangeetha & P. Archana (2014) presented a paper on **"Automatic Ambulance Rescue with Intelligent Traffic Light System"** . The Intelligent Traffic Light system provide a smooth flow for the emergency vehicles like ambulance to reach the hospitals in time by automatic control of the traffic lights in the path of the ambulance and thus minimizing the delay caused by traffic congestion. The system uses two micro controllers and the GPS installed in ambulance and identifies the latitude and longitude of the particular place thereby finding the location of the ambulance unit. After receiving the location, the controller compares the GPS value in PC via RS232 in control room. If the GPS value indicates that the ambulance or the emergency vehicle is near to the traffic junction, then the corresponding signal in traffic is green for the ambulance to pass through without waiting. GPRS 3G modem installed in the ambulance and the traffic junction helps to communicate with each other. The system is using the advanced GPRS technologies for faster data transmission at a greater speed and at greater coverage. The nodes in the ambulance path are accessed and controlled only when the ambulance reaches a distance of around say 100 m from the node.

Dr. Muayad Sadik Croock & Asmaa Shaalan Abdul Munem (2016) presented a paper on the topic "**Smart Traffic Light Control System for**

Emergency Ambulance", which was published in the International Journal of Advanced Research in Computer Engineering and Technology . The system fixed in ambulance contains Arduino Uno as a micro controller, GPS is used to get latitude and longitude (GPS signals) for tracking the ambulance and GSM Arduino shield to send location for ambulance to data centre. The database, which is web based one, is built to store the information of ambulance trips and crowd sensor readings. It is important to note that the data centre includes the database, administration computer and server. In this centre, the control algorithm of changing the traffic lights is implemented as well as the optimal map tracking and monitoring of an ambulance. The data centre is responsible on sending the map and optimal path for navigation the ambulance driver using a screen. Moreover, it sends the changing signals to the traffic lights when an Ambulance being close to the underlying traffic junction.

Anibal Zaldivar-Colado & Carolina Tripp-Barba (2014) presented a paper **"Management of Traffic Lights for Emergency Services"** . This paper presents an approach of the management system of traffic lights for emergency services through a mobile application for the manipulation and synchronization of traffic lights. The application was developed for the Android platform and controlled via a mobile device, with access to GPS (Global Positioning System) technology and internet. The idea of the implementation presented in this article is to provide the co-pilot of the emergency vehicle, a device with Android technology that communicates with the traffic lights of the city, allowing the co-driver to have control over them, from a distance calculated using the GPS by manipulating the light change to optimize the response time in an emergency and therefore the emergency vehicle will not have to slow down due to traffic lights. In this way a number of benefits are provided including the prevention of accidents caused by careless drivers of other vehicles on the road and achievement of a decrease in the response time of the emergency vehicle.

Vidya Bhilawade and Dr. L. K. Ragha (2018) presented a paper on the topic **"Intelligent Traffic Control System"**, which was published in the International Journal of Scientific and Research Publication . The system consists of two units - ambulance unit and junction unit. The ambulance unit is to be installed in the ambulance, consists of an RFID reader, GPS receiver and a transceiver interfaced with a micro controller. The GPS receiver continuously receives the GPS co-ordinates of the ambulance by calculating its position using the timing signals from the GPS satellites. When an ambulance leaves the hospital for an emergency case, a RFID card is swiped near the RFID reader, which when authenticated activates the transmission of GPS co-ordinates through the transceiver. The junction unit is to be installed at the traffic signal post, and it consists of a transceiver interfaced with a micro controller. The GPS co-ordinates transmitted by the ambulance unit are received by the transceiver. Some co-ordinates of a point at a particular distance are specified in the junction unit's micro controller program, which when crossed by the ambulance turns the traffic signal green. A suitable delay is given for the signal to remain green till the ambulances passes through the junction. The distance of the point from the signal may differ according to the traffic scenario across different junctions and may be programmed as per its need.

CHAPTER - 3

SYSTEM DESCRIPTION

The project is aimed at improvising ambulance services by ensuring a clear traffic free road. It is based on RF communication. The driver of ambulance has a transmitter and receiver installed at the traffic light. The driver can thus control traffic lights according to the requirement and thus can control the flow of traffic in its way using Arduino Uno. The Fig. 3.1 represents the wireless communication between RFID card reader and RFID card.

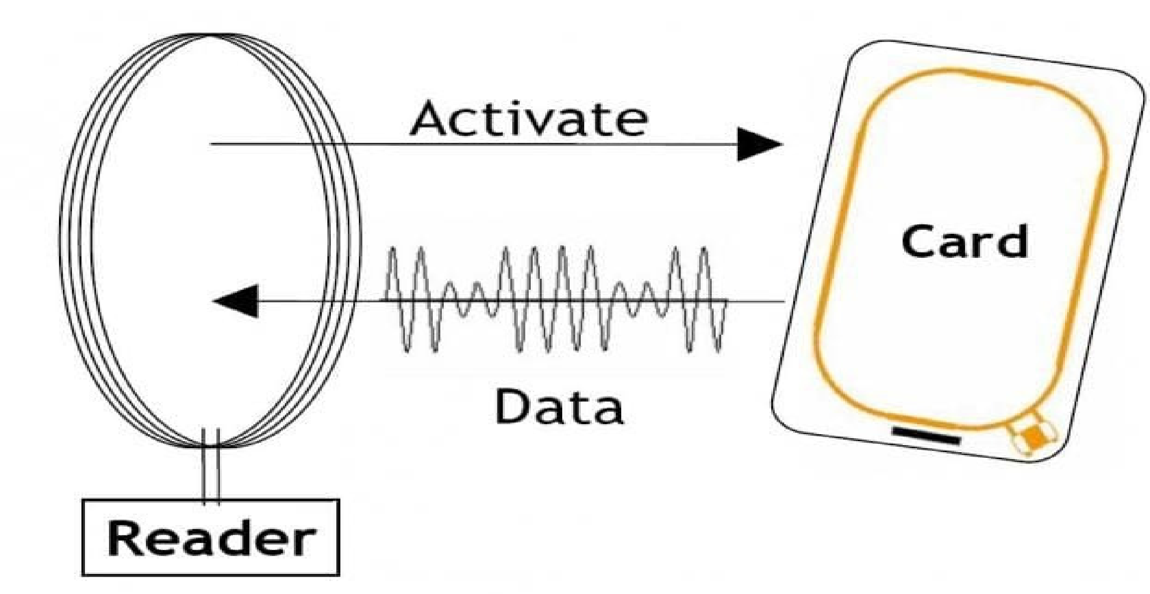

Fig 3.1 Wireless communication between RFID card reader and RFID card

3.1 BLOCK DIAGRAM

The Fig. 3.2 represents the block diagram of the system.

