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RADIO FREQUENCY SIGNAL BASED TRAFFIC LIGHTCONTROL SYSTEM FOR EMERGENCY VEHICLES

A. SRINIVASA RAO [1], Y. HARSHAVARDHAN [2], J. MANASA KALYANI [2], R. RAMYA [2], V. V. LIKHITHA VAISHALI [2], P. SRAVANI [2]

[1] *Associate Professor, ECE department, PBR Visvodaya Institute Of Technology & Science, Kavali, Andhra Pradesh, India.*
[2] *UG students, ECE department, PBR Visvodaya Institute Of Technology & Science, Kavali, Andhra Pradesh, India.*

ABSTRACT

Traffic congestion problem is a phenomena which contributed huge impact to the transportation system in country. This causes many problems especially when there are emergency cases at traffic light intersections which are always busy with many vehicles. A traffic light controller system is designed in order to solve these problems. The system is proposed to operate, when it receives signal from emergency vehicles based on radio frequency (RF) transmission.

The proposed system includes a mechanism with an automatic traffic light controlling system to overcome this delay of first aid service. An ambulance can thereby easily find a freeway to reach the victim in a minimal time and thereby providing first aid as soon as possible. This is possible by using an RF transmitter on the ambulance which will communicate with the RF receiver mounted on the signal post in the traffic control system. To control the traffic signals automatically, and to move towards the location in minimal time. Thus, the traffic light gets controlled by the intelligent ambulance itself, in such a way that it could provide free path to the ambulance.

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Keywords: wireless network, Arduino Uno Board, receiver, traffic control and transmitter.

1. INTRODUCTION

Each day, our lives become more dependent on 'embedded systems', digital information technology that is embedded in our environment. More than 98% of processors applied today are in embedded systems, and are no longer visible to the customer as 'computers' in the ordinary sense. An Embedded System is a special-purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Unlike a general-purpose computer, such as a

personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, benefiting from economies of scale. The increasing use of PC hardware is one of the most important developments in high-end embedded systems in recent years. Hardware costs of high-end systems have dropped dramatically as a result of this trend, making feasible some projects which previously would not have been done because of the high cost of non-PC-based embedded hardware. But software choices for the embedded PC platform are not nearly as attractive as the hardware.

Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Virtually all appliances that have a digital interface -- watches, microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an operating system, but many are so specialized that the entire logic can be implemented as a single program.

Physically, Embedded Systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants.

In terms of complexity embedded systems can range from very simple with a single microcontroller chip, to very complex with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

Embedded system is defined as, for a particular/specific application implementing the software code to interact directly with that particular hardware what we built. Software is used for providing features and flexibility, Hardware = {Processors, ASICs, Memory} is used for Performance (& sometimes security).

The versatility of the embedded computer system lends itself to utility in all kinds of enterprises, from the simplification of deliverable products to a reduction in costs in their development and manufacture.

Complex systems with rich functionality employ special operating systems that take into account major characteristics of embedded systems. Embedded operating systems have minimized footprint and may follow real-time operating system specifics.

The special computers system is usually less powerful than general-purpose systems, although some expectations do exist where embedded systems are very powerful and complicated. Usually, a low power consumption CPU with a limited amount of memory is used in embedded systems. Many embedded systems use very small operating systems; most of these provide very limited operating system capabilities.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Some embedded systems have to operate in extreme environment conditions such as very high temperature & humidity. For high volume systems such as portable music players or mobile phones, minimizing cost is usually the primary design consideration. Engineers typically select hardware that is just "good enough" to implement the necessary functions. For low volume or prototype embedded systems, general purpose computers may be adapted by limiting the programs or by replacing the operating system with a real-time operating system.

The use of personal vehicles is very common now a days and a result, the number of vehicles on the roads are exponentially increasing. Roads without any supervision or guidance can lead in to traffic congestions and accidents. Traffic Lights or Traffic Signals are signalling devices that are used to control the flow of traffic. Generally, they are positioned at junctions, intersections, 'X' roads, pedestrian crossings etc. and alternate the priority of who has to wait and who has to go. The traffic lights will provide instructions to the users (drivers and pedestrians) by displaying lights of standard colour. The three colours used in traffic lights are Red, Yellow and Green.

The system must be used to control the traffic lights for smooth and safe movement of traffic. These control systems consists of electro mechanical controllers with clockwork mechanisms or modern solid state computerized systems with easy setup and maintenance. Traffic lights, also known as traffic signals, traffic lamps, signal lights, robots are signaling devices positioned at or near road intersections, pedestrian crossings and other locations to control competing flows of

traffic. Traffic lights were first installed in 1868 in London, United Kingdom; now used in almost every city of the world. Traffic lights alternate the right of way accorded to road users by displaying lights of a standard colour (red, yellow/amber, and green) following a universal colour code (and a precise sequence to enable comprehension by those who are colour blind).

In many countries, crowds in the area of traffic lights pose a challenge. The increase in the number of vehicles not only affects the environment but also the loss of life and time. In addition, it can cause losses in terms of productivity, which will affect the city's ability to compete globally. In these situations, a better approach is needed to deal with the situation, especially for emergencies such as ambulances, fire-fighters, and emergency policies. A system is needed to control signals at traffic light junctions in an emergency. Numerous research been conducted on traffic signal control for ambulances. Among them, an intelligent traffic signal control using radio frequency (RF) and cloud system has been developed. The system uses Android applications that connect traffic stations and ambulances using the cloud network.

