RFID Based Automatic Traffic Violation Ticketing System

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Abstract- *AsIn recent years, preventing general traffic violation is not easy in roads or urban streets due to the inattentive drivers. 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 common man. The ease of travel is affected by such factors as the quality of road, congestion, time taken, accidents, speed, etc. The major threat is the increasing number of accidents on a daily basis. An accident survey estimated that around 3,00,000 accidents occur on Indian roads every year. These accidents notonly cause huge loss of lives, but also add on to the economic loss of the country. It is reported that over 80,000 people are killed on the Indian roads while the total economic loss owing to road accidents is estimated to be over Rs. 3,600 crores This small violation is one of the leading causes for accidents. In this paper, we present an intelligent traffic violation detection system (TVD) to monitor and measure red light jumping. This system is based upon Radio Frequency Identification (RFID) technology for identification of vehicles on the road. Traffic violation detection algorithm is based upon the information retrieved from vehicle and type of signal from traffic light. The algorithm also extends to calculating and updating the penalty for vehicles jumping red light. The penalty is retrieved from the information publicly available in the traffic police forum. Traffic flow analysis is done by collecting real time vehicle count data and using data analysis techniques.*

Keywords- Radio Frequency Identification (RFID), traffic violation detection system (TVD), signal.

I. 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 common man. The ease of travel is affected by such factors as the quality of road, congestion, time taken, accidents, speed, etc. The major threat is the increasing number of accidents on a daily basis. An accident survey estimated that around 3,00,000 accidents occur on Indian roads every year. These accidents not only costs lives of people but also adds on to the economic loss of the country. It is reported that over 80,000 people are killed on the Indian roads while the total economic loss owing to road accidents is estimated to be over Rs. 3,600 crores. Lack of discipline and emotions of road users cause traffic congestions which might lead to traffic violations. Having a safe and free flow of traffic is crucial for economic development of the country as we must ensure spending less on fuels and less time on the road. Traffic enforcement authorities can deal with the challenge of regulating the traffic and enforcing rules caused by the huge number of vehicles on the road and the indiscipline of the motorists by applying modern technology. Flouting lane discipline is the single major factor in India that inhibits safe and free flow of traffic. It is also a common sight in India to see one slow moving vehicle blocking the way of hundreds of vehicles coming behind it. If keeping slow moving vehicles to the left is enforced, one important cause of traffic jams is removed. The authorities are responsible for controlling the traffic violation and pollution and imposing fine on the violators. The single most important rule is to follow the traffic signals in junctions. Violation of signals results in a number of accidents [6]. The major problem is the manual tracking of every single vehicle that violates signals. This problem can be brought under control if the tracking can be automated along with calculating and updating the fines. In the existing systems, the tracking of signal violation is implemented using image processing techniques. The cameras use infrared signals to capture the number plates of the vehicles round the clock. The vehicle number is extracted from the image of the vehicle's number plate using optical recognition techniques [9]. If a vehicle has violated the signal, the identified owner is imposed suitable fine. However, there area number of limitations in this system.

1. It requires a camera in every lane of the signal.
2. These cameras require high maintenance and are prone to damage in bad weather conditions.
3. Dirt on the number plate makes image processing difficult.
4. Various font types on the number plate cause lack of precision.
5. Objects far from the camera are captured with poor resolution.

6. There is a need for a larger number of technical persons [9].

On the other hand, RFID based traffic violation detection systems use radio frequency waves to identify vehicles which are endowed with unique identification numbers in the form of RFID tags. RFID (Radio Frequency Identification) is one of the upcoming technologies in the field of engineering and innovation. It has a number of applications in the market starting from vehicle identification at tolls to security systems at malls. These RFID based systems consist of 3 main components, namely RFID Reader, RFID Tags and RFID Database [3]. The reader has an antenna that emits the radio waves. When the tag antenna comes within the range of the reader's range, it responds to the reader with the unique identification number of that tag. Tags can be classified into 2 types: passive tags and active tags. A passive tag contains no internal power source whereas an active tag contains its own power source which runs the microchip circuitry and also helps in broadcasting the signal to the readers [7].

Similarly, there are two types of readers:

- Stationary Readers which are fixed at a specific location and able to read the tags within their range.
- Mobile Reader which are movable devices.

The frequency of low frequency tags varies between 30 ~ 300 kHz that of high frequency tags varies from 3 ~ 30 MHz and that of ultra-high frequency varies between 300 ~ 3000 MHz in this work, an RFID reader uses radio waves to read tags and hence does not require to be in line of sight. Every vehicle is endowed with an RFID tag, while RFID readers on the sides of the road. Road markings are done according to the required range. Any vehicle crossing the road marking when the signal is red will be detected from RFID tag of that vehicle.

Figure 1. 1 Block Diagram

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Proposed System

The proposed system as shown in Figure 1 for traffic violation detection and traffic flow analysis comprises threemodules: reading information stored in RFID tag by RFID reader placed near road's traffic signals, extracting ofinformation from RFID reader and traffic signal, and data analysis in server.