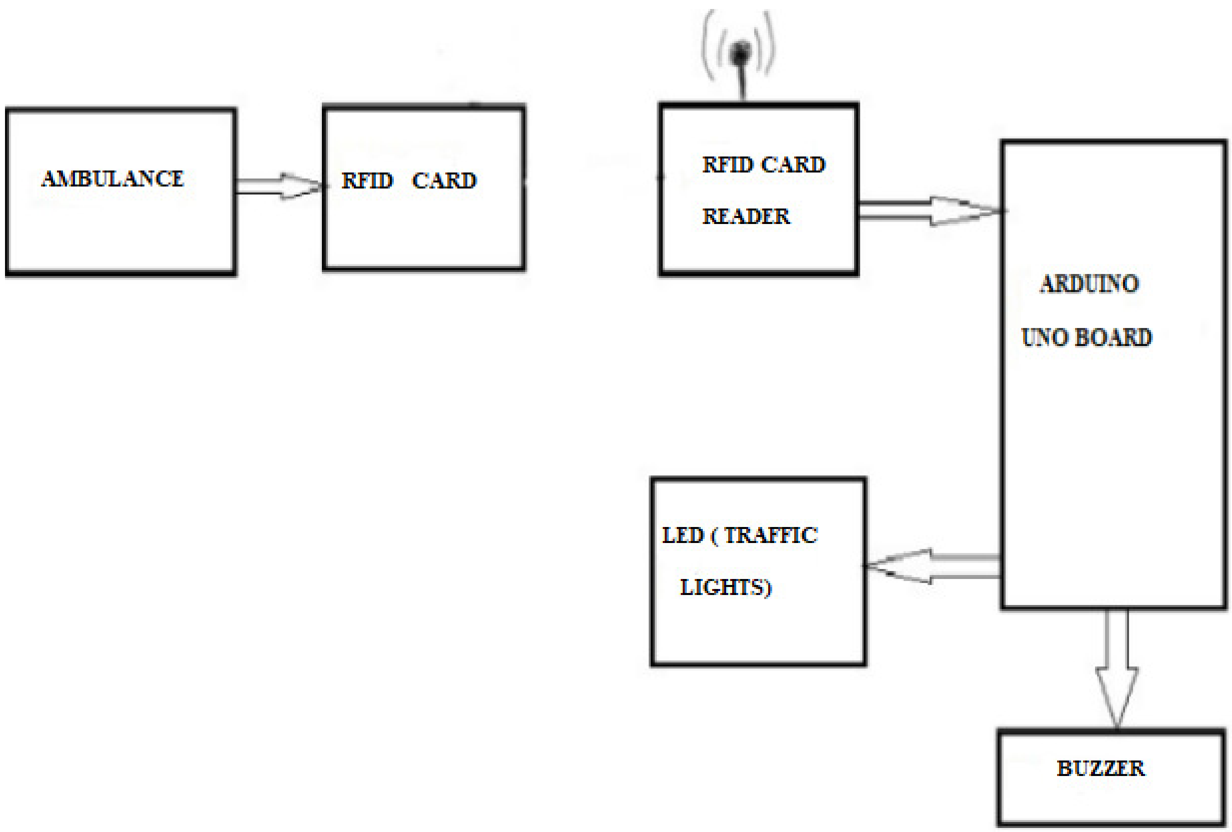

Fig 3.2 Block diagram of the system

3.2 WORKING

Traffic signal monitoring and control system using RFID uses the radio frequency to monitor different systems by linking the RFID to the Arduino.This model is very useful in monitoring different systems and the components used are Arduino Uno, RFID reader,RFID card, LED's and buzzer.This system works on Arduino control which is already coded inside the Arduino to detect the RFID card when it passes through the sensor,the system is designed to read the radio frequency signal from the card and initiate the alarm and the change in lights when the frequency interprets the sensor and triggers the lights and alarms to go on.Initially the lights are programmed to change the colors periodically((i.e)just like traffic lights) and when the RFID card is detected by Arduino sensor,they change the light to a particular colour(i.e)green in this case and the alarm also goes on.

3.3 CONTROLLING OF TRAFFIC SIGNALS USING ARDUINO

The system is based on Arduino that controls and changes the lighting transition slots accordingly based on the route of the ambulance. All these difficulties faced by emergency vehicles can be avoided using this traffic light control system based on radio frequency transmission. The emergency vehicle takes control of traffic lights at an intersection. The technology uses RF transmitter and the unit is mounted on top of the ambulance and RF receivers are placed in every road leading to the every traffic light intersection at a suitable distance from the traffic signal. Initially, the driver of the ambulance switches on the transmitter through a switch placed on the dashboard along with the required route direction. A transmitter placed on an emergency vehicle transmits a signal to the receivers positioned at the traffic lights whenever it is on emergency mode. The received signal is then processed by a master controller which in turn preempts the sequence of the traffic light to control the traffic flow at the intersection. This makes the RF receiver output to go high and thereby interrupting the micro controller and beginning of the interrupt sub routine and the corresponding lane is made green.

Thus, emergency vehicle will have special route from other vehicle to reach the destination. The system will also reduce accidents which often happen at the traffic light intersections because of other vehicle had to huddle for given a special route to emergency vehicle as the project system provides an early warning and active state of emergency at the intersection by special emergency lights and siren prior to the arrival of ambulance to alert the public. Thus, the master controller also provides an output which displays signs to indicate that there is an emergency vehicle, to the other road users from other direction at the traffic light intersection.

The project is designed for the cities with heavy traffic. E.g.: In Bangalore, the roads are fully jammed every time. Most of the time the traffic block will be at least for 100 meters. In this distance the traffic police cannot hear the siren from the ambulance and sometimes traffic police is not present at the signal. Then the ambulance has to wait till the traffic is cleared. Sometimes to leave the traffic it takes at least 30 minutes. With the help of this Intelligent Transportation System, the current scenario of traffic congestion can be solved to a greater extent. This scheme is fully automated control of the traffic lights, and assists the approaching emergency vehicle to find a way out from traffic congestion helping to reach hospital in time.

CHAPTER 4

SYSTEM IMPLEMENTATION

4.1 INTRO

This chapter describes about the implementation process involved in the system design. The hardware and software involved are described in detail.

4.2 ARDUINO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. Tell the board what to do by sending a set of instructions to the micro controller on the board. To do so use the Arduino programming language (based on Wiring), and the Arduino software (IDE) , based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software too, is open-source, and it is growing through the contributions of users worldwide.

4.3 ARDUINO PIN DIAGAM:

The Fig. 4.1 represents the pin diagram of Arduino.

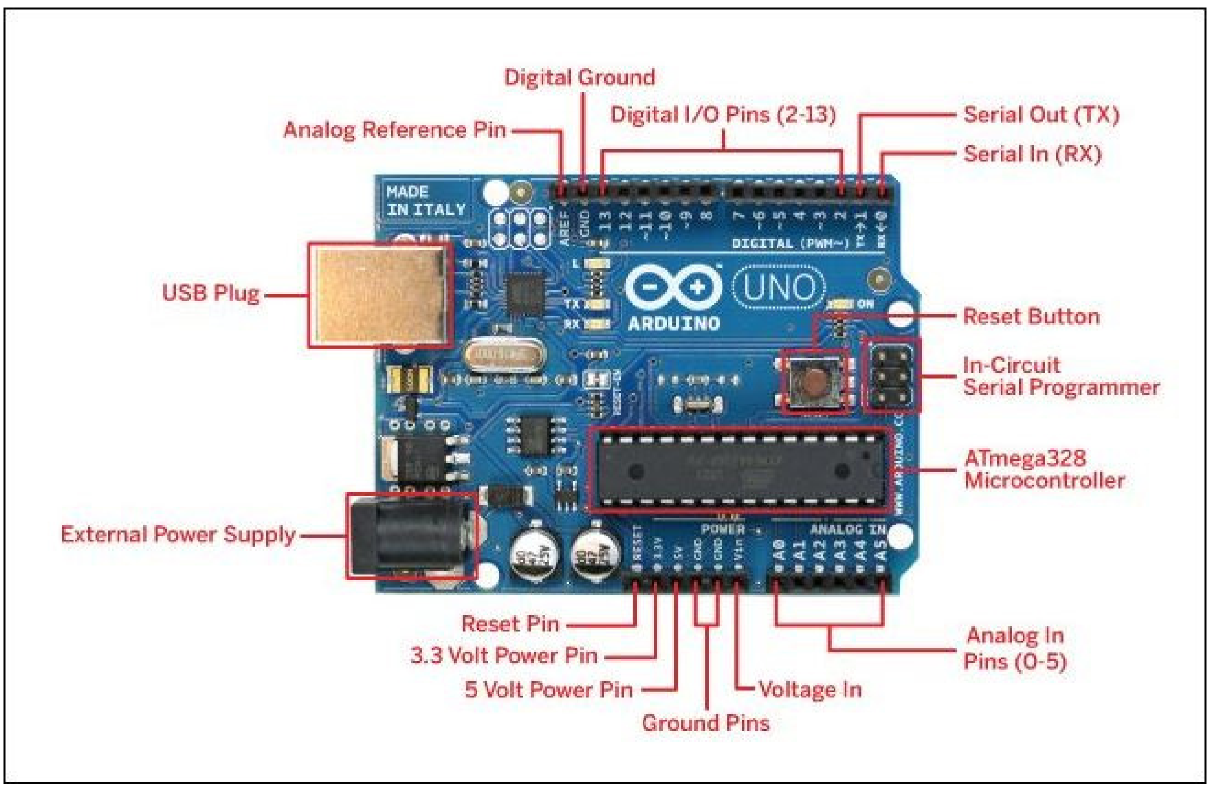

Fig 4.1 Pin Diagram of Arduino

4.4 AURDINO IDE:

The **Arduino Integrated Development Environment (IDE)** is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards.