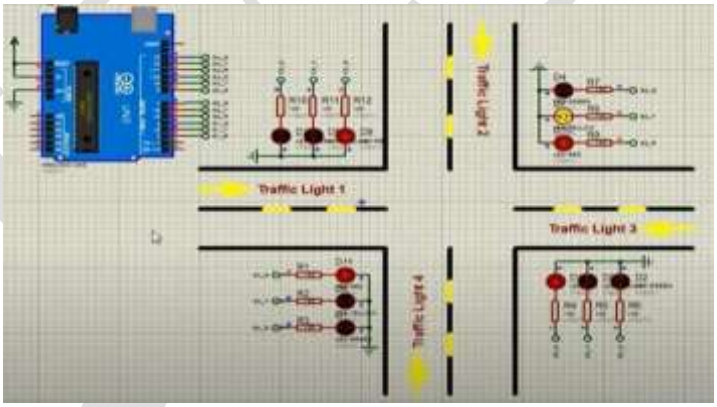

Figure 1.1. Schematic of proposed system at receiver end

In addition, there are researches that used Arduino and mobile applications in systems designed with the advantage of the Internet of Things (IOT). Especially, system for ambulances that can send information to patients in hospitals and at the same time can control traffic lights using the Global System for Mobile system.

After that, the Global Positioning System (GPS) equipped in the ambulance is used to find the operating ambulance unit and Radio frequency transmitter. The system used includes a variety of applications, but this cheap solution involves many

technologies in one system.

Therefore, many methods and techniques can be used to detect and control traffic light control so that there is no tension during the situation when emergency vehicles such as ambulances, fire-fighters, and police are present during their operations. This system is necessary for the safety of emergency persons and other road users so that no road accident occurs.

In today's real world even in increase of vehicles growth, traffic signals are programmed and still running on fixed timers which will does not vary based on the volume of vehicle accumulation at junction. Due to this scenario, there will be a chance of increased waiting time. As no provisions are available with present traffic monitoring system for getting any information about vehicles. Because of this it will become very difficult to track vehicle and to control signals. So, it creates complexities in emergency situations to minimize delay time of emergency vehicle and may put lives at risk.

The basic idea behind the proposed system is, if any emergency vehicles halts on the way due to heavy traffic congestion, 433MHz RF installed at the traffic signal (RF Receiver) to detects the vehicle (RF Transmitter) and sends the data to the Arduino Uno microcontroller (Atmega 328P). The controller IC used here operates the traffic light according to the received data from receiver. Then the particular signal is made Green for some time, till the vehicle passes by the signal and it regains back to its original flow of signalling sequence. This system sends commands to microcontroller for controlling the traffic lights and reduces delay time in emergency periods. Thus, it acts as a life saver project.

2. EXISTING SYSTEMS:

Traffic congestion is an over-growing problem across world as increasing rate of population, automobiles usage which is proportional to it will also increases without any road infrastructure development. Due to this there will be a chance of high accumulation of vehicles at every traffic junction and during rush-hours it results in high congestion compared to normal times. Because of these situations which creates complexities for flow of emergency vehicles in busy-hours and it raise to putting person who are having need of emergency vehicle into critical stage.

Since inefficiency of effective traffic system results in huge economic loss. It will also return loss of human lives. So, a great work has been done to deal with these problems.

➢ According to IEEE paper published on Intelligent Traffic Control System using IR sensors (2009) determines vehicle monitoring and density of vehicles on road. The volume of vehicles will be calculated based on data received from IR sensors and sets the operating time of traffic lights.

➢ A paper is published by Dr. R. S. Deshpande, J. G. Rana on Traffic Control System Based on Embedded Technology (2012). This paper uses sensor nodes and networks in addition to embedded technology to manage traffic congestion through communication between every junction and controls congestion based on information received from other previous junctions.

➢ According to proposed method of Chakkaphong Suthaputchakun, Zhili Sun and Mehrdad Dianati the system will display status of traffic lights in advance to all emergency vehicles. So that driver of vehicle can move down the junction according to the received status. But there may be a chance of occurrence overspeed concept results in accidents.

➢ Rajeshwari Sundar, Santhoshs Hebbar, and Varaprasad Golla proposed Traffic Control System for Emergency Vehicle Clearance and Stolen Vehicle Detection. This system uses RFID readers and RFID tags (2015).

➢ Prajakta Waghere, Priyanka Nalawade, Nisha Vanare, Prajakta Kalbhor, Prof.A.J.Jadhav published IJARSE paper on Dynamic Traffic Control System using RFID technology (2017). It uses IR sensors, microcontroller for controlling traffic flow based on status of IR sensors. This paper deals with decision making algorithm (DMA). So, system flow is designed based on this algorithm do not use abbreviations in the title or heads unless they are unavoidable.

3. PROPOSED SYSTEM:

3.1 OBJECTIVE OF PROPOSED SYSTEM

In this paper, an Arduino based Traffic Light Controller system is designed.It is a simple implementation of traffic lights system based on 433 MHz RF

Transmitter and receiver Module. The main methodology of proposed model is to allow clear flow of vehicles for preventing emergency vehicles from traffic congestion during emergency situations. As the existing model is inefficient to solve congestion controlling for priority vehicle clearance. So, this paper illustrates "Radio frequency signal based traffic light control system for emergency vehicles". The architecture of proposed system is as shown in figure 3.1.

