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Intelligent Traffic Signal Control using RF Technology for Emergency Vehicles

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Abstract*: The transportation system in our nation has been dramatically impacted by the problem of traffic congestion. This leads to several complications or issues, especially during emergencies in the heavily trafficked lanes at traffic lights. To address these challenges, a traffic light management system is built in. Based on an RFID module, this system was designed to operate when it received a signal from an emergency vehicle. The Programmable Arduino Nano microcontroller was used to regulate the LEDs used in the traffic signals. The system's use of LEDs makes it easier for emergency vehicles to manoeuvre through traffic. As a result, the project's analysis and implementation of the traffic signal control system for emergency vehicles were successful.

***Keywords*: RFID, LED, Arduino Nano, Traffic Light Management System.**

I. INTRODUCTION

Today, traffic is expanding worldwide, primarily in urban areas. As the number of street clients continues to increase, intelligent traffic control will become a vital innovation in the future. Blockages in rush-hour traffic have become a significant issue. Numerous vehicles are waiting a long time at the signal. As a result, there will be additional time consumption for humans, which will be a significant issue for people who commute to work and those who attend business meetings. The existing system of controlling traffic is not proportional to the density of vehicles, and it does not mitigate the effects of traffic in metropolitan regions. The traffic lights have been arranged to be fixed recently, exclusively for a specific time. After that time interval, the sign will be naturally different from another sign. This causes the opposite side's path to be delayed for a long time. In certain areas, even traffic signals failed to function as expected. In the proposed system or framework utilising the Arduino Nano Microcontroller, the vehicle density is estimated, and consequently, the traffic will be decreased.

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II. LITERATURE SURVEY

For vehicles of emergency, RF module has been is it used detecting an emergency vehicle and taking action instantly impossible the light is turned on green for the side with minimum traffic congestion case if the congestion stay high one explicit side, then the other side will be delayed for sign in again emergency vehicle green signal will be given and it travels without traffic issue As it will be in Plain view the ambulance driver should update their journey path to get clearance in congestion what is an not effective method [1-2]. Hence, this project enables automation, which gives a green signal for emergency vehicles.

III. PROBLEM DESCRIPTION

Generally, the light changes to green with a specific time delay. The green light will be given even if there are no vehicles on the particular lane, and it delays the cars on the other sides. In case of an emergency vehicle arriving on the other side, they have to wait until the signal turns green for their side.

IV. EXISTING SYSTEM

In the existing system, as shown in Fig. 1 below, it is challenging to clear traffic for ambulances. In the previous system, they used only IR sensors to clear traffic. Depending on the traffic density, the green signal will be activated. If no density is specified, the signal will change every 1 minute by default. Disadvantages: This method has a few disadvantages, including the camera, which is completely immobile.
In this Technique, there is a chance that the speed concept may result in accidents involving emergency vehicles.

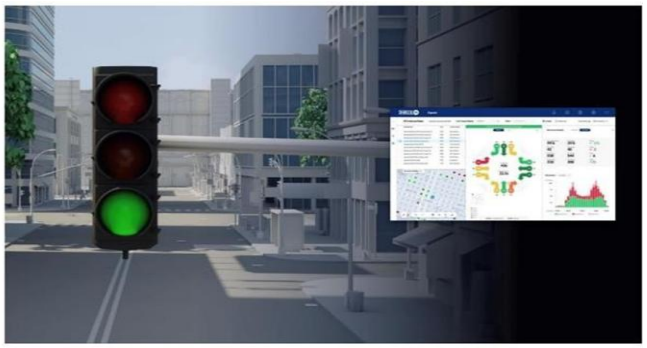

Figure 1: Existing Mode

V. PROPOSED MODEL

Here, we propose a new system that is more useful for clearing traffic for ambulances. To mitigate clogs and undesirable time delays in traffic, a high-level framework is necessary. One such cutting-edge innovation is traffic Control for emergency vehicles using the RC522 module. Whenever an emergency vehicle arrives, the driver must swipe their RFID card, which transmits a signal to the controller. This signal activates the Green LED corresponding to that direction and triggers other side signals to turn Red, indicating that an emergency vehicle is arriving. [3]

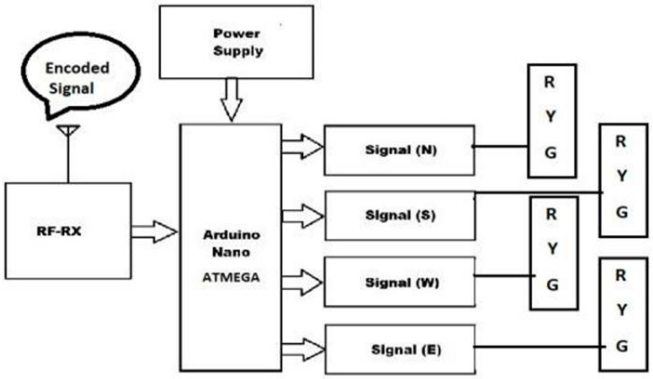

Figure 2: Traffic control unit

Applications: devices can be implanted in emergency vehicles like

- Ambulances
- Fire Tankers
- VIP Vehicles
- Convoys, etc.

