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TRAFFIC LIGHT CONTROL SYSTEM FOR EMERGENCY VEHICLES USING RFTECHNOLOGY

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ABSTRACT

Traffic signal monitoring and control using 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 nano , RF Tx, RF Rx , LED's and buzzer. A circuitof 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 nano 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 detectthe RFID card when it passes through the sensor. The project is designed to read radio frequency signal from the card and initiate the alarm and the change in lights when the frequency interpretsthe sensor and triggers the lights and alarms to go on.Initially the lights are programmed to changethe colors periodically (just like traffic lights) and when RF Tx signal is detected by RF Rx reader,it changes the light to a particular colour is green in this case and the alarm also goes on.

1- Introduction

Many countries in the world are facing the problem at traffic light intersection that causes accidentbetween emergency vehicle and other public vehicle. The traffic control system in Malaysia specifically has not been equipped with appropriate method when emergency case occurs. This will cause the emergency vehicles such as ambulances difficult to reach the destination on time because of the traffic congestion. Moreover, the situation is getting worse when emergency vehicles have to wait for other vehicles to give way at intersections with traffic lights. This causesa delay of time and may affect the emergency case. Besides, the collisions with other vehicles from other direction might occur at intersections when emergency vehicles had to override the red traffic lights.

All these difficulties faced by emergency vehicles can be avoided using this traffic light control system based on radio frequency. Due to the problem, literature review for related issue prior to undertaking research project is decisive. The literature review will provide information on the technology available and methodologies used by other research counterparts around the world on this topic. The traffic light system designed by Levi L. Rose used only for emergency vehicle. Sensor is used to transmit signal that has been installed in every emergency vehicle to the receiver which has been placed at every traffic light intersection.

When emergency vehicle reach at the traffic light intersection, the signal code will be sent information of frequency modulation to the receiver. The receiver demodulates the

received code and the red traffic light will trigger at all the junctions. Thus, emergency vehicle will have special route from other vehicle to reach the destination. The traffic light system designed by M. R. Smithprovided early warning of the approaching an emergency vehicle to find a way out from traffic congestion and lead the emergency vehicle to the destination. The emergency vehicle also may take control of traffic light at an intersection. 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 preempt the sequence of the traffic light to control the traffic flow at the intersection which taken by the emergency vehicle. The receiver demodulates the received codeand the red traffic light will trigger at all the junctions.Thus, emergency vehicle will have special route from other vehicle to reach the destination.

The master controller also provides an output which display signs to indicate that there is an emergency vehicle to the other road users from other direction at the traffic light intersection. Additionally, the display system indicates whether the emergency vehicle has passed through the intersection or not.

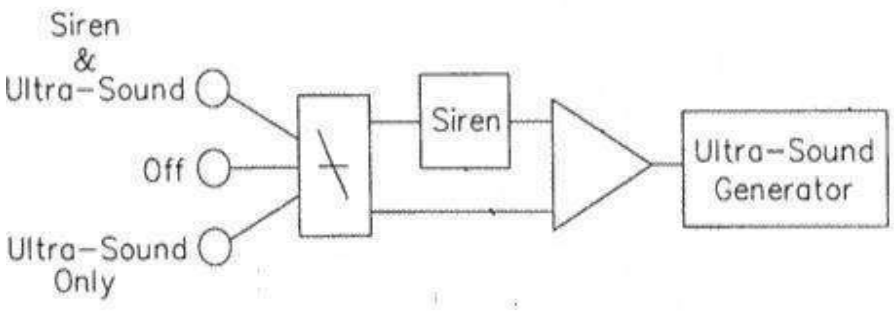


Fig. 1.0: block diagram

W. L. Mitchell has designed a traffic light control system which had overcame the traffic congestion problem and provided an emergency path for the emergency vehicle where the radio transmitter and antenna placed on the emergency vehicle. The radio will transmit the signal to theother vehicle that nearby. The radio receiver had been placed at four junction traffic light will receive the emergency signal from emergency vehicle that passed by the junction. The first signal code contains a frequency for emergency vehicle while the second signal code contains a frequencyfor other vehicle. The transmitted signals provide miscellaneous traffic light pole in normal condition or emergency. The radio will transmit the signal to the other vehicle that nearby. The radio receiver had been placed at four junction traffic light will receive the emergency signal fromemergency vehicle that passed by the junction. The radio receiver had been placed at four junction traffic light will receive the emergency signal from emergency vehicle that passed by the junction When the receiver received the signal from emergency vehicle transmitter, traffic light system for emergency vehicle will be activated.W. E. Brill introduced an

emergency vehicle detection system for alerting a driver of an approaching emergency vehicle includes a sound signal-producing unit mounted on an emergency vehicle, a sound signal detection unit mounted on a non-emergency vehicle, and a display unit remotely located on the non-emergency vehicle.

