Original Research Article

AN AUTOMATIC TRAFFIC VIOLATION TICKETING SYSTEM USING RADIO FREQUENCY IDENTIFICATION (RFID) TECHNOLOGY

ABSTRACT

Aims: The study was conducted to develop an automatic traffic light violation system using RFID technology and a GSM module that is used to track and identify any traffic violator on the road.

Methodology: This system was developed using an Atmega 328 microcontroller, which instructs the system to identify any driver who violates a traffic light and send an SMS message to the road violator and the road management of the violation and location where it is done. This identification is done with the help of RFID reader, which gets the unique ID of the vehicle and sends back the information to the microcontroller, which now instructs the GSM module to send the SMS message.

Conclusion: Today, running red lights violation is one of the most prevalent and significant issues, and it causes millions of car accidents every year at traffic lights signals. Culprit vehicles must be identified in order to punish the drivers who run red light signals. The work's primary goal is to use RFID reader and tag technology to identify traffic signals and red light violators on the road. RFID readers at the signal as well as RFID tags on the vehicle is used in this work. The RFID reader is responsible for detecting vehicles violating traffic rules. The RFID tag has a unique ID. When a vehicle tries to cross at a red light signal, it violates the law. the junction's intersection. So, in order to prevent this, vehicle that ignores the traffic light signals must be found. The information on the RFID tag will be connected to the vehicle owner's mobile number. When a car runs a red light signal, the owner will receive a message with the fine amount and all other relevant information, such as the location and vehicle registration number.

KEYWORDS

Traffic violation, RFID tag, RFID Module, RFID reader, Traffic Signal, GSM Module, Power Supply.

1. INTRODUCTION

Travel is an important part of today's fast-paced life as everyone has to move around for their day-to-day work. Road transport is the most commonly used mode of travel due to its ease, low cost, and availability to the common man [16]. Worldwide, road traffic injuries claim more than 1.2 million lives each year and are among the leading causes of death among young people. It is estimated that road traffic injuries cost governments approximately 3% of their GDP and up to 5% in low- and middle-income countries. Without action, annual road traffic deaths are predicted to increase to around 1.9 million by 2030 and become the seventh leading cause of death [10].

The ease of travel is affected by such factors as the quality of the road, congestion, longer duration, accidents, speed, etc. The major threat is the increasing number of accidents on a daily basis. These accidents not only claim the lives of people but also add to the economic loss of the country. Lack of discipline and emotions of road users cause traffic congestions which might lead to traffic violations [16]. The main types of Traffic Violations are Moving Violations and Non-Moving Traffic Violations. Driving offenses involving fatalities are dangerous driving and careless or inconsiderate driving. A person drives dangerously when the way they drive falls far below the minimum acceptable standard expected of a competent and careful driver; and it would be obvious to a competent and careful driver that driving in that way would be dangerous [14].

2. RELATED WORKS

Radio Frequency Identification (RFID) is an identification technology that utilizes radio waves as a transmission medium consisting of RFID tags and RFID readers [1]. Each RFID tag has a unique code as an identity that can be read by an RFID reader by sending a request. RFID works at various wavelengths with an area of up to 30 m [3]. It can be classified into three categories: passive, active, and semi-passive, having different working frequencies [12]. RFID technology has emerged from obscurity and found widespread use in applications that hasten the movement of materials and manufactured items. In contrast to older bar-code technology, RFID permits identification from a distance and does so without having a line of sight.

This automated system RFID will be implemented at each traffic light pole for a red traffic violation and it will automatically issue a ticket in form of Short Message Service (SMS) to the violator and to the road safety management. Traffic light in American Heritage Dictionary, (2016) is a road signal which operates automatically for directing vehicular traffic by means of colored light 'Red' to stop, 'Amber' to proceed or go with caution, and 'green' light to Go. This RFID system uses the traffic light mechanism to capture any registered motor user that violates the red traffic light i.e., any road rider that move whenever the 'red' light is initiated, a message will be issued as ticket to the violators and as information to the road safety management. The ticket may constitute a notice that a penalty, such as a fine or deduction of points, has been or will be assessed against the driver or owner of a vehicle for a violation, failure to pay generally leads to prosecution or to civil recovery proceedings for the fine [8].