With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers and tools (cores) that can build and upload sketches to other microcontrollers that are not supported by Arduino's official line of micro controllers.

4.5 Traffic Management

It has become very easy for a common person to own a vehicle with affordability and higher purchasing power. It creates a problem in terms of road congestion and increasing traffic in big cities though this has led to comfortable lifestyles. Smart traffic management system is an alternative way to solve road traffic problem and this system will support existing operation system. Traffic congestion is a severe problem in almost every modern cities around the world. Traffic congestion has been causing many critical problems and challenges in the major and most populated cities. It is becoming more difficult and time-consuming to travel to different places within the city. Due to these congestion problems, people lose time, miss opportunities, and get frustrated. Due to traffic congestion, there is a loss in productivity from workers, trade opportunities are lost, delivery gets delayed, and thereby the costs goes on increasing.

4.6 Role of Arduino in the project

The project uses one Arduino UNO where all the three LED's (as signals) to handle the traffic in a road junction and one RFID reader is connected to it. Arduino Uno board is connected to each other with the help of jumper wires to form a circuit. Let us consider a four number of roads (R1, R2, R3 and R4) to form a road junction. Now, for road R1, there will be two barricades for each lane (left and right lane), a signal, and RFID reader. This is applicable to all the remaining roads, i. e., R2, R3 and R4. When the signal for road R1 becomes green, the barricades of both the lanes will be up (open), the signals for roads R2, R3 and R4 becomes red and the barricades of those respective lanes will be down (closed) so that no vehicles can break the signal and also it will help to reduce traffic congestion and number of accidents. Now, after a particular time, the signal of road R1 turns yellow and then red so that the barricades of the road will be closed and again no vehicles can break the signal. Also, signal for road R2 becomes green and the barricades of that road will be opened. This operation will be continued for all the remaining roads. Now, for example, if any emergency vehicle comes on the road R3 (which has the red signal) and if suppose the road R1 has green signal, then the RFID reader placed on road R3 detects the tag which is placed on the emergency vehicle (saved in the program) which turns the signal for road R1 to red (barricades will be closed) and R3 to green (barricades will be opened), so that the emergency vehicle will be passed without any obstacle. This operation will be performed for all the roads, from where the emergency vehicle is coming from.

4.7 Role of RFID in the project

This project will apply the Radio Frequency Identification (RFID) technology to scan and read the radio frequency tag placed on the emergency vehicles at road junction. This system has a potential to replace a manual inspection process of the police which is also another cause of the traffic jam. In this project,a radio frequency based vehicular system is introduced. An radio frequency receiver and transmitter are used to receive and transmit the information from the emergency vehicles to the signal points. Radio frequency technique deals with multi-lane multi-junction areas. The use of radio frequency distinguishes between the emergency service vehicles and rest traffic, thus preventing the unnecessary traffic congestion. The communication is done through the transceiver and receiver and the system is fully automated and there is less need of human intervention. For manual operation, remotes are also provided through which barricades will be opened if required. There will be additional hardware of Servo Motors which be placed on the barricades by which the barricades will be opened. The Fig. 4.2 represents an RFID Tag and an RFID card reader.

(b) An RFID Reader

(a) An RFID Tag

Fig 4.2 RFID Technology

4.8 Arduino:Piezo speakers (buzzers)

The Fig. 4.3 represents a piezo speaker or a buzzer.

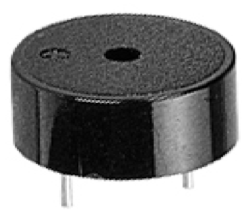

Fig 4.3 Piezo speaker

A "piezo buzzer" is basically a tiny speaker that can be connected directly to an Arduino.

"Piezoelectric" is an effect where certain crystals will change shape when electricity is applied to them. By applying an electric signal at the right frequency, the crystal can make sound.

If the buzzer has a sticker on top of it, pull the sticker off. Connect one pin (it doesn't matter which one) to the Arduino's ground (Gnd) and the other end to digital pin 8.

From the Arduino,it can make sounds with a buzzer by using **tone**.

It has to tell which pin the buzzer is on, what frequency (in Hertz, Hz) it wants, and how long (in milliseconds) it wants to keep making the tone.

4.9 FLOWCHART:

The Fig. 4.4 represents the flowchart of the system.

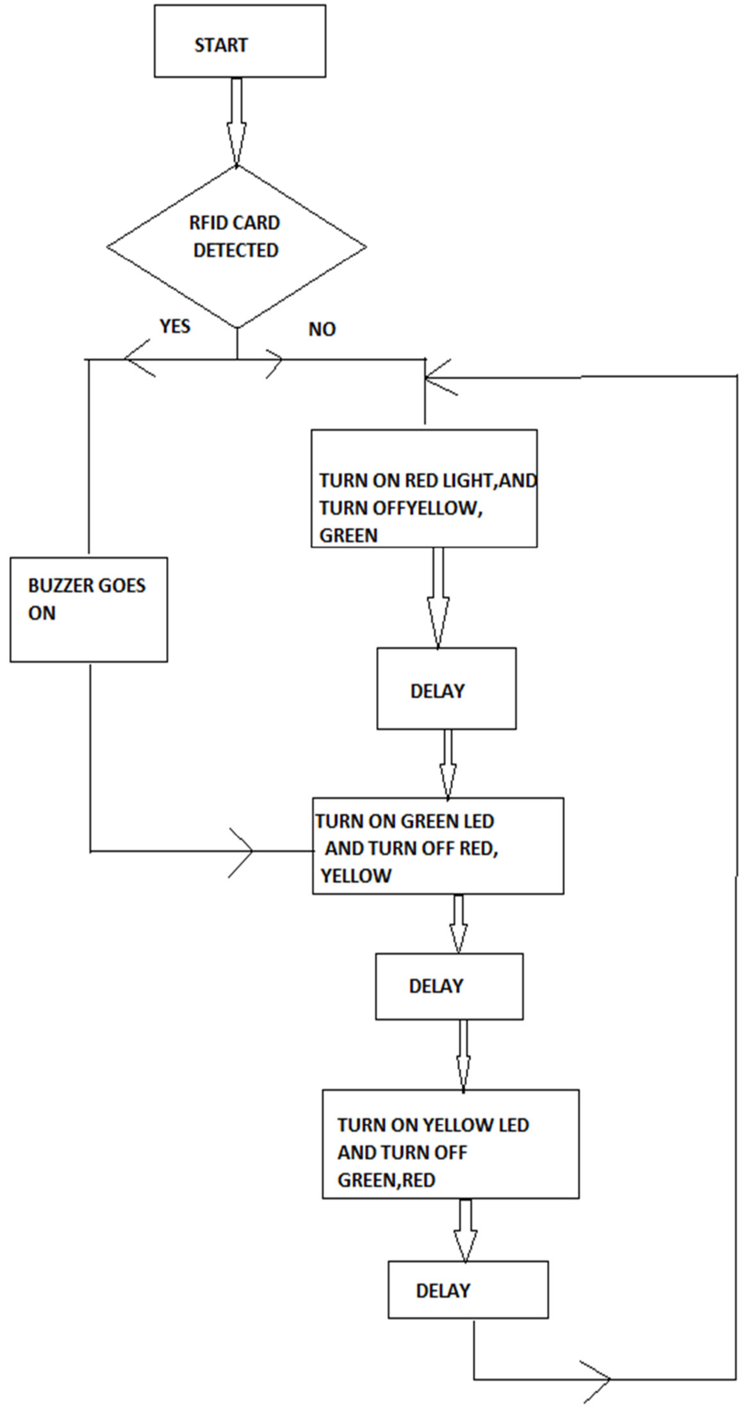

Fig 4.4 : Flow-chart representation of the system

4.10 PROPOSED METHODOLOGY

A. Overview of proposed real time traffic signal control algorithm

This algorithm is designed with the prime objective of minimizing traffic congestion and allows emergency service vehicles to reach their destinations with minimum time delay.Arduino circuit board and the Uno board are used in our proposed system. So there are two algorithms for the two circuit boards. The algorithm designed for the Uno board is used for the radio frequency readers at roadside to detect and scan the cards.This system will detect, scan the emergency vehicle only if it arrives from the left lane of any road. The two functions ‘setup()’ and ‘loop()’ are two built-in functions of Arduino IDE, which are used for initialization and repeated execution phases respectively.