Steps to Design PCB:

- Create the Schematic
- Create a Blank PCB Layout
- Schematic Capture: Linking to Your PCB
- Designing Your PCB Stackup
- Defining Design Rules and DFM Requirements
- Place Components
- Insert Drill Holes
- Route Traces

Software requirements:

- Arduino IDE software
- Easy EDA PCB design

VI. ACTIVE TAGS & PASSIVE TAGS

The active tags will be used for short-range applications and have very low prices. An active tag, a reader, and an antenna comprise an active RFID tag system. An active RFID tag typically features an integrated long-life battery as its power supply. This enables the tag to transmit the data continuously and uninterruptedly, regardless of whether it is in the field of action of a reader. In contrast to passive RFID tags, which only contain an antenna and a microchip without any internal power supply.

Applications: Tracking vehicles, Auto Manufacturing, Mining, Construction, and Asset Tracking.

Passive Tags: Onboard transceiver batteries must be replaced. The longer range frequency is 433 MHz to 915 MHz. These tags are designed to work in high temperatures and extreme moisture. The cost of the passive tags is very high. They are used for identification purposes on any object. Applications: Inventory Tracking, Supply Chain Tracking, Race Timing, Manufacturing, Electronic Tolling, Asset Tracking. The following figure shows the physical appearance of active tags and passive tags.

Figure. 3: RFID tags

A. Rc522 RFID Module:

The 13.56 MHz RFID module RC522 is based on NXP Semiconductors' MFRC522 controller. The module typically ships with an RFID [10] card and key fob and can support I2C, SPI, and UART. It is generally used in applications for person or item identification, such as attendance systems [4]. The RC522 module should only be used with communication lines of 3.3V because it has a voltage operating range of 2.5V to 3.3V. As a result, it is often powered by 3.3V. However, since this module's communication ports are 5V tolerant, it can also be used with microcontrollers of 5V, such as Arduino, without the need for any additional hardware. SPI, IIC, and UART communication are all supported by this module; however, SPI is typically utilised because it is the fastest, with a maximum data rate of 10 Mbps. Since in an application, the reader module will frequently be waiting for the tag to approach, in battery-operated applications, the Reader can be put into power-saving mode to conserve energy. The IRQ pin on this module can be used to achieve this. The module will only use 10 µA of current at its lowest during power-down mode.

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Figure. 4: RC522 Sensor

Pin No.	Pin Name	Description
1	Vcc	Usually 3.3V is used to power the module.
2	RST	Reset pin: used to turn off or restart the module
3	Ground	Connected to Ground of system
4	IRQ	Wakes the module up via the interrupt pin when a device enters range.
5	MISO/SCL/Tx	MISO pin when used for SPI communication, acts as SCL for I2c and Tx for UART.
6	MOSI	Pins for SPI communication are master out and slave in.
7	SCK	Used to supply a clock source is the serial clock pin.
8	SS/SDA/Rx	Carries out the functions of Serial input (SS) for SPI communication, SDA for IIC, and Rx for UART.

B. RFID Reader

A radio identification reader is a physical device used to read the data from an RFID tag. Radio waves are used to transfer the data from the tag. To read data from an RFID tag, the RFID reader must be positioned near the tag, which should be within a range of 0 to 300 feet. It has three types: fixed, mobile, and handheld units. The kind of RFID used is based on the environment and application. [5-6]

Figure. 5: RFID tag reading Emergency Vehicle

C. Arduino Nano

The transmitter/receiver (Tx/Rx) pair used in this RF communication system operates at 434 MHz. The transmitter module receives serial input and uses RF to send these signals. The receiver module, which is installed far from the source of transmission, receives the broadcast signals. The technology enables transmission and reception, or one-way communication, between two nodes. Four-channel encoder/decoder ICs have been utilised in conjunction with the RF module. The encoder changes the remote switches' parallel inputs into a collection of serial signals. Through RF, these signals are transmitted in serial to the reception site. The decoder decodes the serial format after the RF receiver, and the original signals are output as the result. The outputs are observed on the respective LEDs.