In the [11]., an RFID reader is an intelligence system used for identification of vehicles on the road, The RFID reader is placed on the surface of the road, so when a vehicle crosses it, it, it will immediately pick the unique ID of the vehicle.

[2] used GPS to obtain details about the location and speed of the vehicle. A traffic violation warning and storage device is built into the car, and it can also be used to store the map data, the rules of the road, and any infractions the driver has committed. To handle and control the device's various units, a controller was released. To ascertain whether a violation has occurred, the GPS data is compared with previously saved map data and traffic regulations. Depending on the outcome, the motorist may receive a warning if a potential violation is identified or a ticket may be recorded in the device's violation memory if a violation has been committed. Furthermore, To save encrypted tickets in the memory, an encryption mechanism is also offered. On the management display, you may later check the issued tickets as well as the specifics of the violations and personal data.

[19] presented an intelligent traffic management expert system using RFID technology for data gathering and control information that can track criminal or unlawful vehicles like stolen cars or vehicles that avoid paying fines, tolls, or vehicle taxes. To collect traffic data, regulate traffic, find the shortest routes, and track down unlawful vehicles, a passive RFID reader and tags were employed in this study. to

reduce traffic offenses, lower costs, and delay travel time when entering and departing highways. [13] presented an intelligent highway system that offers assistance to drivers of moving vehicles on the highway, detects improper parking, including in no parking, accident, or stop zones, and also detects overspeeding or lane changes. The software sent a warning signal to the patrol cop after receiving a signal from the reader in the intelligent light pole or forwards multiple signals to subsequently emergency vehicles or to nearby police if the parking violation is on. The RFID reader is installed in the intelligent light pole, powered by solar cells, which covered the highway in the shape of every third pole. the main lines of the road, and last but not least, the reverse light pole number that appears on the tag; if the car is traveling in the incorrect lane, the RFID reader sends the tag data to the main computer.

[18] utilized Radio Frequency Identification (RFID) Technology to suggest a redesigned automated ticketing system that is more effective and improved. The paper's main goal is to evaluate and circumvent its limitations in order to increase the effectiveness of the already recommended RFID ticketing system. To make distance calculations easier, the current approach suggests installing an RFID reader circuit in each and every bus stop. This paper proposes the implementation of the ticketing system using a cyclometer, which may be connected to the bus' wheel or wheels to measure the precise distance travelled by the user, while taking into account the cost and complexity (read automobiles). The corresponding cost is automatically subtracted from the user's account based on the distance traveled. An automated database system is used to carry out the work, which speeds up, simplifies, and eliminates ambiguity in all interactions.

[13] proposes An Approach for RFID Ticketing used for Personal Navigator for a Public Transport System which is based on ticketing and identification of the passenger in the public transport. There are several security issues as well as a serious malfunction of public transportation in large cities like Mumbai and Kolkata. Three modules make up the overall network: the base station module, the in-bus module, and the bus stop module. Two Microcontrollers, a GSM Modem, GPS, Zigbee, RFID, LCD, and an infrared sensor are included in the In-Bus Modules. RFID for ticketing purpose. In order to communicate information about buses to bus stops and from bus stops to buses, the microcontroller and Zigbee

module are also interfaced. The Bus Stop Module, which is permanently installed at each bus stop, consists of a Zigbee node connected to a microcontroller.

[17] proposed a system that helps conductor in transport fare collection called Automatic Fare Collection System implemented using RFID /Smart card. RFID card is given to the passenger and when gets into the bus he has to swipe the card in the RFID reader and has his destination point in the device, which would automatically calculate the fare and deduct the money automatically. Conductor also feels free and more organized in the money from the people. All the record will update automatically in the server continuously when more people are travelling, and easy issuing of the ticket. A based webpage monitors the bus for amount, path taken, bus status number of passengers, and distance information. It fixes every issue with the IOT-based web page monitor system in buses. Index Terms: Radio Frequency Identification, Internet of Things (IOT), and Network Security (RFID).