B. Following libraries are used:-

Serial Peripheral Interface (SPI):- It allows us to communicate with the peripheral devices quickly over short distances.

RFID: - A library for interfacing RFID readers with Arduino board UART.

Software Serial: - This library allows serial communication on other digital pins of the Arduino using software to replicate the functionality.

MFRC 522:- Read and write different types of Radio Frequency Identification cards on the Arduino board.

C. Steps of proposed traffic signal algorithm

Algorithm for UNO_Board:

{

1) Declare the signal variables.

2) Declare the serial numbers to the UART.

3) Define the digital input/output used for the SDA and reset pins.

4) Create objects of the RFID library.

5) Function setup()

{

1. Enable the SPI interface.

2. Initialize the RFID readers.

3. Set digital pin as output to connect it to the RFID and enable pin.

    pinMode (pinNumber, OUTPUT);

4. Set the enabled digital pins off.

    digitalWrite (pinNumber, LOW);

5. Approximate the card to the reader.

}

6) Function loop()

{

a) Set the signal variables off.

b) Check whether a card is being detected or not. Do:-

{

i) If so, get serial number of the detected card.

ii) Display card detection time and card number.

iii) Display card details in decimal format.

iv) Check if the scanned serial number is present in the program:-

{

i. If yes, then set the signal variable of the corresponding reader on.

ii.Wait for a few seconds.

iii. Set the signal variable off.

}

}

c) Repeat above both steps for all roads.

}

7) End algorithm

}

TRAFFIC LIGHTS, TRAFFIC SIGNAL,STOPLIGHTS or ROBOTS are signaling devices positioned at road intersections,pedestrian crossings, and other locations to control flows of traffic.

The world's first traffic light was a manually operated gas-lit signal installed in London in December 1868. It exploded less than a month after it was implemented, injuring its policeman operator. Earnest Sirrine from Chicago patented the first automated traffic control system in 1910. It used the words "STOP" and "PROCEED", although neither word was illuminated.

Traffic lights follow a universal colour code which alternates the right of way accorded to users with a sequence of illuminating lamps or LED's of three standard colors:

- **GREEN LIGHT**

  Allows traffic to proceed in the direction denoted, if it is safe to do so and there is room on the other side of the intersection. The green light was traditionally green in colour (hence its name) though modern LED green lights are turquoise.

- **RED LIGHT**

  Prohibits any traffic from proceeding. A flashing red indication requires traffic to stop and then proceed when safe (equivalent to a stop sign).

- **AMBER LIGHT** (also known as 'orange light' or 'yellow light')

  Warns that the signal is about to change to red, with some jurisdictions requiring drivers to stop if it is safe to do so, and others allowing drivers to go through the intersection if safe to do so. In some European countries (such as the UK), red and amber is displayed together, indicating that the signal is about to change to green.

- A flashing amber indication is a warning signal. In the United Kingdom and Ireland, a flashing amber light is used only at pelican crossings, in place of the combined red–amber signal, and indicates that drivers may pass if no pedestrians are on the crossing.

In some countries traffic signals will go into a flashing mode if the conflict monitor detects a problem, such as a fault that tries to display green lights to conflicting traffic. The signal may display flashing amber to the main road and flashing red to the side road, or flashing red in all directions. Flashing operation can also be used during times of day when traffic is light, such as late at night.

Arduino Pin Description

This tabular column represents the pin descriptions of Arduino.

Pin Category	**Pin Name**	**Details**
Power	V_{in}, 3.3V, 5V, GND	V_{in}: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power micro controller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the micro controller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output	Digital Pins 0 - 13	Can be used as input or output pins.

Pins		
Serial	$0(R_x)$, $1(T_x)$	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

Arduino Uno Technical Specifications

This tabular column represents the technical specifications of Arduino Uno.

Micro controller	8 bit AVR family micro controller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Boot loader)
SRAM	2 KB
EEPROM	1 KB

Frequency (Clock Speed)	16 MHz

- The Fig. 4.5 represents the components of Uno board.

Fig 4.5 Components of UNO Board

4.11 Applications of Arduino Uno:

- **Arduino Uno** is used in Do-it-self projects prototyping.
- In developing projects based on code-based control.
- Development of Automation System.
- Designing of basic circuit designs.

4.12 RFID System Construction

Any RFID System will consist of a RFID card reader and a RFID card. The card will often be small and portable.A simple RFID system can be represented using the below block diagram. The Fig. 4.6 represents the block diagram of RFID system.

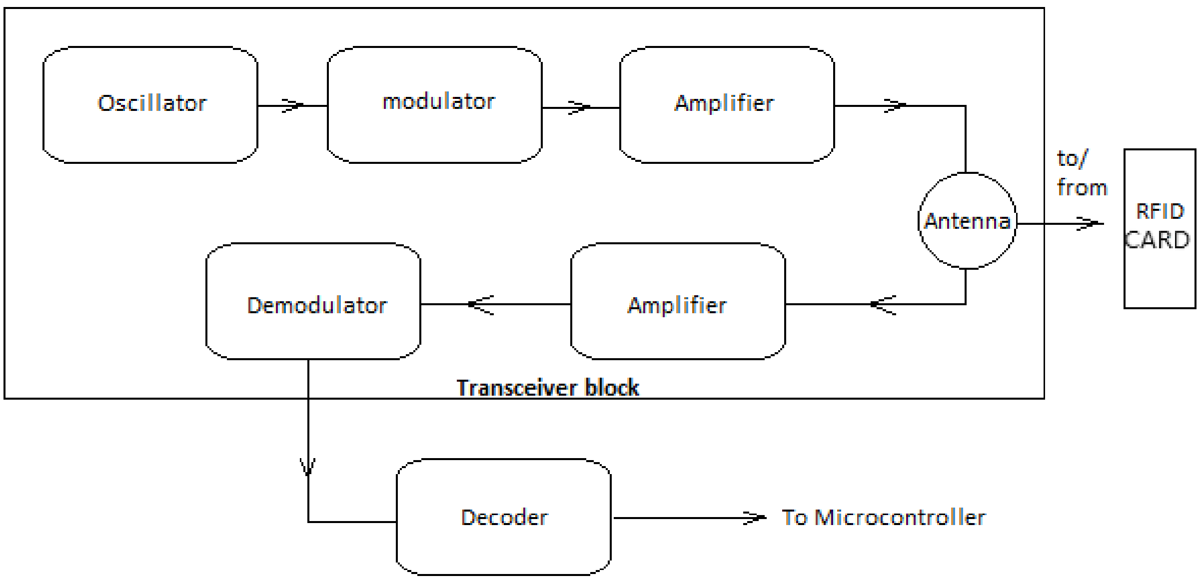

Fig 4.6 Block Diagram of RFID system

4.13 RFID Reader

It is a device which consists of an antenna, transceiver and a decoder.

- **Transceiver**: It can be used either as a transmitter or a receiver. It consists of an oscillator to generate a continuous signal which is modulated to a required frequency and then transmitted into air through an antenna.

- **Antenna**: It is a device which converts the electrical signal into electromagnetic signal which is efficient in propagating the signal in air.
- **Decoder**: When a RF signal is detected at the antenna from a tag, the decoder helps in retrieving the data.

4.14 RFID CARD

It consists of 2 components (in case of a passive tag). They are Microchip and an antenna.

- **Microchip**: It is a semiconductor device which consists of a circuit etched in it with some KB of memory storage, capable of storing data and transmitting it whenever needed.

- **Antenna**: It is used to transmit the data that is present in the chip into air so that it can be detected by a reader.
- **Battery**: In active devices in order to power up the microchip battery is externally used.

4.15 Working principle of RFID system

A RFID reader stays powered on all the time and is normally powered from an external power source. So when it is ON, the oscillator in it generates a signal with a desired frequency but as the signal strength will be very less (which may lead to fading off the signal if it is transmitted directly) it has to be amplified which can be done using an amplifier circuit, in order to propagate the signal to a longer distance it needs to be modulated using a signal which is done by a modulator. With all these improvements the signal is now ready to be transmitted which can be done by an antenna which converts the electrical signal into a electromagnetic signal.