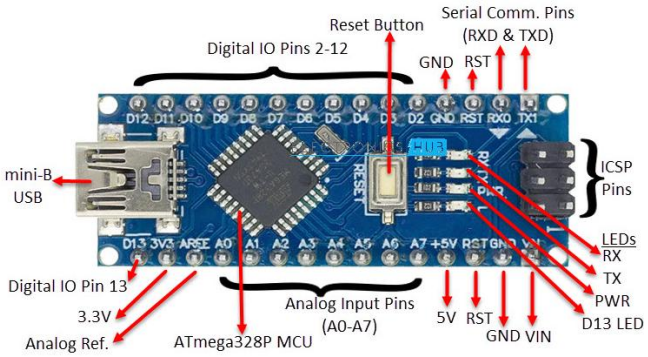
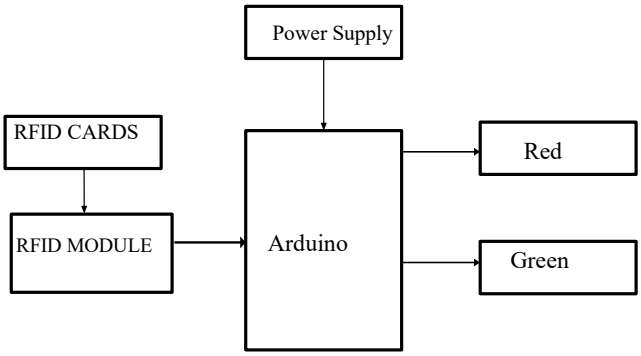
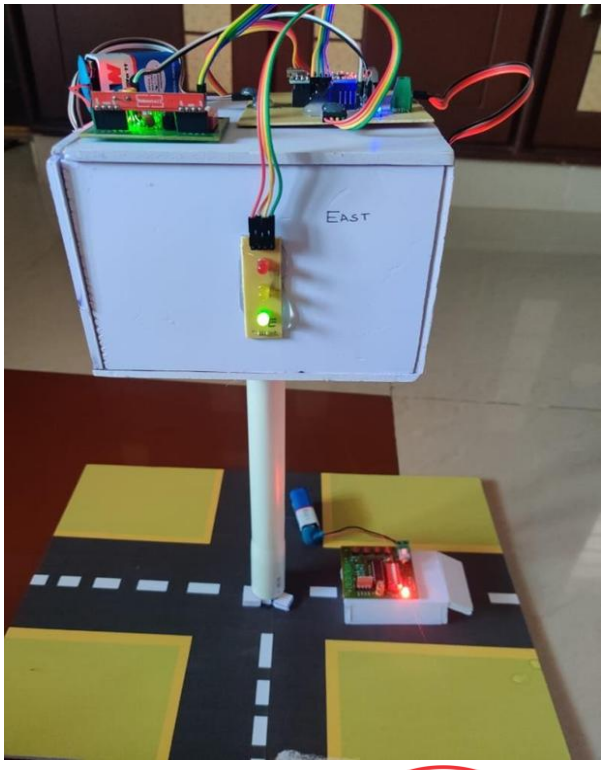


Figure. 6: Arduino Nano Microcontroller

D. Block Diagram





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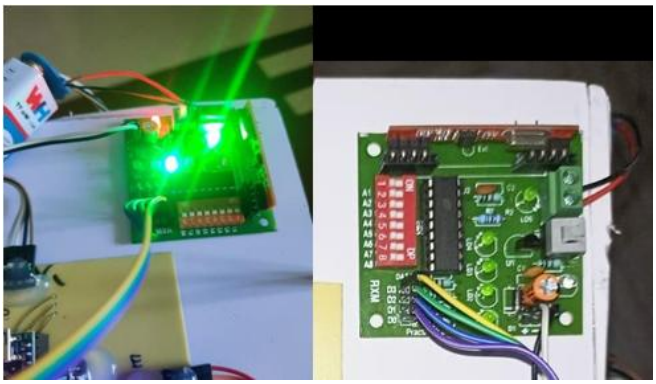

Figure. 7: Results of the proposed model

E. Light-Emitting Diode (LED)

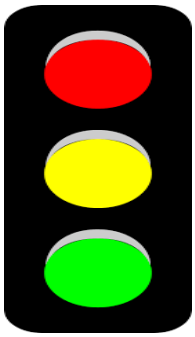

Figure. 8: LED Traffic Light

When current flows through a semiconductor light source, such as an LED, it emits light. In that semiconductor, energy is released in the form of photons by recombining electrons and electron holes. It will signal when a vehicle is ready to move, stopped, or both. The standard traffic light colours are arranged horizontally or vertically in the order of red, yellow, and green. Despite being globally standardised, there are differences in traffic light legislation and sequences at the national and municipal levels. On Parliament Square in London, the technique was first used in December 1868 to lessen the need for police personnel to regulate traffic. Since then, traffic light technology has progressed, and intersection capacity has increased thanks to electricity and computerised control. The technique is also used to manage pedestrian traffic, control variable lane widths (such as on tidal flow systems or smart highways), and regulate level crossings on railroads. [9]

VII. CONCLUSION

This paper reports the development and testing of the "Intelligent Traffic Control System for emergency vehicles using RF technology" project. To identify emergency cars in our implementation, we used radio frequency technology. All of the hardware components were integrated throughout the development process. The existence of every module has been carefully considered, and its placement has contributed to the unit's optimal performance. Second, the project has been implemented effectively thanks to advanced technology and exceptionally sophisticated ICs. We developed an Arduino-based traffic congestion control system with automatic signal clearing for emergency vehicles, utilising the Arduino Mega and RC522 module, in response to traffic congestion in urban areas. The method offers more versatility in managing the traffic. The effectiveness of an automatic traffic signal control system lies in its ability to reduce time lost to traffic-related delays in metropolitan areas.

DECLARATION

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Conflicts of Interest/ Competing Interests	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval or consent to participate, as it presents evidence that is not subject to interpretation.
Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	All authors have equal participation in this article.

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