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 emergencyvehicles 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.

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 intersections.

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 controlof 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.

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 trafficlights in the path of the ambulance and thus minimizing the delay caused by traffic congestion. The system usestwo 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.

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.

3- HardwareRequirements

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

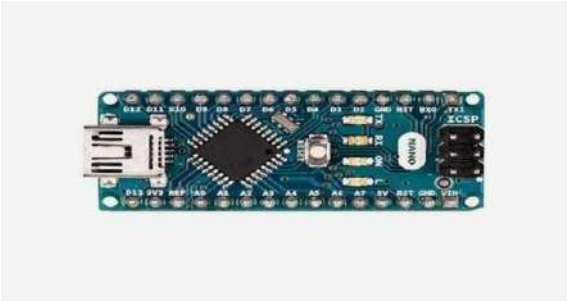


Fig 2.1: Arduino Nano

The Arduino nano is a micro controller board based on the ATmega328.It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, anICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The nano differs from all preceding boards in that it does not use the FTDI

USB-to-serial driver chip. Instead, it features the Atmega16U2(Atmega8U2 up to version R2) programmed as a USB-to-serial converter.The Arduino Nano is much smaller than the Arduino Uno, making it ideal for projects with limited space.The Arduino Nano is powered by the **ATmega328**, an 8-bit AVR micro controller from Atmel (now part of MicrochipTechnology). It has a rich set of features suitable for a variety of embedded
applications.

POWER

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery.The board can be powered via USB or an external power source (VIN pin). It features a voltageregulator to ensure stable 5V operation from an input voltage ranging from 7 to 12V. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supplyof 6 to20 volts. If supplied with less than 7V, however, the 5V pin may supplyless thanfive volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7to12 volts. The power pins are as follows **VIN.**

The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You cansupply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin of 5V Additionally, it has 8 analog input pins, allowing it to read datafrom analog sensors like temperature sensors, potentiometers, or light sensors.

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 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pinsbypasses the regulator, and can damage your board. We don't advise it.

3V3. A 3.3-volt supply generated by the on-board regulator. Maximum currentdraw is 50 mA.

GND. Ground pins.

IOREF. This pin on the Arduino board provides the voltage reference with which the micro controller operates. A properly configured shield can read theIOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

MEMORY

The ATmega328 has 32 KB (with 0.5 KB used for the boot loader). It also has2 KBof SRAM and 1 KB of EEPROM (which can be read and writtenwith the EEPROMlibrary). EEPROM is used for storing data that needs to persist across power cycles, such as configuration settings or sensor calibration data.It allows for limited write cycles, so it’s typically used for storing data that doesn’t change frequently.

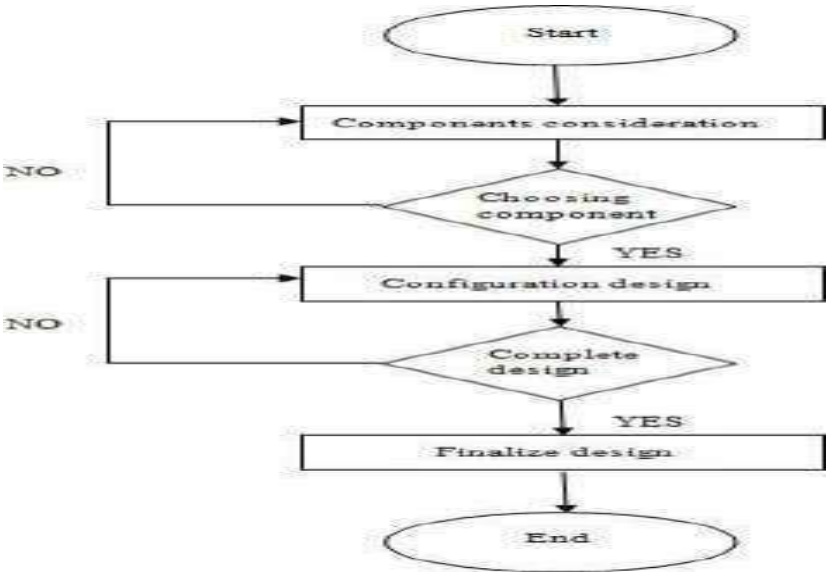
RF Module

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 ofmodulation 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 stronger andmore reliable than IR transmission.

RF communication uses a specific frequency unlike IR signals which are affectedby other IR emitting sources. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) 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.

LED's are usually built on an n-type substrate, with an electrode attached to the p-type layer deposited on its surface. P-type substrates, while less common, occur as well. Many commercial LEDs, especially GaN/InGaN, also use sapphire substrate.