The RFID reader signals are everywhere with it's proximity to detect a card. When a RFID card comes in the proximity of the RFID reader the card detects the readers signal through a coil present in it which converts the received RF signal into a electrical signal. This converted signal alone is sufficient to power up the microchip present in the tag. Once the microchip gets powered up, its function is to send the data (unique ID) which it is stored in it. The same way the signal came in, it is sent out through the same coil into the air.

As discussed earlier the RFID reader also has a transceiver in it. When the signal comes back from the card through the antenna of RFID reader it is fed to the demodulator and then decoded by a decoder where the original data can be obtained and then further processed by a microcontroller or a microprocessor to perform a specific task.

Note that the above explanation is for a passive RFID card. In case of an active RFID card it detects the signal from the reader only to trigger the circuit and make the card ready to send the data to the reader, since active tags have built-in power source.

4.16 Frequency Range used by RFID Technology

The Radio frequency range is from 3 kHz to 300 GHz but the RFID generally uses Radio frequencies in ranges within the Radio frequency (RF) band categorized as below:

- **Low frequency RFID**: Its range is in between 30 kHz to 500 kHz but the exact frequency used by it is 125 kHz. Its detection range is 10 -15 cm.
- **High frequency RFID**: Its range is in between 3 MHz to 30 MHz, the exact frequency used by the module is 13.56 MHz. Its detection range is up to 1.5 meters.

- **Ultra High frequency RFID**: Its range is 300 MHz to 960 MHz but the exact frequency used is 433 MHz. The detection range is up to 20 meters.
- **Microwave RFID**: It uses a frequency of 2.45 GHz and the detection range is up to 100 meters far.

- So based on the application and the detection range required the suitable RFID should be chosen. The detection range varies based on the size of antenna size and tuning.

4.17 Types of RFID systems

The RFIDs are broadly categorized into two types mainly based on the type of RFID card used. The two systems are called Active RFID system and Passive RFID system.

1. Active RFID system

The Active RFID system has active cards which are powered up with a power source (a battery). So the active cards are capable of radiating their own Radio frequency signals to transmit the data that contains in the microchip, without depending upon the Reader's signals to power up.

The active RFIDs are typically categorized under UHF RFID which has detection range up to 20 meters. These active tags are further categorized into Transponders and Beacons.

Transponders:

As the name itself specifies that it receives a RF signal and emits another RF signal (usually data) as a response. The transponders are not active (powered up) all the time but they become active only when it detects a signal from a Reader and then powers up the microchip to get the data which is then transmitted back to the Reader. So transponders are the active cards which power ups only when the Reader transmits the signal. This allows the transponders to have high battery life compared to Beacons.

Beacons:

Beacons are the active cards which are powered up all the time but transmit the data only in specified time intervals (time interval can be once in a minute or once in a day). When the data is transmitted, corresponding Reader within its proximity detects the signal and respective action can be performed. Battery life span is low when compared to Transponders but is faster since it stays active all the time.

2. Passive RFID system:

This is the most commonly used type of system that can be found in ID cards, banking cards etc. It consists of passive cards which doesn't have any battery to power up the chip in the card. Instead the Reader transmits the RF signals which are detected by the card. These RF signals induce current into the cards antenna which is then used to power up the chip. Then the card responds with the data in the chip through the coiled antenna which is detected by the Reader and respective action will be performed. These are generally seen in maintaining attendance systems at offices and colleges.

4.18 RFID Module Pin Description

Typically an RFID module comes with 8 pin RFID readers namely V_{cc}, GND, IRQ, RST, MISO/SCL/T_x, MOSI, SCK and SS/SDA/R_x.The significance of each pin is briefly discussed below. The Fig. 4.7 shows the pin description of RFID module.

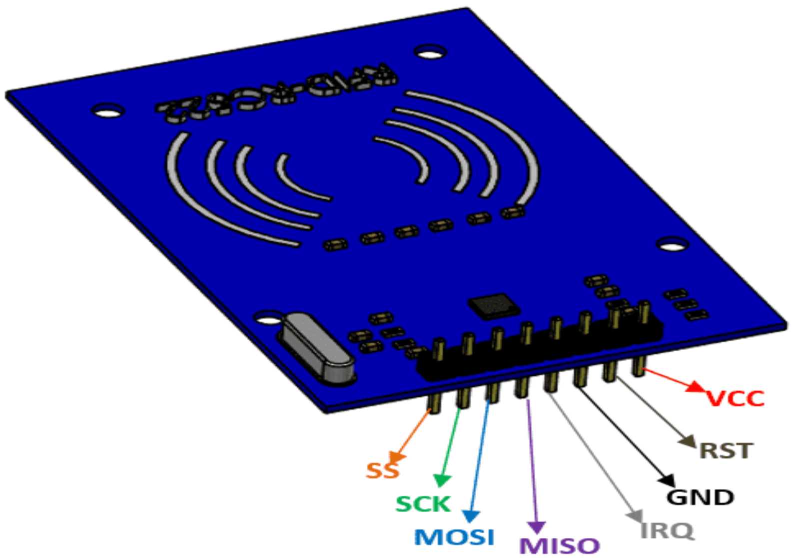

Fig 4.7 RFID module pin description

- V_{cc}: In order to run the module the allowable voltage is up to 3.3V. Unlike most of the modules RC522 doesn't accept 5V as an input.
- GND: In order to make a closed circuit GND terminal is required.
- IRQ (Interrupt Request): It goes high when a RFID tag comes into the proximity of RFID reader. It helps in interrupting the micro controller to pause (or perform) the task as designed by the engineer.
- RST (Reset): It is an active low pin. When logic 0 is applied to the pin, the RFID reader will be switched OFF.
- MISO (Master In Slave Out): In a SPI (Serial Peripheral Interface), multiple peripheral devices (Slave) are being communicated with the micro controller (Master) quickly. So MISO is used to send the data to the master (micro controller) from the salve (peripheral device).

- MOSI (Master Out Slave In): Similar to the MISO, using MOSI pin Master can send the data to the peripheral devices.
- SCK (Serial Clock): In order to synchronize the data transmission between the master and slave SCK pin is used which generates clock pulses.
- SS (Slave Select): In case if the slave devices are more than one, the SS can be used to select the desired device when required.

4.19 Features of RFID Module

- Host interfaces supported are SPI, RS232 serial UART and I^2C.
- Typical operating distance in Read/Write mode is up to 50 mm based on the size of antenna size and tuning.
- Reset with low power function for power efficiency.
- Interrupt modes are flexible for interfacing with micro controller when multiples devices have to be connected.
- 2.5 V to 3.3 V operating voltage.
- Internal self test for testing the device by itself when powered ON to check whether the system is working as expected or not.

4.20 Applications of RFID

- Used in office/schools for attendance management.
- Used for inventory tracking.
- Used to avoid fraudulent/stolen products from malls and super markets.
- In constructions industries RFID technology can be used to manage materials.

- Used in Real Time Location systems (RTLS) for tracking the location of a particular asset or an employee.
- Used to lock and unlock the doors.

4.21 Advantages of RFID

- Security:Data on key cards is usually secure because it takes specialized equipment to read it. This maintains the lock system security.
- Convenience:It only takes a fraction of a second to put the RFID key in the proximity of the reader to open the lock.
- Size:The size of the card is almost identical to that of a regular bank or ID card, making it easy to store.Generally carrying these cards most of the time,so it makes it less likely that the card will be forgotten when going to work, or anywhere else where card access is required.
- Diverse:As RFID locks come with a range of different cams and spindle lengths, they can be fitted to a wide range of doors and furniture. This makes them suitable for use in many different businesses and applications.
- Master Card Functionality:A single RFID key card may be programmed to work with many locks, each potentially having their own access policies, etc. This saves someone from having to carry 8 keys to have access to 8 locks, while still allowing each of those 8 locks to have independent access policies.

4.22 Disadvantages of RFID

- Lost Key card:Just like traditional lock and keys, can also forget or misplace the key card giving the double headache of trying to figure out how to open the locker and tracing back the step to find the key card.

- Hacker Alert*:*An RFID system can be hacked or bypassed by someone who is tech-savvy, so they are not totally foolproof.