3.2 BLOCK DIAGRAM OF THE PROPOSED SYSTEM

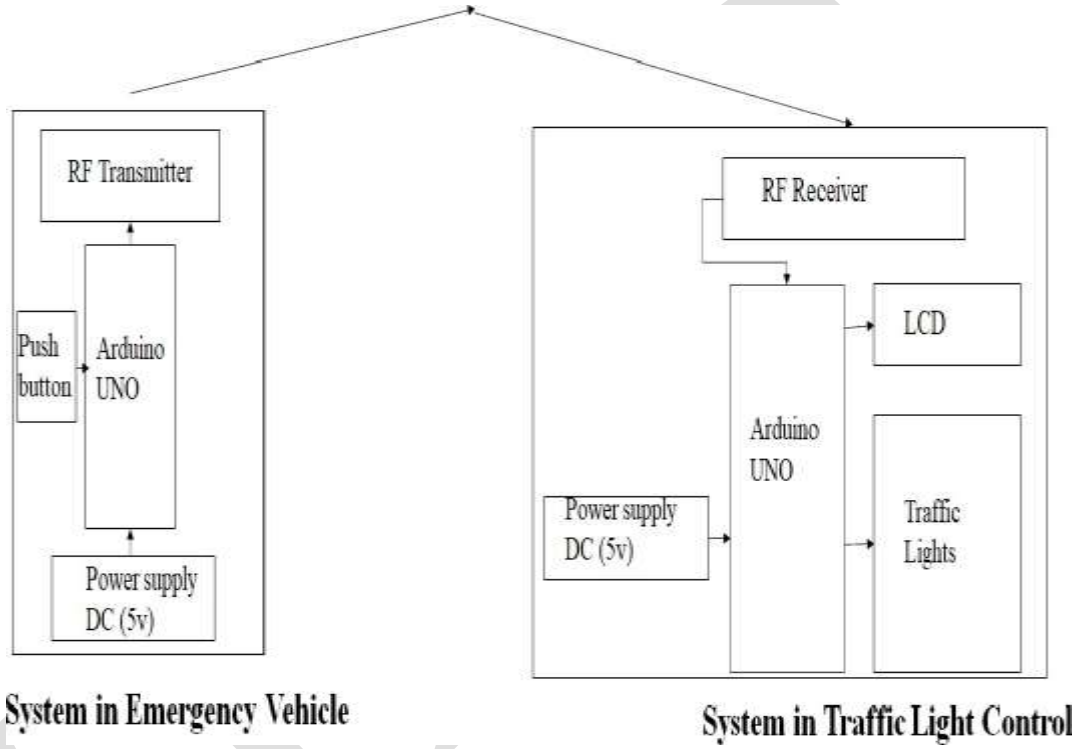

Figure 3.1 Block diagram of the proposed System

This system consists of main components that play a vital role in the transmission and reception of signals. They are discussed below

Encoder:

An entity or device which will encode information in several ways such as compressing, converting or securing it into a different format is known as Encoder.

Decoder:

Decoder puts back together all the pieces of data up which are essentially scrambled into pieces by the encoding process.

RF Transmitter and Receiver Module:

RF Transmitter and receiver module is used in this proposed work to implement wireless communication.

SMPS (Switched Mode Power Supply):

Switched Mode Power Supply (SMPS) is the most following method for DC power supply in a modern system, mainly for its capability to handle fluctuating loads. This is becoming a great area of concern, apart from the efficiency of the size and weight of the power supplies. A list of RF ranges with different frequency rates are tabulated in Table 3.1.

Table 3.1 RF Frequency Ranges

Designation	Frequencies	Wavelengths
Very Low Frequency	3 kHz- 30 kHz	(100 – 10) km
Low Frequency	30 kHz- 300 kHz	(10 - 1) km
Medium Frequency	300 kHz - 3 MHz	(1 – 100) m
High Frequency	3 MHz - 30 MHz	(100 - 10) m

The basic diagram shown in figure 3.1 is that the general arrangement of the components or parts of a complex system or method, such as industrial equipment or an electronic circuit. The method concerned in traffic light management which has acquisition, analysing and signal processing that is explained each and every component in below chapter.

4. PROPOSED SYSTEM REQUIREMENTS:

HARDWARE COMPONENTS REQUIRED

- Microcontroller (ARDUINO UNO BOARD)
- 433 M Hz RF Modules
- 16X2 LCD
- Switches
- Traffic Lights
- Miscellaneous

4.1 ARDUINO UNO BOARD:

It is a simple microcontroller board. It is an Open-Source computing platform and has an environment for developing software for the Arduino board. It can be used to make computers. It is used to create interactive projects. It takes input from sensors or switches and controls the outputs. Arduino boards are inexpensive compared to other microcontroller based devices. It can stand-alone or can communicate with the software of the computer.

Arduino software can run on Windows, Linux and Macintosh OSX. It provides an Integrated Development Environment (IDE) which is written on Java for programming microcontrollers. It supports C, C++ programming languages. So, anyone who knows the basic programming C can easily access Arduino IDE. It is very simple. Arduino has built-in functions. It can access serial port.

Figure 4.1 Arduino UNO Board

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in Arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 Kilo ohms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

4.2 433 MHz RF MODULES

The 433 MHz RF transmitter and receiver module is a pair of small RF (i.e. radio-frequency) electronic modules used to send and receive radio signals between any two devices. The transmitter module sends the data from the transmitter end and the Receiver module receives that data at the receiver's end.

Figure 4.2 shows is a transmitter among two. It is really simple as it looks. The heart of the module is the SAW resonator which is tuned for 433 MHz operation. There is a switching transistor and a few passive components, that's it. When a logic HIGH is applied to the DATA input, the oscillator runs producing a constant RF output carrier wave at 433 MHz and when the DATA input is taken to logic LOW, the oscillator stops. This technique is known as Amplitude Shift

Keying, which we will discuss in detail shortly.

