ARDUINO BASED AUTOMATIC TRAFFIC CLEARANCE FOR AMBULANCE VEHICLE USING RFID

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Abstract

Traffic congestion is the biggest problem faced by densely populated countries like India, China etc. In order to overcome the vital issues of vehicle congestion & time consumption in traffic signals, a new method using IR sensor technology is proposed. The prototype model was developed using IR sensors and Arduino RFID. A congestion control system is developed in such a way that it should be activated when it detect a signal from an ambulance based on Radio Frequency(RF). This work is implemented using Embedded C and is simulated in an Arduino processor kit. This application detects the traffic density by using IR sensors which are arranged on each side of the road. The traffic light controlled by using RFID tags. It is dependent on number of vehicles available on the road. The object detection sensor deployed at the traffic signal path measures the density of the vehicle on the road. Here, a RF Transceiver is used to pass an Ambulance immediately to avoid the queues in traffic. The particular path signal will changes to the Green signal, indicating the ambulance arrival which saves time and lives of people as well.

Keywords: IR sensors, Arduino RFID, RF Transceiver.

1. INTRODUCTION

Population in developing countries such as India, China etc, is increasing significantly. This results in a number of problems such as heavy traffic rules and sometimes even accidents. Additionally, traffic congestion leads to long waiting times, fuel depletion and even money waste. In particular, traffic congestion contributes to high rates of emissions impacting the health of the local population, shuttles and animals. Traffic congestion is often commonly associated with some other traffic issues, such as the blocking of Emergency vehicles. Precisely, the traffic congestion often blocks the path of the emergency vehicles which may Human Life is a very valuable thing for any country [1].

The regular occurrence of incidents and medical emergencies such as Road accidents, Fire accidents and Medical Emergencies etc. It is really necessary that emergency vehicles arrive on time to prevent serious loss of Humans. Thus, hospitals and fire stations are throughout the city to reduce response time in case of such emergencies. A very rapid population growth in cities has resulted in tremendous road traffic within the city. In addition, in recent times the number of deaths due to delays in the arrival of Emergency vehicle has risen to a greater extent. Hence, emergency services such as ambulance and fire engines etc, must be on time to avoid loss of human life [2]. In the current traffic situation, helping an emergency vehicle get out of traffic congestion is very important. Now-a-days, vehicular traffic is increasing throughout the world, especially in urban areas. As the number of road users increases constantly a smart traffic control will become a very important issue in the future. Congestion in traffic is becoming a serious issue. Many vehicles wait at the signal for a long time. Because to this time, consumption is more for the people and there is a lot of problems for the people who go to their work and some of them to business work. The traffic signals are prepared previously fixed for some time only after that time, the signal will be changed to another signal [3].

In some places, traffic lights did not work properly. On the contrary, modern transport is failing to provide a smooth transportation system for the people. The excessive traffic jams affect people, like delays in reaching the

office, home etc. Now-a-days, transportation systems are an essential part of human activities. But, transportation infrastructure in the urban areas is almost saturated due to the lack of land resources, a growing number of vehicles on the road, damages of the road due to increased potholes, pits and so on. Because of this saturation, various traffic-related problems have erupted in the urban areas where people need to move very fast from one place to another [4]. One of the major issues with the public transportation system in recent times is traffic congestion. In general, traffic congestion is also associated with a few more traffic problems, such as emergency vehicles like Ambulance, Fire engine get blocked. Precisely, the traffic congestion often blocks the path of the emergency vehicles which may prove fatal at times. Also, the number of deaths due to the delay in the arrival of emergency vehicles has increased to a greater extent in loss of human life. Thus, helping an emergency vehicle to move out of traffic congestion is very much essential in the current traffic scenario. Therefore, intelligent traffic management has evolved as a compulsory requirement for proper civilization. Current, smart and adaptable traffic control systems are being preferred over fixed time systems in most developing nations [5].