- Power Shortage Issue*:*One major problem is that electric RFID systems may malfunction during power outages causing some lockers to either shut it out or worse leave the lockers open where people may try to steal what is inside.

4.23 RF MODULE

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz and 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK). Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications .RF transmission is more strong and reliable than IR transmission.

RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (T_x/R_x) pair operates at a frequency of 434 MHz .An RF transmitter receives serial data and transmits it wireless through RF through its antenna connected at pin4. The transmission occurs at the rate of 1 Kbps - 10 Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D, HT640-HT648, etc. are some commonly used encoder/decoder pair ICs. The Fig. 4.8 shows the data transmission operation of RF communication system.

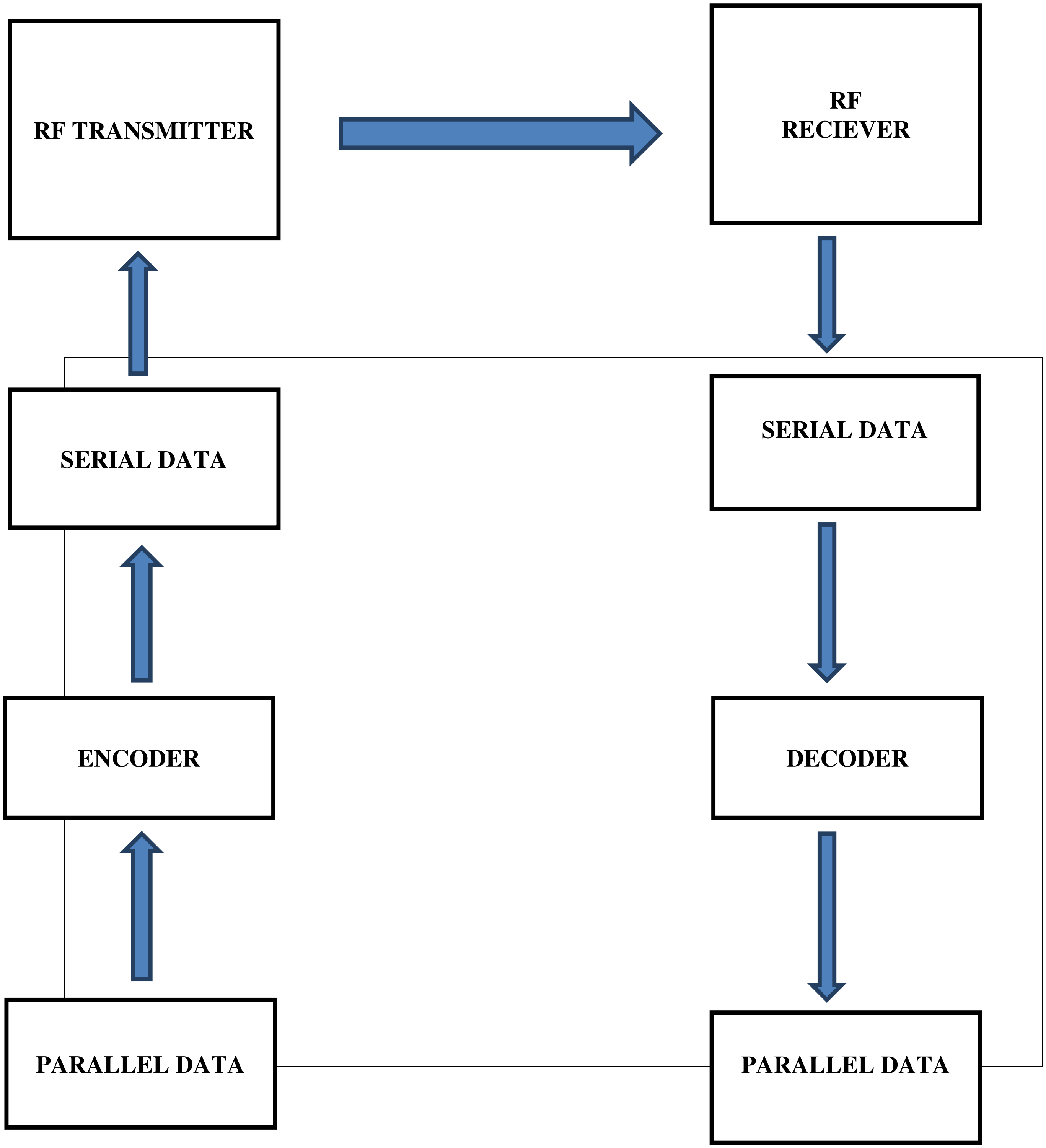

Fig 4.8 Data transmission

4.24 RF Transmitter and Receiver module

This radio frequency (RF) transmission system employs Amplitude Shift Keying (ASK) with transmitter/receiver pair operating at 434 MHz. The transmitter module takes serial input and transmits these signals through RF. The transmitted signals are received by the receiver module placed away from the source of transmission.

The system allows one way communication between two nodes, namely, transmission and reception. The RF module has been used in conjunction with a set of four channel encoder/decoder ICs. HT12E and HT12D have been used as encoder and decoder respectively. The encoder converts the parallel inputs (from the remote switches) into serial set of signals. These signals are serially transferred through RF to the reception point.

The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs. These outputs can be observed on corresponding LED’s.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 CONTROL OF TRAFFIC SIGNAL:

A circuit of three traffic lights has been designed for the project. The three LEDS used are Red,Yellow and Green. This is done to bring out a real time scenario of a traffic signal intersection. The three LED's are powered by Arduino Uno using jumper wires from the Arduino board to the breadboard where the LED's are placed strategically to represent a traffic signal intersection. The sequence of the traffic lights is generated by coding the Arduino Uno board using the Arduino IDE software. When powered on the yellow LED is programmed to light first followed by the red and green LED's. The time range between the change in traffic light color between red and green is programmed for 20 seconds and the time span between yellow and red and green and yellow is set at 5 seconds. The Fig. 5.1 represents the hardware model of the system. The Fig. 5.2,5.3 & 5.4 represents the simulation of traffic light for yellow,red and green LED's respectively.