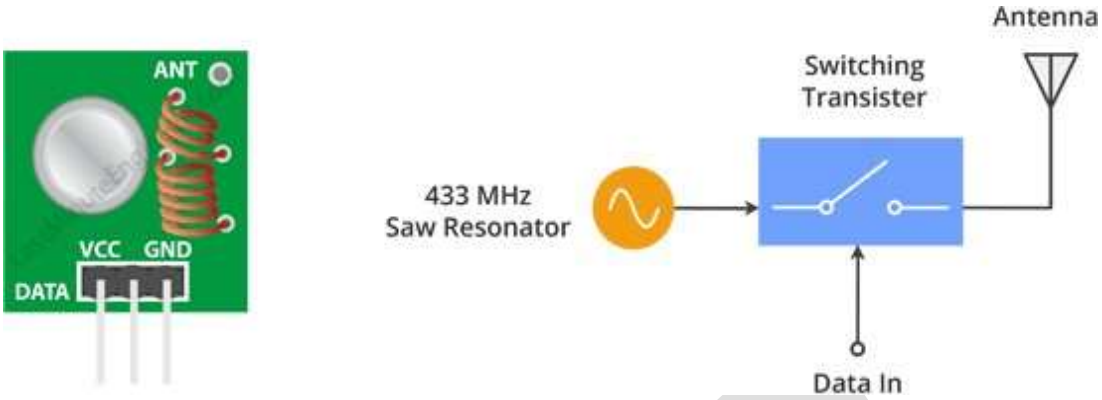

Figure 4.2 RF transmitter

Figure 4.3 shows a receiver module. Though it looks complex, it is as simple as the transmitter module. It consists of a RF tuned circuit and a couple of OP Amps to amplify the received carrier wave from the transmitter. The amplified signal is further fed to a PLL (Phase Lock Loop) which enables the decoder to "lock" onto a stream of digital bits which gives better decoded output and noise immunity.

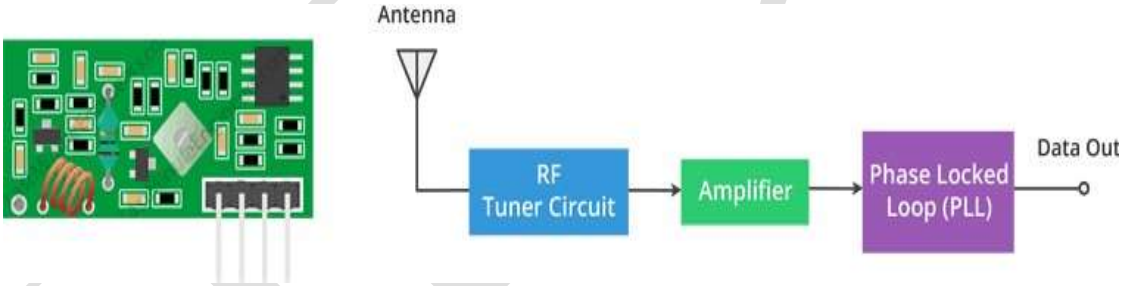

Figure 4.3 RF receiver module

As discussed above, for sending the digital data over radio, these modules use a technique called Amplitude Shift Keying or ASK. In Amplitude Shift Keying the amplitude (i.e., the level) of the carrier wave (in our case it's a 433MHz signal) is changed in response to the incoming data signal.

4.3 16X2 LCD

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome. LCDs are

available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock.

Figure 4.4 16x2 LCD Display

Since LCD screens do not use phosphors, they rarely suffer image burn-in when a static image is displayed on a screen for a long time, e.g., the table frame for an airline flight schedule on an indoor sign. LCDs are, however, susceptible to image persistence. The LCD screen is more energy-efficient and can be disposed of more safely than a CRT can. Its low electrical power consumption enables it to be used in battery-powered electronic equipment more efficiently than a CRT.

4.4 SWITCH

A Push Button switch is a type of switch which consists of a simple electric mechanism or air switch mechanism to turn something on or off. Depending on model they could operate with momentary or latching action function. The button itself is usually constructed of a strong durable material such as metal or plastic. Push Button Switches come in a range of shapes and sizes. We have a selection of push button switches here at Herga. Push button switches are used throughout industrial and medical applications and are also recognizable in everyday life.

Figure 4.6 6-Pin ON/OFF Switch

An example of a pull-down resistor in a digital circuit is shown in the following figure. A pushbutton switch is connected between the supply voltage and a microcontroller pin.

5. FLOWCHART AND WORKING PROCEDURE:

The below Figure 5.1 depicts the working process of the project. The entire working process is illustrated in the form of flowchart which explains each and every operation to be performed by the 433 MHz RF module from starting.