The problem of urban traffic congestion is spreading constantly. The increase in traffic is due to the growing population and number of vehicles. Due to an increase in the population and the increased use of automobiles, it has become a huge challenge for emergency vehicles like an Ambulance to pass through the Traffic Signal. The migration of the population from rural to urban and sub-urban areas makes the conditions more critical. As a result of this, the number of road accidents also increased to a great extent. In order to avoid this excess time consumption, an intelligent traffic control system is used which turns the signal in the path of the Ambulance to green [6]. The IOT in traffic management plays an important role here by collecting data from various sources such as traffic cameras, mobile phones and sensors on the road etc. Traffic IOT provides traffic information collection and incorporative analysis of all categories of traffic information on roads in a large area automatically and intelligently. Modern traffic management is evolving into an intelligent transport system based on IOT. IOT functions in traffic management such as consolidating traffic data coming from different sources, analysing traffic information to provide near real time insights, monitoring traffic operations and supporting the storage, it is represented by a geographic information system. Essential characteristics of IOT such as Dynamic and Self-Adapting, Self-Configuring, Communication protocols, Integrated into Information Network. Traffic congestion has been causing various critical problems and encounters in the major and most populated cities. To travel to different places within the city is becoming more difficult for the travellers in traffic [7].

Technology has been improved and implemented widely and in almost all sectors. A comfortable life is what the people of this century are leading with the help of devices and machines and much more. This increases the number of vehicles on the road, which further hurdles the smooth flow of vehicles on the road. Thus, giving rise to the issue of Traffic Congestion. Traffic Congestion aids road accidents due to irritated drivers. Thus, controlling this issue becomes obligatory to avoid unnecessary accidents[8]. Traffic signaling systems employed are still dependent on trained officers for density based control. This is a tedious job for a person to perform as the traffic congestion is increasing day by day. To ease this, taking the help of technology by using certain devices to understand the traffic conditions and take the necessary decisions to control the situation. The traffic density is detected by the help of sensors whose readings are fed to the microcontrollers that are programmed to take the necessary actions according to the condition of the Traffic Congestion. The emergency vehicles are prioritized on the road, which leads to delay in serving the needs of victims. There are hundreds of cases in which the victim or patient dies on the way to the hospital due to traffic congestion caused on the way to the hospital. Also, there are cases where the emergency vehicles are unable to reach the place on time when the accident has occurred. Thus, to avoid this scenario we need to prioritize the emergency vehicles on the roads, so that they reach the needy at the right time to serve them better [9,10].

Every year, many people die, lose their lives, and are exposed to permanent injuries or physical disabilities due to road accidents, fire accidents etc. This becomes worse in the case of delay in the required assistance from emergency response vehicles such as ambulance vehicles. A steady increase in the metro-city population, the number of automobiles and cars increases rapidly and metro traffic is growing crowded which leads to the Traffic jam problem. Now-a-days, the management of traffic is really inefficient. The major reason for this is because of poor traffic prioritization. Here, in this project we implemented a Smart Technology i.e., by using IR Sensors and RFID tag and reader to pass an Ambulance immediately to avoid queues in Traffic.

2. RELATED WORKS

Many methodologies such as Density based Smart Traffic Light control system, Traffic Control System by using RFID, Smart Traffic control with Ambulance Detection system, Traffic controls for emergency vehicle has been proposed by many authors. A detailed explanation about these methods is as follows.

S.M.Kang et.al.,[11] developed an algorithm for the working of the traffic signal using location based information. In this system, the ambulance gives its location to the nearest traffic signal to control the traffic for clearance of the traffic. Z.Wang et.al.,[12] designed an architecture of the road at the Traffic Signal. Every traffic signal will have a separate road way for the moving of an Ambulance Vehicle to pass from the Traffic Signal at the time of Emergency.

M.E.Ben Akiva et.al.,[13] implemented a system in which it will evaluate the time taken process for the ambulance to cross at the Traffic Signal. And make automatic time levels for the different path ways for changing of signals at the junction. S.R.Samantha et.al., [14] developed a system based on artificial intelligence traffic control system. And also by using of RFID technology, it is implemented in artificial intelligence system for the operation of Traffic Signal. S.H.Kim et.al., [15] they developed a model by using of Global Positioning System. While the ambulance reaches to the hospital it tracks the density of traffic at the traffic signals by using of GPS tracking system. To avoid traffic, the ambulance vehicle uses the GPS technique, for reaching to the Hospital.