3. MATERIALS AND METHODS

3.1 System Design

The automated traffic violation ticketing system using radio frequency identification technology (RFID) system consists of different units which include microcontroller unit, Radio Frequency Identification Technology (RFID) Unit and the communication unit using GSM. The RFID tag is attached to the user car. The RFID reader then reads the RFID tag attached to the car. The RFID reader will give a beep sound whenever an RFID tag is at the same frequency with the RFID reader (i.e. the RFID tag is within the range at which communication can be established between the RFID reader and the RFID tag) when the user pass the traffic light whenever the red light is high thereby sending data to the GSM module through the microcontroller and issue ticket to the road user violator registered number informing road user violator about the violation and the fine to pay and also to the road safety admin.

The system design consists of hardware design and software design, implemented together to achieve this project. Figure 1. depicts the block diagram of the system. The system has several hardware components such as the ATMEGA328Microcontroller, RFID tag, RFID reader, GMS module (SIM 800), relay, Power Supply Unit, Jumper wire, Traffic light and some other electronic or electrical component. The software consists of code that would be compiled on the

arduino IDE and embedded into the microcontroller; it would be a part of the hardware design. The designing and constructing of automated traffic violation ticketing system using the radio frequency identification technology (RFID), was designed to overcome the issue of accident, Corruptions and nepotism on part of road safety agencies, Intensive stress from the part of road safety officer on duties, Deviance to traffic rules by road users, by not violating the traffic light rule.

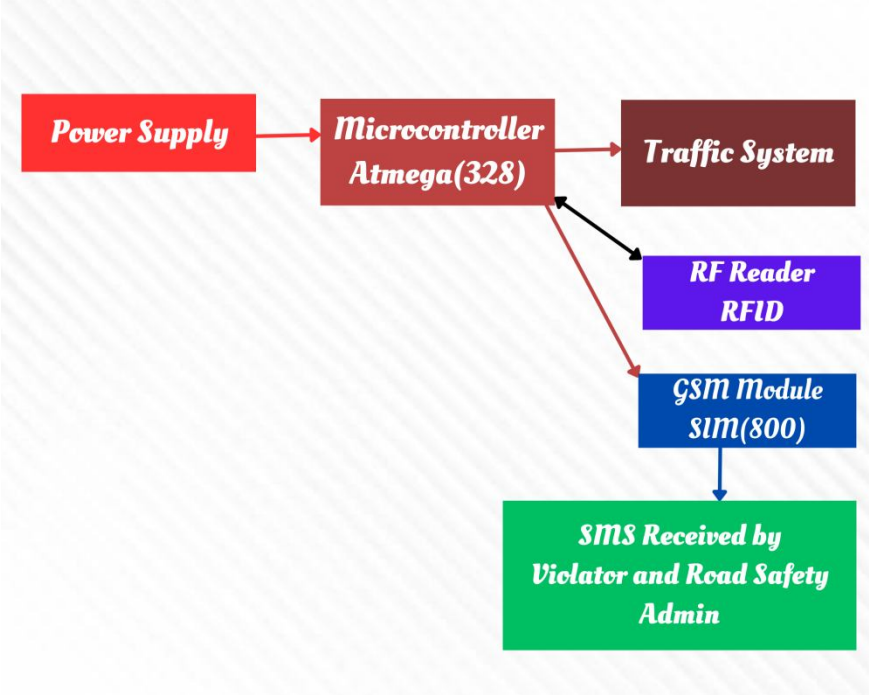

Figure. 1. Block Diagram of an Automated Ticketing System

3.2 Power Supply Unit

This unit was designed to supply DC voltage and current to the whole constructed circuit as shown in Figure 2. In order to build this power supply, a step-down transformer is used to reduce the input voltage from 220 VAC to 12 VAC. A full-wave bridge rectifier is then used to rectify the voltage, turning 12 VAC into 12 VDC. Finally, a capacitor is used to filter out any pulsating AC voltage that wasn't completely converted. The power supply connected to the outlet socket on the wall supplying unregulated AC voltage, and the output pin is connected to the input pin (Vin) of the voltage regulator. The regulator modulates and regulates the 12VDC to give a constant regulated 5VDC needed by the controller