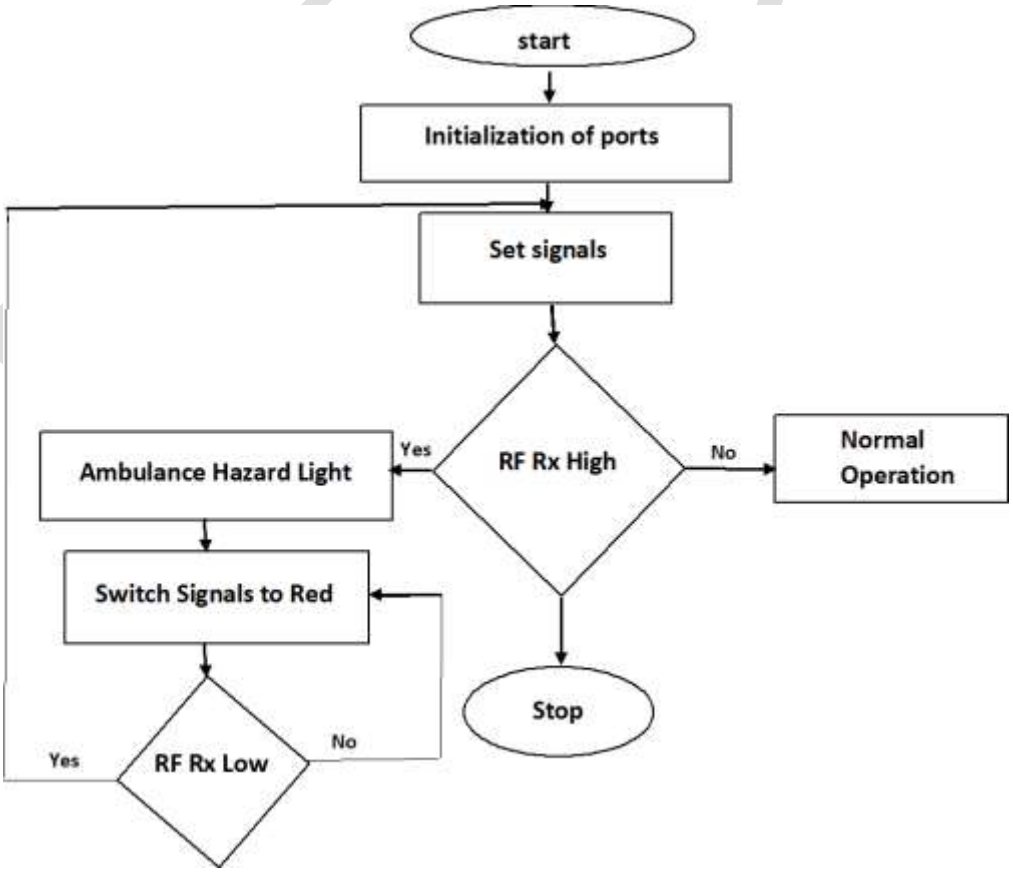

Figure 5.1 Flowchart of the proposed system

5.1 WORKING

In this project, the first step is transmitting the signal from the motorcar. It ought to be simply actuated by the driver who is driving the passenger to the hospital that the transmitter trigger switch is connected on to the siren switch. Therefore, whenever the driver activates the siren, it'll mechanically trigger the transmitter.

Once the transmitter is triggered it'll begin transmission 434 MHz signals. The transmitter is supplied with an encoder IC. The encoder starts operating with a low signal on the TE pin by Transmitting ‘a’. When a signal ‘a’ is received in decoders of receiver to Arduino and it will switch on the desired traffic lights in a Lane. Similar for all the possible cases. This model utilizes the RF module (Tx/Rx) which is employed to drive output from a faraway place.

The RF module uses radio frequency to send signals. These signals are transmitted at a specific frequency and a baud rate based on the necessity. The corresponding frequency range varies from 30 kHz to 300 GHz. In the RF system, the digital data that is transmitted is drawn because of the variations within the amplitude of the radio wave. This sort of modulation used here is thought of as Amplitude Shift Keying (ASK).

Transmission through Radio Frequency is best than Infrared as a result of several reasons. Signals through RF will travel larger distances by creating it appropriate for long-range applications. Whereas IR is generally operated in line-of-sight mode, RF signals will travel even once there's an obstruction between transmitter & receiver. Next, RF is a lot of robust and reliable for transmission. RF communication uses a specific frequency for applications.

The transmitter/receiver (Tx/Rx) pair operates at a frequency of 433MHz. The RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The parallel to serial data conversion is finished the Encoder. The transmission rate is of 1Kbps - 10Kbps. The transmitted data is received by an RF receiver in operation at a constant frequency as that of the transmitter and it's decoded.

Table 5.1 Traffic Light Sequence in the Proposed System

LED's /LANE NUMBER	LANE1	LANE2	LANE3	LANE4
RED	0	1	1	1
YELLOW	0	0	0	0
GREEN	1	0	0	0

6. RESULTS AND DISCUSSIONS:

The system working has successfully designed and verified from the truth table given above considering the ambulance is arriving in the first lane. The indication was provided with the help of triggered emergency hazard light in the signal poles, for indicating about the ambulance arriving lane. The remaining signals were at a low state which indicates the red light in the traffic signal. The prototype of the proposed model uses the frequency 434MHz which will fall under the frequency margin of 3KHz to 300GHz.The output describe that the desired objectives has been attained. We managed to control an emergency vehicle at distances 100m to 1Km based on the densities of traffic in the different cities far from the traffic signal. Based on the datasheet from the RF frequency range we have been able to achieve the prototype by using RF of suitable frequency.

Figure 6.1 Working model of proposed system

The figure 6.1 shows the working model proposed system, which contains system at control room and system at vehicle end. In this proposed system we used 433MHz RF transmitter and receiver to communicate the signals.

In transmitter section we used control switch as input signal. The RF signals are encoded by the encoder and later encoded signals are transmitted through the transmitter. The RF Transmitter is interfaced to microcontroller in the emergency vehicle and which is shown in below figure 6.2. The RF Receiver is interfaced to microcontroller in the control room and which is shown in below figure 6.3.