M.A.Salahuddin et.al., [16] implemented a system by using of infrared sensors. These sensors works with the more density of vehicles stuck at the particular way at the Traffic Signal. The Ambulance vehicle is stuck at more density of vehicles side, using of this infrared sensors the ambulance vehicle moves from the Traffic signal. W.Wang et.al., [17] developed a system with the artificial intelligence system for clearance of road way for the Ambulance vehicle at the Traffic Signal. R.F.Benekohal et.al., [18] developed an algorithm for the application to run the emergency vehicle at the time of Emergency. They developed a system which is initialized at the vehicle to show the navigation for the vehicle.

W.H.K.Lam et.al., [19] implemented a system in which each individual vehicle is equipped with a special radio frequency identification tag which makes it impossible to remove or destroy. It counts the number of vehicles that passes on a particular path during a specified duration in Urban traffic networks. When less number of vehicles passes at a particular way it gives a red signal to that way and gives the green signal to the highest passing of vehicles at the Traffic Signal. A.Skordylis et.al., [20] they developed a model based on taking two conditions in those one is heavy traffic control and another one is making a route for emergency vehicle like Ambulance. Implemented a sensor network work which is used to detect the ambulance based on the embedded systems. At the traffic signal it automatically changes the time cycle of the signal for passing of the Ambulance vehicle.

These existing methodologies have a few drawbacks such as operating of a Traffic Signal is not interfaced with a RFID system. And the Sensors are not placed along with the RFID tags. Motivated by these failures, an advanced system is proposed in this work, that aims to handle the traffic signals automatically and helps the ambulance vehicle to cross at the traffic signals. The rest of this paper represents the required materials and proposed model (section 3), experimental results (section 4) followed with conclusions and future scope.

3. MATERIALS AND METHODS

3.1. Requirements

The proposed system requires the following hardware:
Arduino Mega (ATmega2560), RFID reader, RFID Tag, IR Sensors, LED, Power Supply (5V Battery)

Arduino Mega (ATmega2560):

The Arduino Mega 2560 is a Microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP 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 Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila [21].

RFID Reader and RFID Tag:

RFID Reader is a device that has one or more antennas that emit radio waves and receive signals back from the RFID Tag. RFID Tag is a electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number or information, back to the reader [22].

IR Sensors:

An Infrared Sensor (IR Sensor) is a radiation-sensitive optoelectronic component with a spectral sensitivity in the infrared wavelength range 780 nm to 50 μm. The Infrared Sensor includes both the Transmitter as well as the Receiver. IR Sensors are now widely used in motion detectors, which are used in alarm systems, density based traffic or to detect the unwelcome guests [23].

LED (Light Emitting Diode):

A Light-Emitting Diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the Semiconductor recombine with electron holes, releasing energy in the form of photons [24]. It will indicates the vehicles for Go, Stop and Ready to go.

Power Supply (5V Battery):

Arduino boards can operate satisfactorily on power that is available from the USB port. It provides 5V DC Voltage and can be sourced from the port from a PC, wall socket adapter or portable power bank. Using of 5 Volts because that provides the best combination of noise immunity, power consumption and speed with the existing technology. Naturally, connecting circuits such as Sensors and other devices tried to use the same voltage to avoid the need for extra power supplies [25].

The algorithm of the proposed model is developed in Embedded C and simulated on Arduino IDE. Embedded C is generally used to develop microcontroller-based applications. Embedded C is a well defined and standardised general purpose programming language. A platform specific application known as compiler is used for the conversion of programs written in C to the target processor specific binary files. We use Arduino IDE for executing the programs for the operation of the proposed system. Arduino IDE is an open source platform which is used to program the microcontroller to perform some specific task. In this work, we are using Arduino IDE software version 1.0.6. The Arduino IDE supports C and C++ programming language. The Arduino Software(IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions. It connects to the Arduino hardware to upload programs and communicate with them. In Arduino, we use the two main functions for the execution of the code i.e.-setup() and loop() function. Arduino IDE is easier to reuse the code for the execution of Program [26]. The specifications of the required hardware is presented   in   table   1.