Flowchart



4- Traffic Light Control System For Emergency Vehicles usingRF Technology

Overpopulation is one of the biggest problems in the world today. The earth populationin 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%.

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 phenomenalgrowth 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 invehicles, 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 journeyspeeds 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.

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 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.

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 ambulancesystem to utilize each and every second efficiently to save the life of a person. The ambulanceonce 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. The proposed system overcomes every problem that are faced in the existing system. It uses RF wireless technology. It is a form of wireless communication which uses radio waves to identify.

Block Diagram

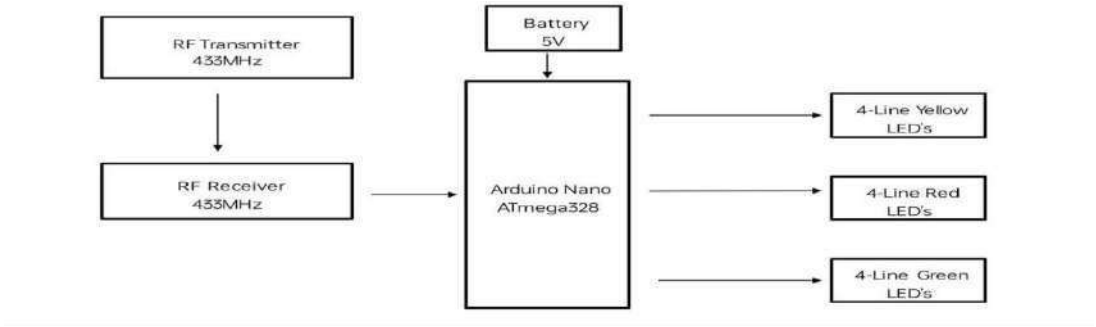


Fig 3.2 :Block Diagram of Traffic Light control System using RF Technology

The Arduino Nano is a small, compact microcontroller board based on the ATmega328Por ATmega168 microcontroller, making it suitable for embedded systems and IoT projects. It is a smaller version of the Arduino Uno but with the same functionality.

4-Methodology

1. System Design

- RF Transmitter: Installed in emergency vehicles to send signals.
- RF Receiver: Placed at traffic signals to receive signals from the transmitter.
- Micro controller: Processes the received signals and controls the traffic lights.

2. Signal Transmission

- When an emergency vehicle approaches an intersection, the RF transmitter sends asignal to the RF receiver at the traffic light.

3. Signal Reception and Processing

- The RF receiver detects the signal and sends it to the micro controller.
- The micro controller processes the signal and determines the appropriate action (e.g.,changing the traffic light to green).

4. Traffic Light Control

- The micro controller changes the traffic light to green, allowing the emergencyvehicleto pass.
- After the vehicle has passed, the traffic light returns to its normal operation.

5. System Integration

- Integrate the RF-based control system with existing traffic management systems for seamless operation.
- Ensure the system is scalable and can be expanded to cover more intersections.

6. Testing and Validation

- Conduct thorough testing to ensure the system works reliably under various conditions.
- Validate the system's performance in real-world scenarios to ensure it effectivelyreduces response times for emergency vehicles.

5- Result And Discussion

In this chapter, we will discuss about the results of the traffic light control system for emergency vehicles using radio frequency technology. This project is divided into two parts of electronic circuit. First part is the RF transmitter circuit which can override the sequence of the traffic light. Meanwhile, the second part is the RF receiver and the micro controller circuit that generate the traffic light sequences for a four-traffic lights intersection.

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 signalintersection. The three LEDs are powered by Arduino Uno using jumper wires from the Arduino board to the breadboard where the LEDs 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

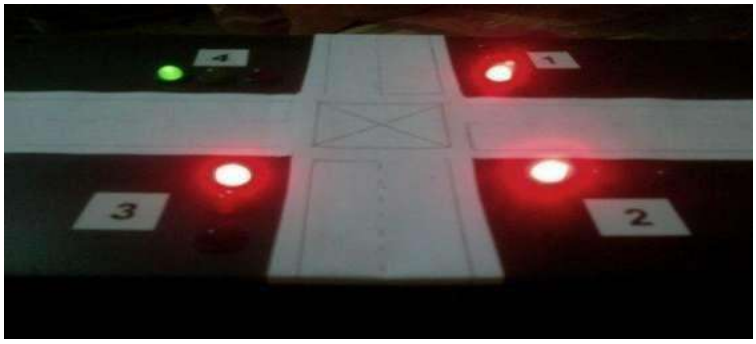


Fig5. 1:Green light of traffic light 4 is on for 2 seconds

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 yellowis set at 5 seconds.

The Fig. 5.1,5.2 & 5.3 represents the simulation of traffic light for yellow, red and green LEDs respectively.