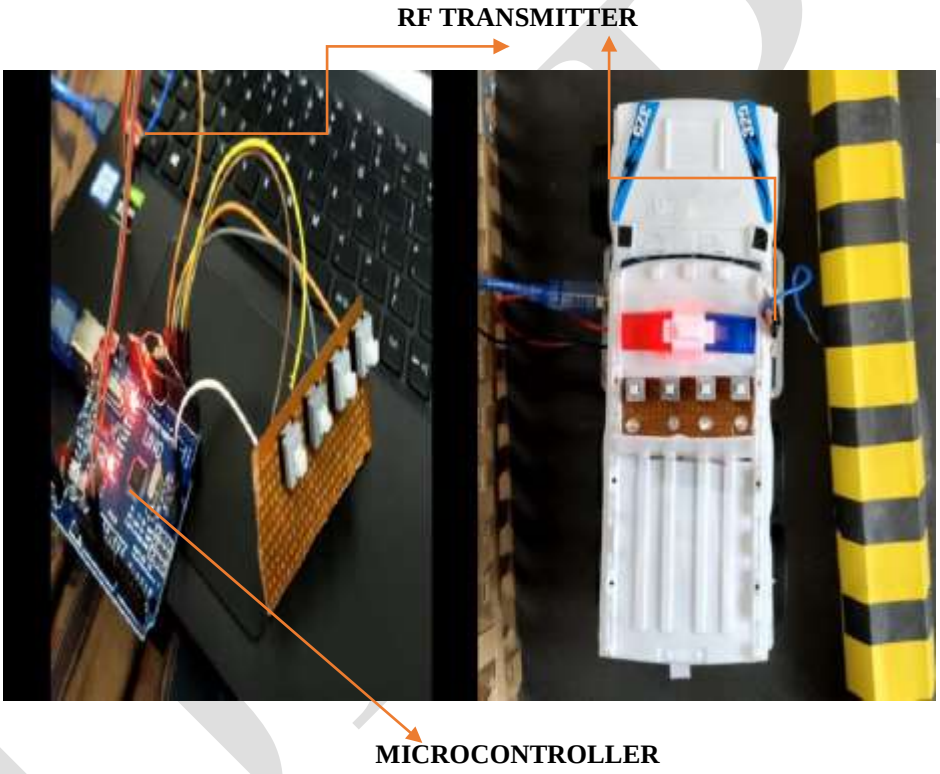

Figure 6.2 System at vehicle with RF Transmitter

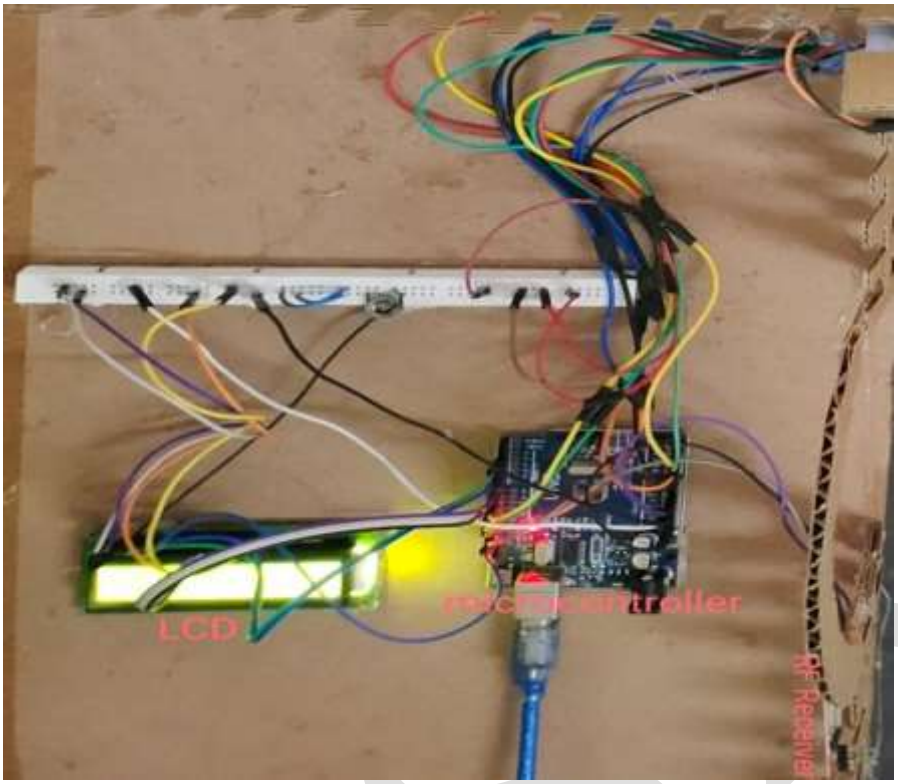

Figure 6.3 System at control room with RF Receiver

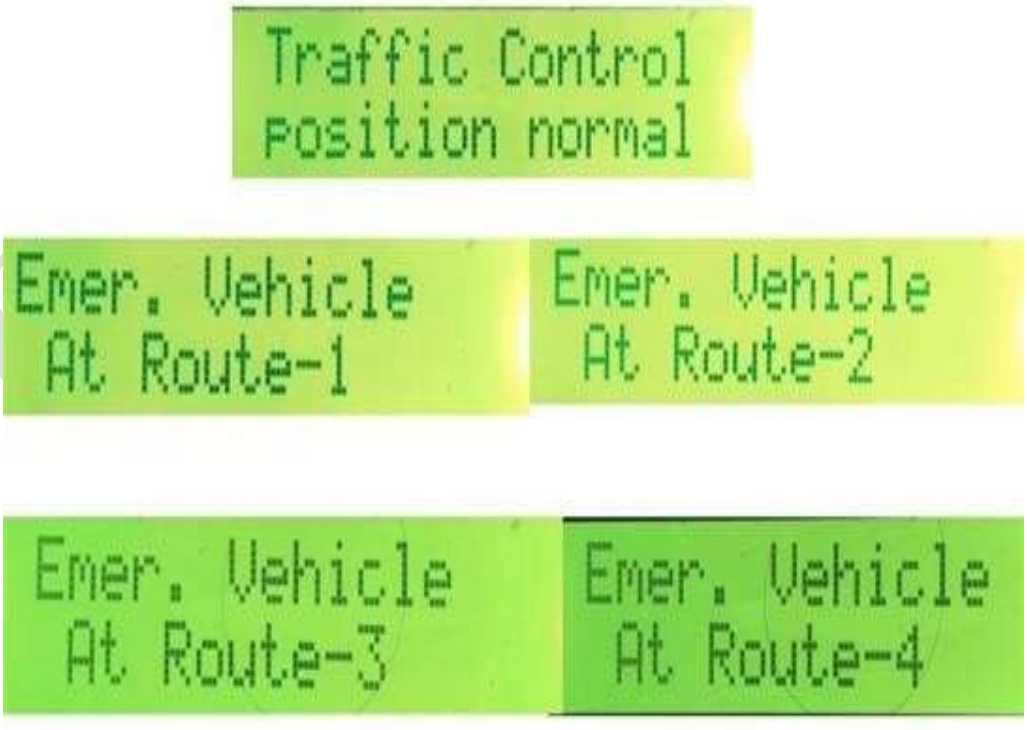

Figure 6.4 Zone Status on LCD, when Control Switch is OFF and ON state

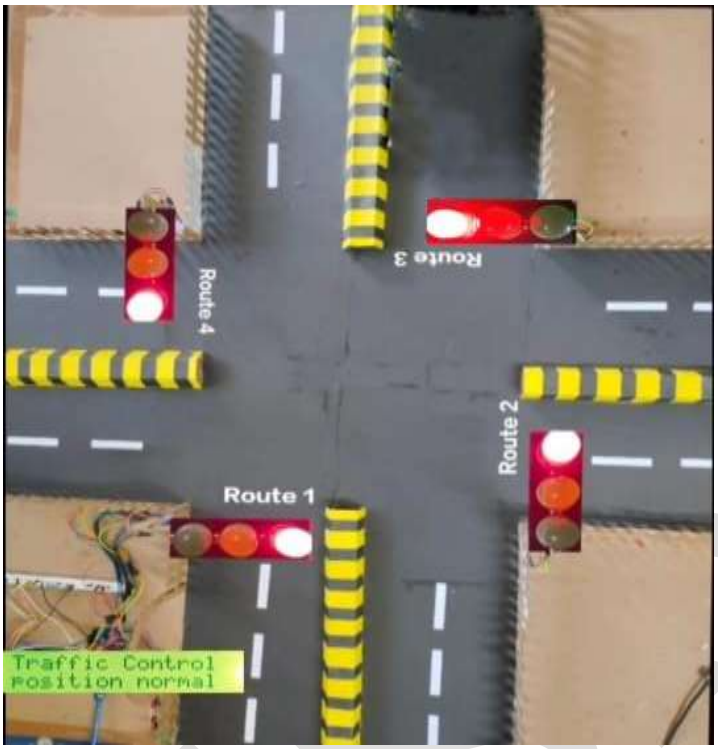

Figure 6.5 when there is no emergency

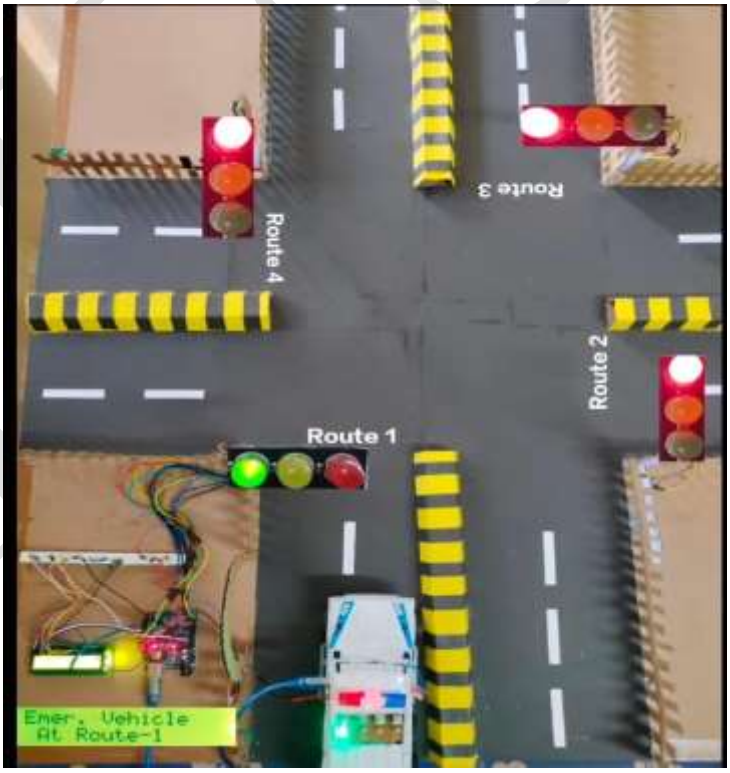

Figure 6.6 when emergency vehicle at route 1

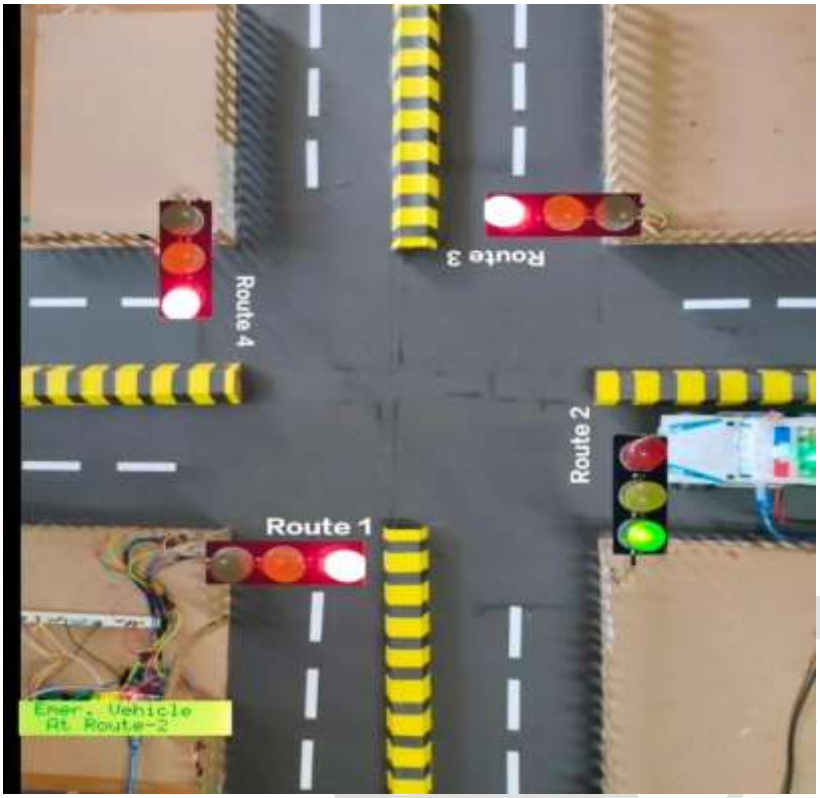

Figure 6.7 when emergency vehicle at route 2

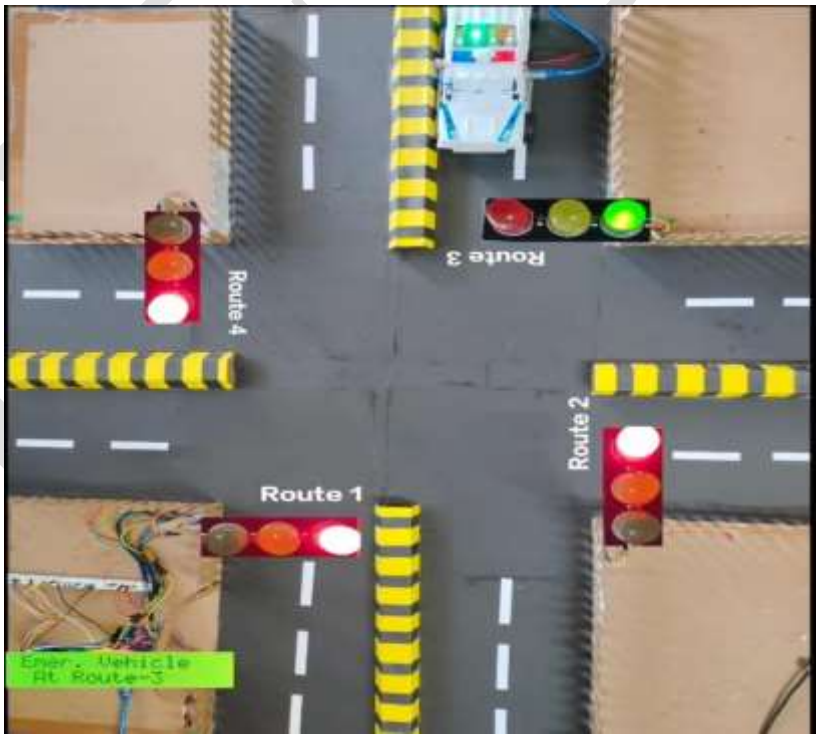

Figure 6.8 when emergency vehicle at route 3