Table 1 : Hardware Specifications

S.No.	Hardware Name	Specification
1	Arduino Mega (ATmega2560)	Operating Voltage : 5V Clock Speed : 16MHz Flash Memory : 256 KB
2	RFID reader	Frequency range : 865 to 868 MHz Temperature range : -25 to +75 ^{0}C
3	RFID Tag	Transmit power : 0.1 W to 2 W ERP Tag read range : 10 cm
4	IR Sensors	Field of view : 18^0 half angle Wavelength range : 8 to 14 μm
5	LED (Light Emitting Diode)	Beam angle : 120^0 LED chip : Epistar SMD

6	Power Supply (5V Battery)	Mode of operation : Pulsating DC Pulse rate : 2 Hz Maximum current : 350 mA

3.2 Proposed Model

The Emergency Vehicles like Ambulance passes at the Traffic Signal with the help of a RF Transmitter. The RF Transmitter is built at each side of the four ways of Traffic Signal. When anyone switches on any one side of RF Transmitter, when an Ambulance comes nearer to the Traffic Signal. The Traffic Signal automatically changes into a Green Signal. Therefore, the Ambulance passes from the Traffic Signal. In this project we proposed a new system which is more useful and takes less time to operate and which is more useful to clear the Traffic for Ambulance at the Traffic Signal. To reduce the congestion and unwanted time delays in traffic, an advanced system is proposed. One such advanced technology we implemented in our project is Smart Ambulance using RFID Tags and RFID Readers. This RFID tag is attached to the Ambulance, reader is placed at the Traffic Signal. When the reader reads the tag and gets the input information, when the ambulance comes nearer to the Traffic Signal. And process the operation by using an Arduino Processor Kit to change the Traffic Signal i.e., Red Signal to Green Signal and give way to the Ambulance vehicle at the Traffic Signal.

The block diagram of the proposed system is represented in figure 1. The key block of the system includes Arduino ATmega2560, IR sensors, RFID readers, tags and traffic light led setup.
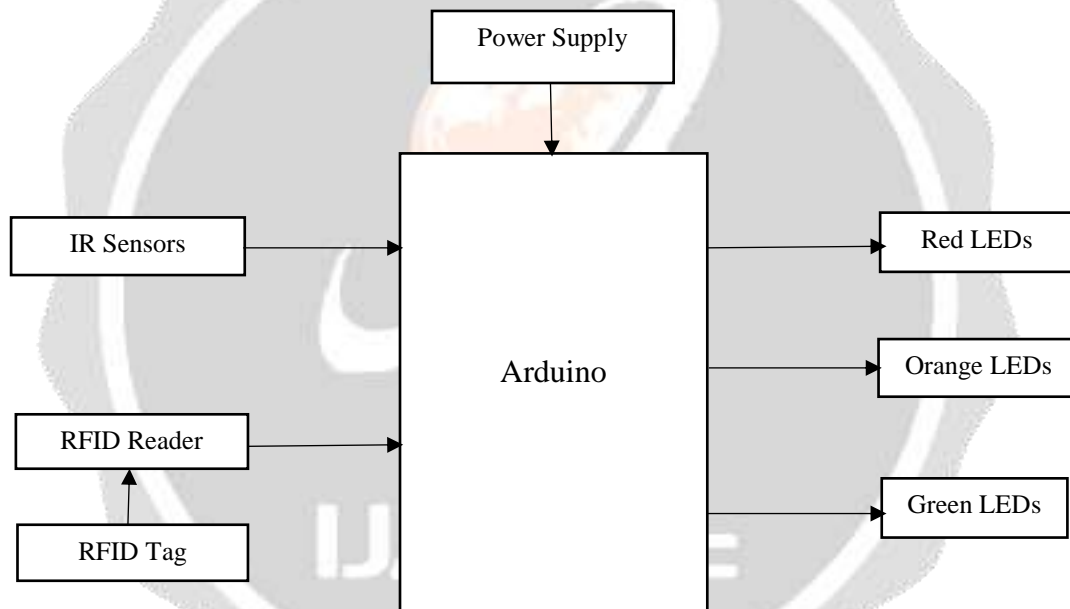