and provide the other electrical and electronics component used in the circuit designed their exact standard operating voltage, However, this was done to prevent damages to the microcontroller ICs and other component used from excess supplied voltage.

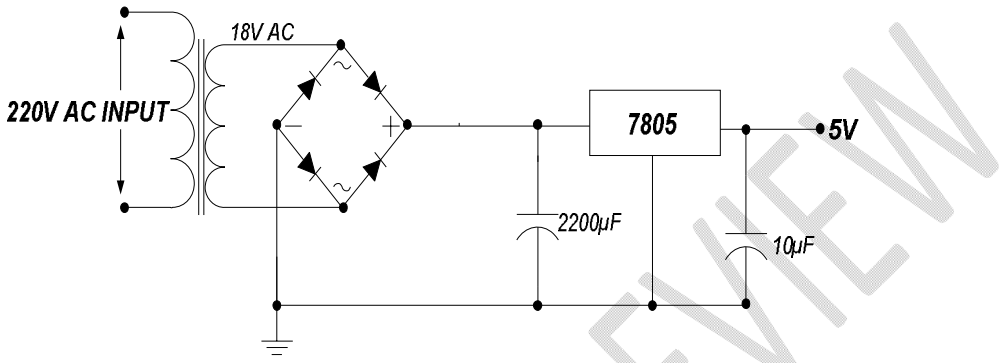

Figure. 2. Regulated power supply

3.3 Microcontroller Unit

This is a unit that works like a compressed micro-computer, programmed with C language to control and manage the functions of the embedded system. The factors considered when choosing our microcontroller are:

- The number of digital inputs and output pins. The system concerned requires a microcontroller with large pin counts.
- The size of the program memory storage required.
- The magnitude of clock frequency; a factor which decides the execution rate of task of the microcontroller.
- The number of interrupts and timer circuits required i.e no of additional ICs required.ATMEGA328P is the type of 8-bits AVR microcontroller based on the advanced reduced instruction set computer (RISC) architecture. It is low power CMOS technology based controller due to its architecture it can execute millions of instructions in a seconds, if cycle frequency is 1MHz provided by crystal oscillator.

Some of the internal and external features of this controller are 2kilo bytes of internal static RAM, 32x8 general working purpose registers, 28 pins dual-in-line package, 23 programmable I/O lines pins,

programmable serial USART, 1024 bytes EEPROM. EEPROM is normally used to store coded data that needs to be saved over a long period over many power-up and power off cycles. This memory is nonvolatile, which means that it will retain its data, even if the power is lost. In this design this EEPROM is used to store codes written to control the traffic system and the RFID operation. It was inserted into its socket already soldered on the Uno board, out of its 28 pins, the pin1 known as reset pin is attached to a Pull up resistor (linked with Vcc) which keeps the reset button high for the microcontroller to operates smoothly. The value of pull up resistor was calculated using the

Ohms law $V = IR$. (3.1)

$$v = I \, x \, R$$

The voltage of the microcontroller (Vcc) is 5V and the current through is 1mA

Resistor value $_{(pull\text{-}up)} =$ $\frac{Vcc}{\text{Current through}}$ (3.2)

$$= \frac{5.00V}{0.001A}$$

$$= 5k\Omega$$

However, the value of pull up resistor used for the reset button was not exact 5k Ω but 10kΩ, it was advisable not to use the exact value to avoid damage due to excess current. A computer serial port (USART), GSM module (SIM 800) and RFID connector were connected to the TX pin to transmit signal (such as written program) to the microcontroller and RX to receive signal from the microcontroller, pin 7 and pin 20 were connected to Vcc and pin 8 and pin 22 were grounded, thus 0.1uF coupling capacitor was placed near VCC and GND to prevent noise entering the controller IC, the remaining digital input pins: 3, 4, 5, 6, 11, 12, 13, 14 and 15 were connected to the nine LED terminals used for T-junction traffic light system.