A traffic light control system for emergency vehicles using RF technology works by enabling the vehicle to send a unique radio frequency signal to traffic lights as it approaches an intersection. The emergency vehicle is equipped with an RF transmitter, while the traffic lights have RF receivers.

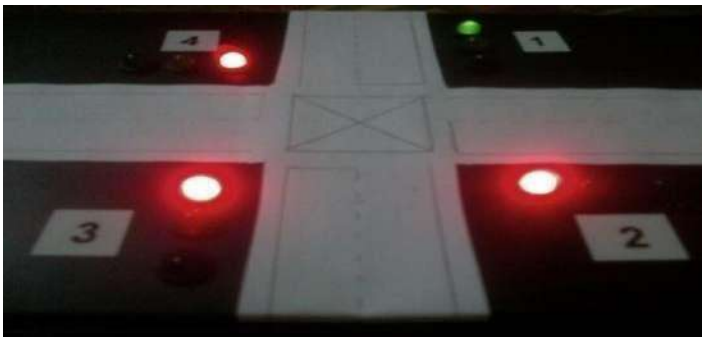


Fig 5.2 sequence of the traffic light is back to normal

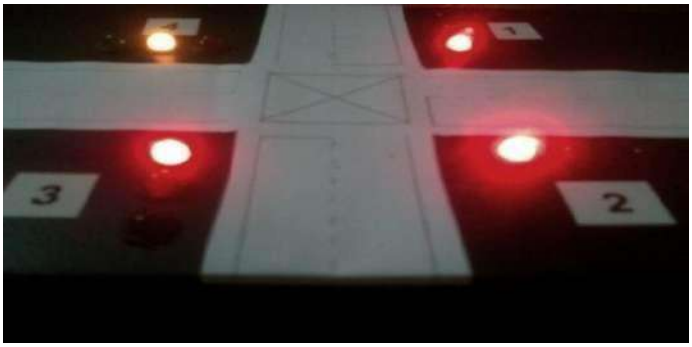


fig 5.3 Yellow light of traffic light 4 is on for 2 seconds

The emergency vehicle is equipped with an RF transmitter, while the traffic lights have RF receivers. When the receiver detects the signal from the approaching vehicle, it overrides the normal light sequence and switches the light in the vehicle's direction to green, ensuring a clear path. Once the emergency vehicle passes, the traffic light reverts to its normaloperation, allowing regular traffic to resume. This system ensures faster and safer passage foremergency vehicles through intersections.

A traffic light control system for emergency vehicles using RF technology prioritizes the passage of emergency vehicles at intersections. The emergency vehicle sends a unique RF signal via a transmitter, which is detected by RF receivers installedat traffic lights. Upon receiving the signal, the system overrides the normal traffic light sequence, turning the light green for the emergency vehicle and red for other directions, ensuring a clear and safe route. Once the vehicle passes, the system restores the traffic lights to their normal operation, minimizing delays and improving emergency response times.

The system successfully prioritizes emergency vehicles, reducing delays at intersections. As a result, emergency vehicles can pass through green lights, cutting down on response times significantly, especially in urban areas with high traffic volumes.The real-time communication between emergency vehicles and traffic lights ensures that regular traffic is stopped in controlled manner, preventing bottlenecks or erratic stops that might otherwise occur when emergency vehicles pass through intersections. Traffic congestion is minimized as the system intelligently returns to regular operation after the emergency vehicle has passed.By providing clear, advanced signal changes, the risk of accidents involving emergency vehicles and other road users is greatly reduced.The system ensures that other drivers are aware of the emergencyvehicle's presence and that they are safely halted by the traffic lights before the vehicle crossesthe intersection. The RF technology is integrated into existing traffic control infrastructure with minimal additional hardware. This reduces installation costs and avoids the need for complex overhauls. The system's simple design using RF modules ensures compatibility with existing control systems.

6- Conclusion

As a conclusion, this project has achieved the main objective stated earlier which is analyzing and implementing the wireless communication; the radio frequency (RF) transmission in the traffic light control system for emergency vehicles. The prototype of this project is using the frequency of 434 MHz compared to the range of about 3 kHz to 300 GHz of frequency which have been reserved for the RF theoretically. Besides, the functionality of this project proved that the other objectives have been successfully attained which are designing an emergency sequence mode of traffic light when emergency vehicles passing by an intersection and changing the sequence back to the normal sequence before the emergency mode was triggered. The sequences for this project have been developed using the programming in the microcontroller PIC 16F877A. In future, this prototype system can be improved by controllingthe real traffic situation and the study can be done by investigating the length, reception and transmission issue for the system to be operated with this traffic light system. 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 systemis implemented, realized electronically, and tested to ensure complete validation of its operations and functions.

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