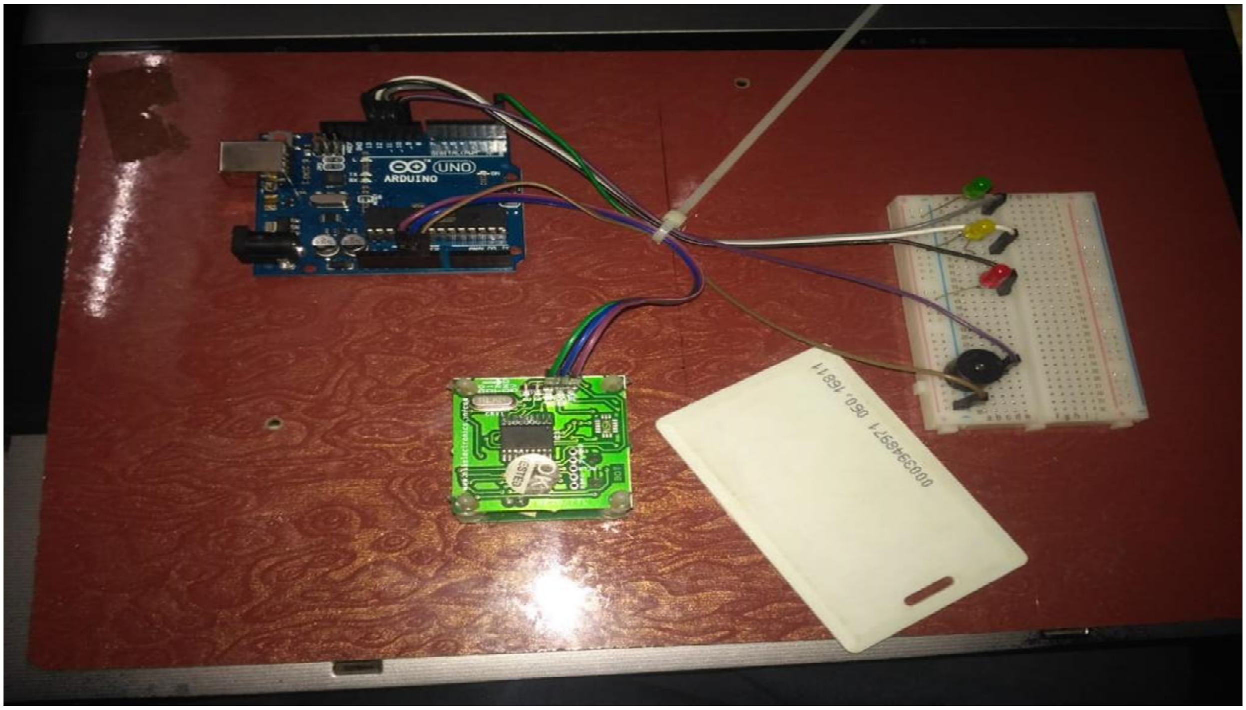

Fig 5.1 HARDWARE MODEL

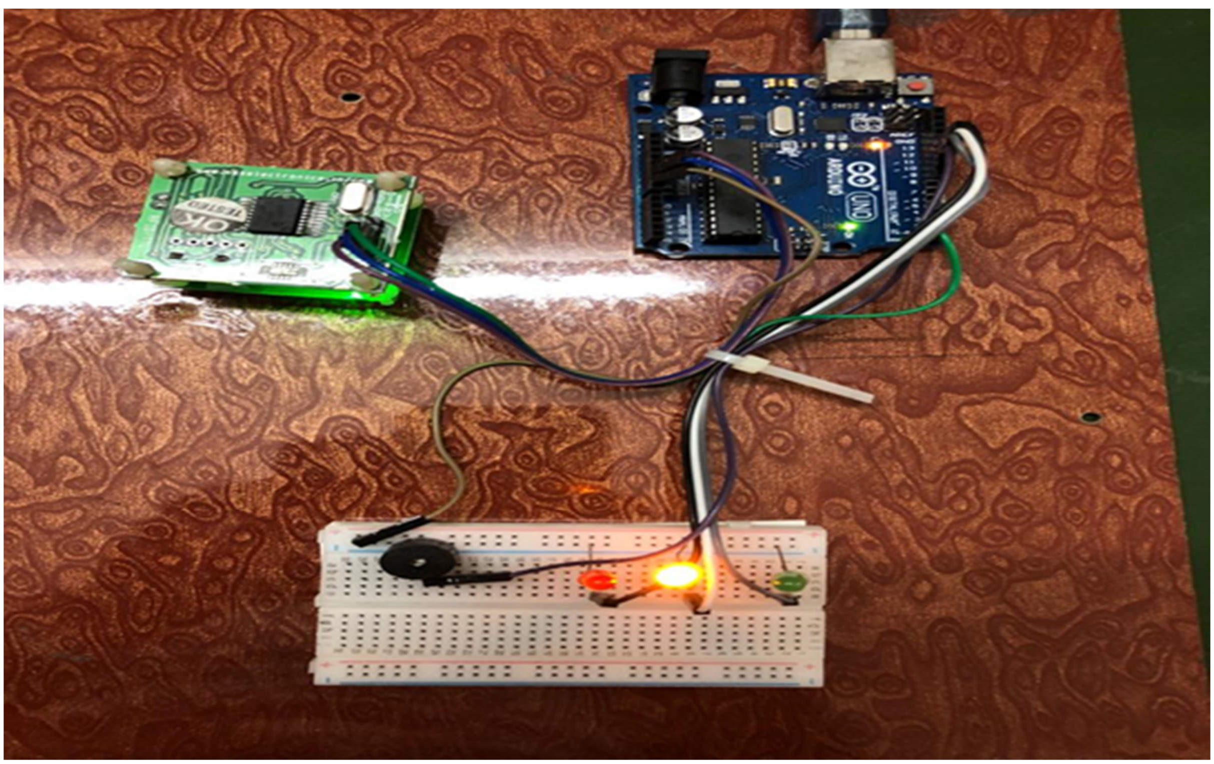

Fig 5.2 SIMULATING TRAFFIC LIGHT FOR YELLOW LED

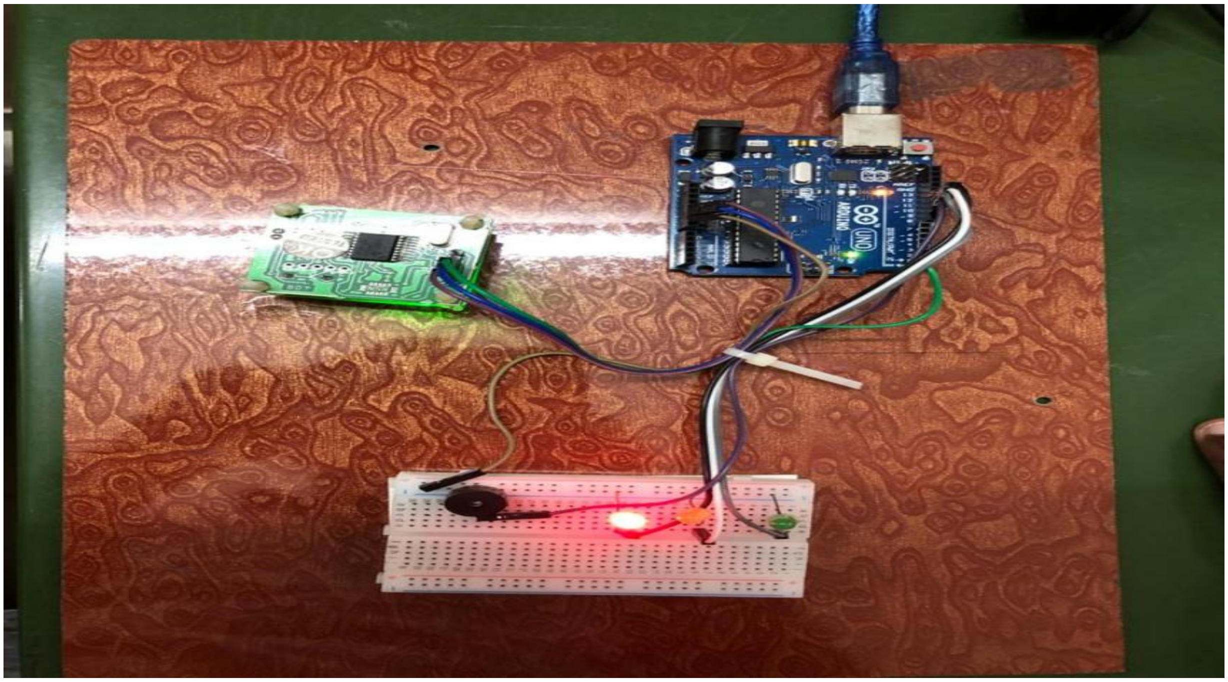

Fig 5.3 SIMULATING TRAFFIC LIGHT FOR RED LED

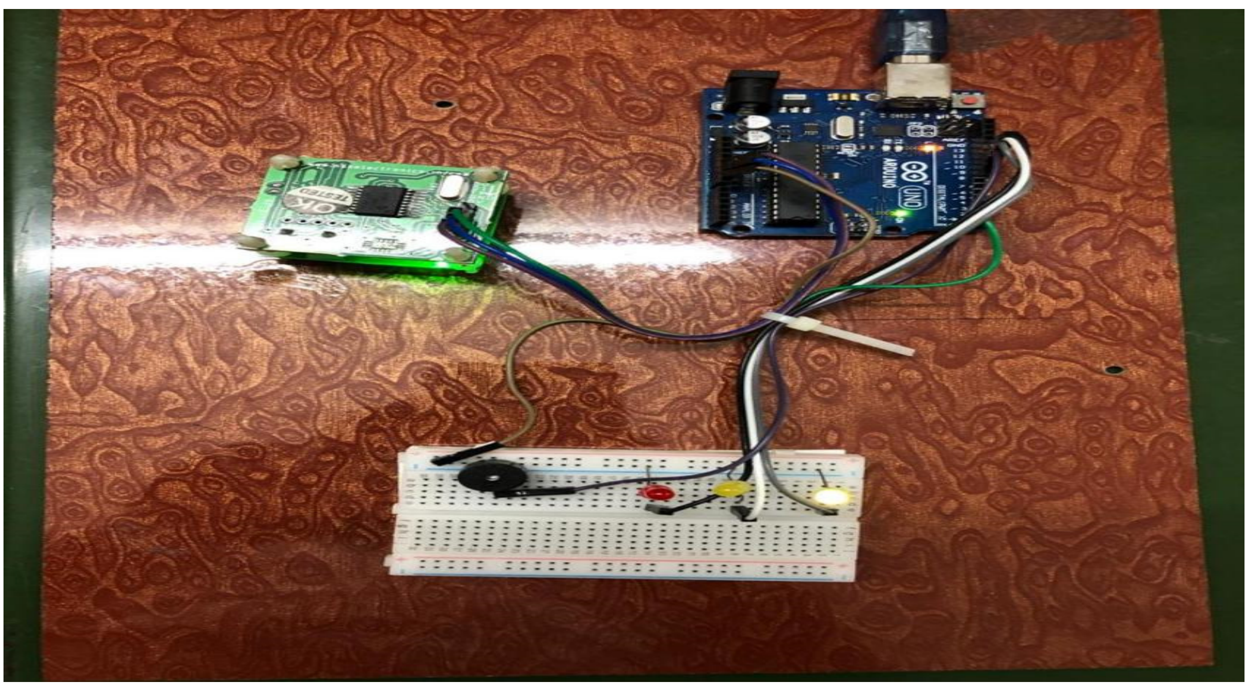

Fig 5.4 SIMULATING TRAFFIC LIGHT FOR GREEN LED

The project uses RFID reader and RFID card to detect the ambulance. The RFID reader is connected to the Arduino Uno board using jumper wires and the project uses a buzzer which produces a warning noise for the incoming vehicle with the RFID card towards the signal. The RFID reader module is interfaced with the Arduino board using a program. The input to the buzzer is given from the input side of the Arduino board and it is also programmed to synchronize with the RFID reader. The output from the buzzer is also given to the output side of the Arduino board. The RFID reader is powered by the 5V from the Arduino board. The input for the RFID reader is given from the pin 0 to the transmitter of the RFID reader. The RFID works on TTL logic. The receiver side of the Arduino board is connected to the transmitter side of the RFID reader. The input to the buzzer is given from the pin 9 of the Arduino board and the input to the LED's are given to the pin 10,11 and 12 of the Arduino board.

When the power supply is given to the Arduino Uno board through an USB cable and it in turn turns on the LED in respective order as per the coding. The yellow light turns on first for 5 secs and after the 5 secs the signal changes from yellow to red light. The red light is programmed to be kept on for 20 secs and then the light shifts from red to green. The green light is also programmed to turn on for 20 secs and then it shifts to yellow and then the process continues like this as programmed until a vehicle or object with a RFID card approaches the signal , which is fitted with the RFID card reader. The connection between the RFID card reader and the RFID card is a wireless communication using Radio frequency of the range of 125KHz - 134KHz, i.e low frequency range. After turning on the kit, the traffic lights start to function normally as mentioned above. When a vehicle with the RFID card approaches the RFID card reader which is placed 100m from the traffic lights, the RFID card reader receives the signal and the connection to the traffic signal and buzzer is triggered and the traffic light turns from red/yellow to green instantly and the input to the buzzer is also triggered which produces a noise which indicates that an emergency vehicle is nearing the signal thus helping others to give way for the vehicle, minimizing the travel duration for emergency vehicles and also reduces the waiting time at traffic signals. Once the emergency vehicle passes through the connection can be reset again to work again thereafter.

CHAPTER 6

CONCLUSION

The traffic signal issue is a critical problem that worries everyone in case of emergency. As stated in the objectives of the project, this work has resulted in a significant contribution of identifying the emergency vehicle with RFID card and detecting it to change the signal to green and turning on the buzzer to indicate the arrival of ambulance to clear the path by using Arduino and RFID card and RFID card reader . Besides this, the other objective of activating the traffic signal from the emergency vehicle is for smooth transition and hence further changing the sequence back to the normal sequence after the emergency mode was triggered.