3.4 TRAFFIC SYSTEM

This unit was responsible for the controlling of traffic of the t – junction road, using three-sided traffic light system. The unit was designed using nine different LED connected to the microcontroller with resistor to control the current flowing through the LED, to prevent damage of the LED. The value of the resistor used was obtained by using this formula.

$$\frac{\text{The battery voltage – the voltage drop of the LED}}{\text{The current of the LED.}}$$

The voltage drop of the LED is 1.7V and current is 10mA

Resistor value = $\frac{5V-1.7V}{10\ x\ 10-3}$ = $\frac{3.3}{10-2}$ = 330 Ω

Hence a resistor of 330ohms was connected to the LED to prevent damage by current

Each side of the traffic light system used three LED of different colors (green, amber, red). These LEDs are programmed, using C programming language, to operate exactly like a real traffic light system. Whenever the green LED on side 1 of the traffic light is High, the red LED of the other two sides must be high indicating that only a road out of the three roads is allow to traffic for 60seconds, then the amber LED is high for side1 and side 2 for 5 seconds indicating that road1 traffic is ready to stop and road 2 traffic is ready to go, then the side 2 green LED is high this makes side1 and side3 red LED high, indicating movement alone in side 2 for 60 seconds. The amber LED of side2 and 3 turn high for 5 seconds then the green LED of side3 turn high and movement is allowed. NE555 timer was connected to microcontroller to control the timing of the traffic light.

3.5 RF READER RFID (RC522)

This unit, Radio Frequency identification describes the system in which the identity of an object is communicated through radio waves from the tag to reader. RFID used is RF522 with the following consideration; low power consumption, low cost, pretty rugged in any form of weather condition and easy to interface with the microcontroller for transmission of signals using UART communication. The RFID Reader and its pins as connected to the Uno board. The RFID 522 Reader Module was directly interfaced with 5V ATMEGA 328P microcontrollers on the Uno board, a RFID Tag is brought in to the field of RFID Reader to check for functionality i.e. if reader and tag can both communicate successfully, it will read its tag number and give output via TX terminal to the controller.

3.6 GSM module (SIM800)

This unit was responsible for issuing of ticket. It serves as RFID communication channel. The SIM800 is a cellular communication module with 850MHZ frequency that can make calls, send email and SMS texts, and even connect to the internet. It extensive features include portable size, affordable module, a micro

SIM card interface, in built GPS, and 8 external pins and UART.

3.7 SMS Message

When a violation occur, this technology help send message directly to the mobile device of the violator right after the violation. The decided SMS message for violation is sent to the violator's registered mobile number which include the fine to be charged.

3.8 Principle of Operation

If the system is connected to 240V AC power supply and powered ON, the traffic light, radio frequency technology (RFID) and GSM module (SIM800) automatically switched ON, once a vehicle move across the radio frequency technology when the traffic light is red which indicate stop, the microcontroller quickly trigger the GSM module (SIM800) to send SMS message to the road violator and road safety management informing them about the road violator. The message issued to the violators entails the fee to be paid and the deadline of the payment and that of the management was for the body to document the violation and get to action if the violator refuses to pay or keeps violating. The system design for this work is depicted by the flowchart. The flowchart shows the diagrammatical stepwise algorithm that was illustrating the operating principle of the programmed automated traffic violation ticketing system using radio frequency identification technology (RFID). The cycle start by checking the state of traffic light. If green the car should initiate movement, if amber it should get to stop or move but if red the car should stop, any detected movement the reader should read the information on the tag of registered violator, relay the information to the RFID microcontroller which will initiate the GSM module (SIM 800) to issue ticket to the violator inform of SMS and then send information about the violation to the road safety administration for management.