Figure 1 : Block diagram of the Proposed System

Arduino is an open-source electronic 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 message and turn it into an output. Over the years, Arduino has been the brain of thousands of projects. 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. IR Sensor – Infrared technology addresses a wide variety of wireless applications. The main areas are sensing and remote controls. In the electromagnetic spectrum, the infrared portion is divided into three regions: near infrared region, mid infrared region and far infrared region. Optical wireless communication is done with IR data transmission for short range applications. An infrared sensor emits or detects infrared radiation to sense its surroundings.

A RFID system is comprised of two components: RFID Reader and RFID Tag. The RFID reader consists of an antenna to emit high-frequency EM waves to a tag. RFID Tag can be either passive or active. Active Tags are powered by batteries while the passive RFID tags are powered by the energy from the reader's interrogating EM waves. The tags are available in different forms of shapes like cards, tags, key fobes or stickers. The RFID reader will check for any tags in the vicinity and if a tag is found, the reader will read the

unique ID from the tag. And if the UID matches with the UID in the code, the Arduino will toggle the LED state. All Arduino boards need electric power to function. A power supply is used to provide electric power to the boards and typically can be a battery, USB cable, AC adapter or regulated power source device. The most common ways to power supply the Arduino is a USB connector to perform the operation.

4. EXPERIMENTAL RESULTS

The prototype of proposed system which helps for the Ambulance Vehicle to cross at the Traffic Signal is shown in figure 2. This model includes RFID Readers and Tags which will take the input from the Ambulance in which the RFID tag is attached to the Ambulance Vehicle. This input gives back to the RFID reader which is placed at the Traffic Signals. We use four RFID Tags and four RFID Readers at the Traffic Signals. When the ambulance reaches to the traffic signals the reader, reads the input from the tag and gives it to the Arduino Microcontroller for the operation. By using an Arduino microcontroller (ATmega2560) this input information is collected and processed the operation and gives the output in the form of changing the LED lights from Red Signal to Green Signal according to the particular way of road on which the Ambulance Vehicle is stuck at the Traffic Signal.
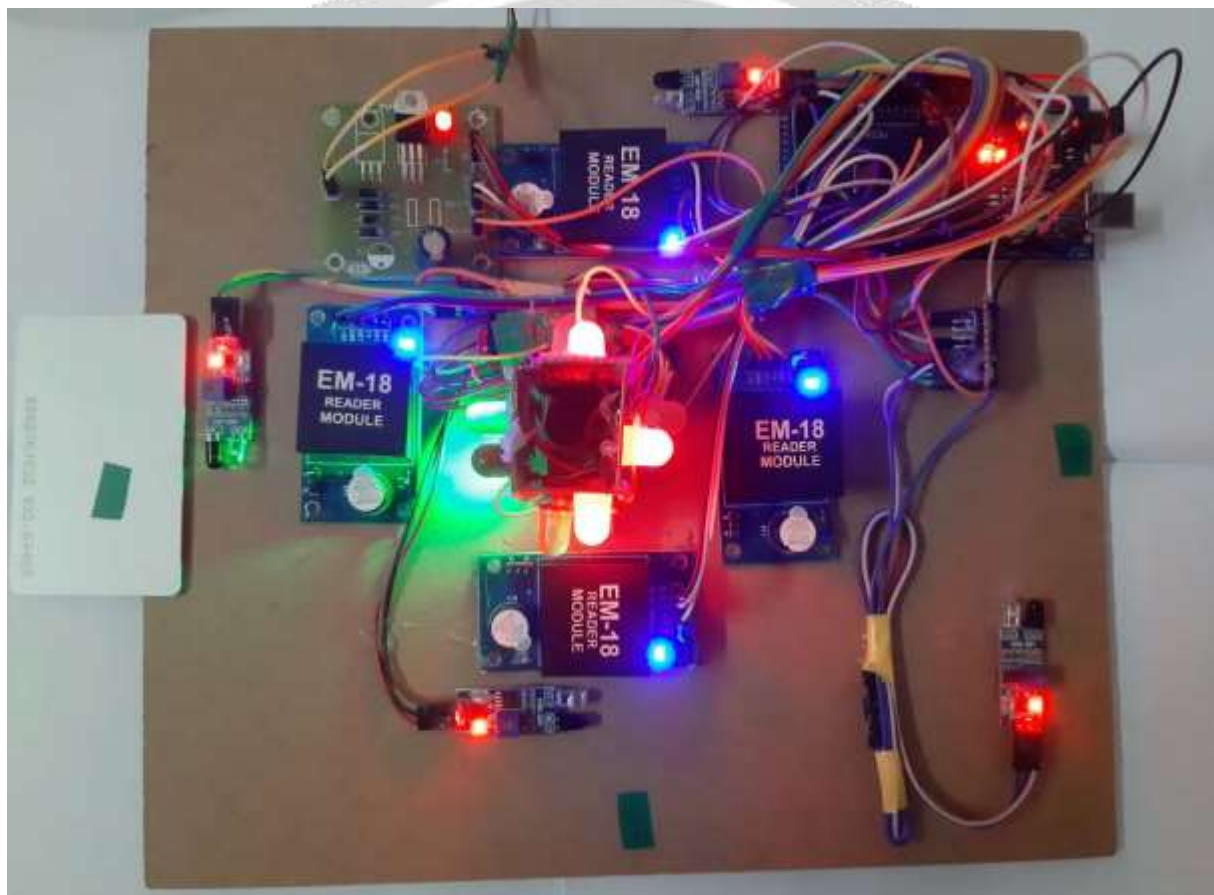