The advancement of technologies and the miniaturization of control devices, appliances and sensors have given the capability to build sophisticated smart and intelligent systems to solve human problems and facilitate the sophisticated life style. The designed system is implemented, realized electronically, and tested to ensure complete validation of its operations and functions.

FUTURE SCOPE

In real-time, the traffic data can be analyzed and recorded to a computer platform, where statistical studies can be applied for better understanding of the traffic flow between the intersections. Further, it can be improved by investigating the length, reception and transmission issue for the transportation system to be operated with the traffic light system. Better radio frequency communication design with larger distance coverage can be accomplished by suitable antenna design of RF system to facilitate the identification of emergency vehicle at a larger distance from the traffic signal.

APPENDIX:

Arduino IDE Program for Traffic signals and RFID:

```
 // variables
int GREEN = 2;
int YELLOW = 3;
int RED = 4;
int DELAY_GREEN = 5000;
int DELAY_YELLOW = 2000;
int DELAY_RED = 5000;

// basic functions
void setup()
{
  pinMode(GREEN, OUTPUT);
  pinMode(YELLOW, OUTPUT);
  pinMode(RED, OUTPUT);
}

void loop()
{
  green_light();
  delay(DELAY_GREEN);
  yellow_light();
  delay(DELAY_YELLOW);
  red_light();
  delay(DELAY_RED);
}
void green_light()
{
  digitalWrite(GREEN, HIGH);
  digitalWrite(YELLOW, LOW);
  digitalWrite(RED, LOW);
}
void yellow_light()
{
  digitalWrite(GREEN, LOW);
```

```
  digitalWrite(YELLOW, HIGH);
  digitalWrite(RED, LOW);
}
void red_light()
{
  digitalWrite(GREEN, LOW);
  digitalWrite(YELLOW, LOW);
  digitalWrite(RED, HIGH);
}
```

The Arduino code is as follows

```
// Include required libraries
#include <LiquidCrystal_I2C.h>
#include <SPI.h>
#include <MFRC522.h>

// Create instances
LiquidCrystal_I2C lcd(0x27, 16, 2);
MFRC522 mfrc522(10, 9); // MFRC522 mfrc522(SS_PIN, RST_PIN)
// Initialize Pins for led's,  and buzzer
// Blue LED is connected to 5V
constexpr uint8_t greenLed = 7;
constexpr uint8_t redLed = 6;
constexpr uint8_t yellowLed= 8;
constexpr uint8_t buzzerPin = 5;

String tagUID = "29 B9 ED 23";  // String to store UID of tag. Change it with the tag's UID
void setup() {
  // Arduino Pin configuration
  pinMode(buzzerPin, OUTPUT);
  pinMode(redLed, OUTPUT);
  pinMode(greenLed, OUTPUT);

  lcd.begin();   //
  lcd.backlight();
  SPI.begin();      // Init SPI bus
  mfrc522.PCD_Init();   // Init MFRC522

  lcd.clear();
}
```

```
void loop() {
 lcd.setCursor(0, 0);
 lcd.print(" RFID Door Lock");
 lcd.setCursor(0, 1);
 lcd.print(" Show The Tag ");

 // Look for new cards
 if ( ! mfrc522.PICC_IsNewCardPresent()) {
  return;
 }
 // Select one of the cards
 if ( ! mfrc522.PICC_ReadCardSerial()) {
  return;
 }
 //Reading from the card
 String tag = "";
 for (byte i = 0; i < mfrc522.uid.size; i++)
 {
  tag.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
  tag.concat(String(mfrc522.uid.uidByte[i], HEX));
 }
 tag.toUpperCase();
 //Checking the card
if (tag.substring(1) == tagUID) //change the UID of the card/cards to give access
{
  // If UID of tag is matched.
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Access Granted");
  lcd.setCursor(0, 1);
  lcd.print("Door Opened");
  sg90.write(90);
  digitalWrite(greenLed, HIGH);
  delay(3000);
  digitalWrite(greenLed, LOW);
  sg90.write(0);
  lcd.clear();
 }
 else
 {
  // If UID of tag is not matched.
```

```
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Wrong Tag Shown");
  lcd.setCursor(0, 1);
  lcd.print("Access Denied");
  digitalWrite(buzzerPin, HIGH);
  digitalWrite(redLed, HIGH);
  delay(3000);
  digitalWrite(buzzerPin, LOW);
  digitalWrite(redLed, LOW);
  lcd.clear();
}
```

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