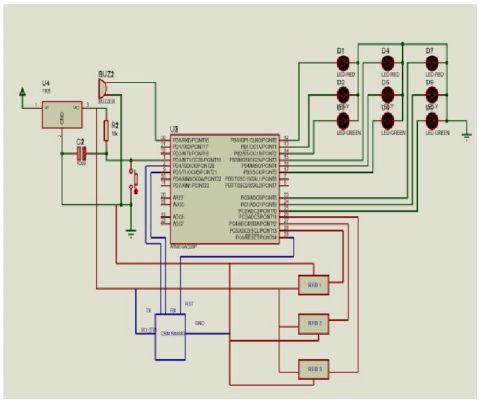

Figure. 3. The Circuit Diagram of an Automated Ticketing System using RFID

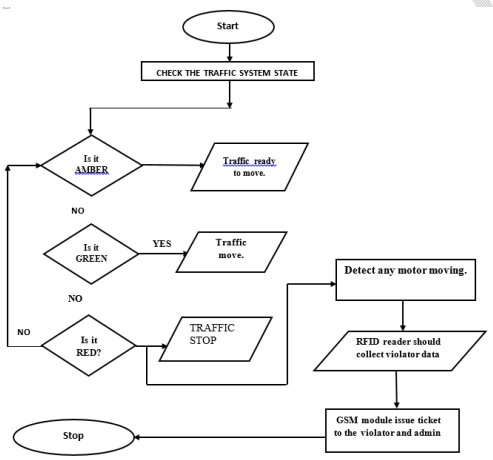

Figure. 4. System Flowchart

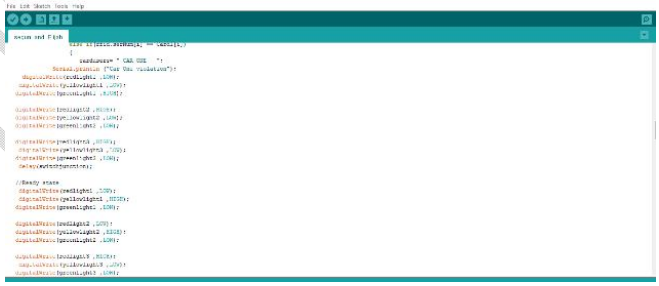

Figure. 5. Extraction of the code

4. RESULT AND DISCUSSION

When violations occur, the entered information is processed by the microcontroller chip, which then decides the correct action to take. The RC522 RFID reader is responsible for detecting the model vehicles violating the traffic

light. The RFID tag has a unique ID that is placed under the model vehicle. A red-light violation indicates when a vehicle tries to cross the RFID reader so as to issue the penalty to the violator via the RFID tag detail, which is connected to the vehicle owner's mobile number. This work was made to control and regulate any traffic violation and also reduce corruption and nepotism.

Figure. 6. Testing of the whole circuit.

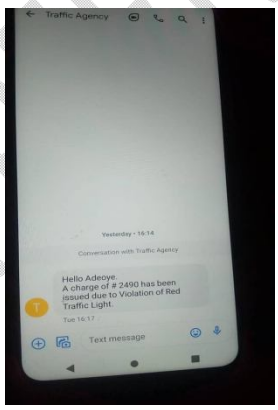

Figure. 7. Ticket received by violator.

5. CONCLUSION

The work was accomplished by developing a T-junction light model that aids to reduce the rate at which road users violate traffic lights. This model helps in the immediate identification of road violators through the registered RFID tag placed under the vehicle. If any model vehicle passes over the RFID reader whenever the traffic light is red, which indicate stop. The GSM module sent an SMS message to the violator's mobile device informing the user about the violation and the fine to be paid.

As stated in the specific objective of the project, a critical design was done and achieve in which stress undergone by traffic officers are drastically reduce. Therefore, with the implementation of this automated ticketing system with some little improvement on its limit goes a long way in assuring an improved technology in area of traffic safety and security especially in developing countries.

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