Figure 2 : Working of the Proposed System

This system includes the usage of RFID Reader and Tag. An IR Sensor is used to clear the traffic based on the density of vehicles at the Traffic Signals. We placed the IR Sensors at each side of the Traffic Signal to find the high density of vehicles stuck at the traffic signals. So, by using of Arduino microcontroller, it takes the input from the IR Sensors and clears the traffic for the High Density of Vehicles stuck at the Traffic Signals. For working of this proposed system, we use Embedded C language to perform the operation depending upon the conditions for the working of the Arduino Microcontroller (ATmega2560).

Embedded C is generally used to develop microcontroller-based applications. This language optimizes machine instructions for the given input, which increases the performance of the Embedded System. We use Embedded C for coding in this proposed system. Because it gives a lot of control over program for the Arduino board for creating some Embedded systems application. And it also has minimum execution time on hardware in comparison to other high-level programming languages for the operation.

5. CONCLUSION & FUTURE SCOPE

In this project we aim to design an Arduino based Traffic Congestion control system with automatic signal clearance for the Emergency Vehicle by using an Arduino Mega, RFID Module and an IR Sensor. The system could automatically works with the simulated program in the Arduino Processor Kit and the Ambulance can also move from the Traffic Signal smoothly. The system aims to provides better flexibility to manage the Traffic. The Automatic traffic light control system is productive and it reduces the traffic in urban areas, and also it decreases the time consumption due to heavy traffic. And this system helps to the Ambulance Vehicle to reach Hospital without stuck at the Traffic Signal. This model experiences a delay in switching over the traffic signal to the appropriate traffic line at which the Ambulance RFID tag is read out by the RFID reader. This can be avoided with the usage of fast processing handheld processors like raspberry pi. Further the enhance version must include controlling of two traffic line when another ambulance at the same junction requires traffic clearance. This can be achieved by more practical traffic analysis and intelligence which demands the need of a machine learning system.

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