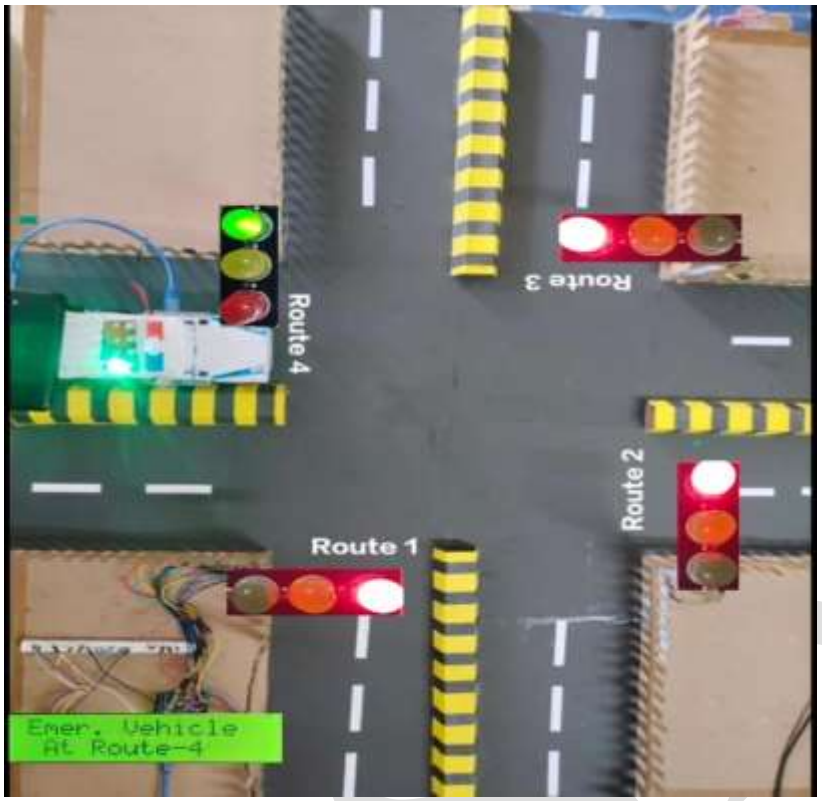

Figure 6.9 when emergency vehicle at route 4

7. CONCLUSION AND FUTURE SCOPE:

Thus, as we stated earlier which is analysing and implementation of the Radio Frequency (RF) transmission in the traffic light control system for emergency vehicles was achieved through this project. The proposed system makes use of the frequency ranging 434MHz which comes under Very Low Frequency Range. Besides, the functionality of the proposed work has successfully cleared the objectives which are designing an emergency sequence mode of traffic light, when emergency vehicles passing by an intersection and changing the sequence back to normal when no emergency exists without causing any disturbance to both the pedestrians and the vehicles in traffic. The prototype sequence of proposed work was developed with the help of an Arduino.

In the future, this prototype can be implemented in real-life traffic scenarios and study can be done by investigating the communication range, reception and transmission issue for the system to be operated with this traffic light system. In real-time, the prototype along with LoRa transceivers can be used for long-range communication without any hindrance and with high accuracy.

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