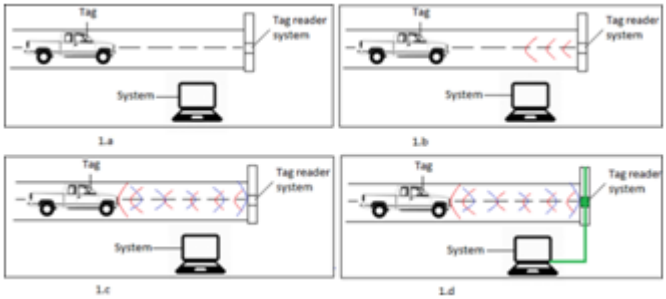

Figure 1. 2a) System setup b) Scanning RFID tag by reader c) Reading information from RFID tag d) Extracting information from tag reader and analysis.

The overall control flow of system takes place in three stages: environment perception (sensor data acquisition), decision, and control action. In the perception stage, the data from the traffic environment and the vehicles are acquired. This stage includes the first two modules of the proposed system. The traffic environment is shown in Figure 2.

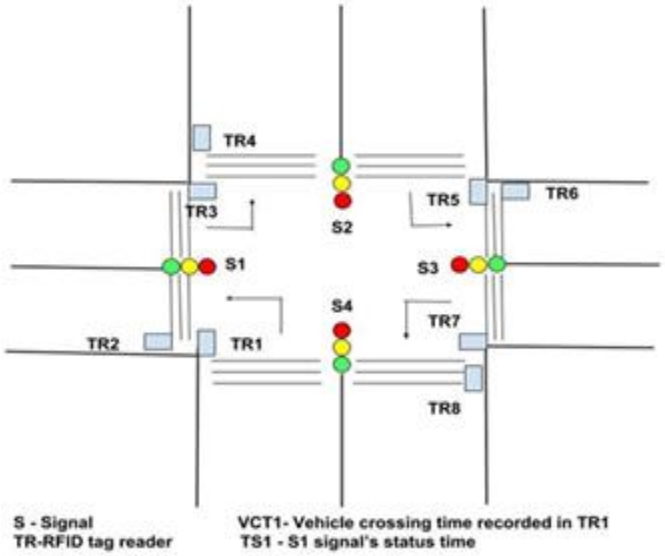

Figure 1. 3 Traffic Environment

II. LITERATURE SURVEY

Table 2. 1 Literature Survey

SNO	TITLE	AUTHORS
1	An RFID-based intelligent vehicle speed controller using active traffic signals"	Perez J, Seco F, MilanesV,Jimenez A, Díaz JC, De Pedro T
2	A RFID Based Traffic Information Acquisition System and Vehicle Positioning Method	Cheng-an ZT, Min-lu J
3	RFID tracking system for vehicles (RTSV)	Pandit AA,Mundra AesK,TalrejaJ
4	A RFID-based material tracking information system	Min Z,WenfengL,Zhongy unW,Bin L,Xia R
5	Applications of fast-moving RFID tags in high-speed railway systems	Li Wei, Zhang Zhen-gang
6	Suitability of passive RFID technology for fastmoving vehicle identification	Khali H,AraarA, Abdulla EZ
7	Automatic vehicle identification (AVI) system based on RFID	Li C

III. METHODOLOGY

There are two sensorial inputs: RFID detections from passive RFID tags placed in vehicle and signal from active traffic signals. The information about the vehicle is read using RFID tag reader. The RFID tag attached to a vehicle contains a microchip which has unique tag number, vehicle number and owner's name, address, phone number and email. The RFID reader which is a two-way radio transmitter-receiver sends out electromagnetic signal to these tags. The tag antenna, which is tuned to receive these waves, responds by modulating the waves and sending it back to the reader which converts the response waves into digital data. A passive RFID tag is used as it draws power from field created by the reader and uses it to power the microchip's circuits. Moreover, RFID reader has ability to read more than one tag response at the same time, thereby improving the overall performance of the process. The status of the traffic signal is acquired from the traffic light controller. In the decision stage, the data obtained in perception stage is analyzed. The data acquired from traffic signal and RFID reader are transmitted to the main computer via wireless communication. The Arduino UNO with built -in WIFI module is connected to RFID reader and used for data communication. The extracted data is pre-processed, filtered and analyzed. The signal transmitted to the server is converted to binary format, 1 for red signal and 0 for green or amber. The date and time of a vehicle crossing are converted to yyyy/mm/dd hr: min: seconds. The tag id, vehicle number, owner's name, phone number, address and email id are also stored in the server. The server checks for the violation of traffic signals. The RFID reader does not flag all vehicles crossing the signal. For instance, in a crossroad, vehicles can turn left freely but not proceed forward. Therefore, if the same vehicle is encountered the second time by a neighbor RFID reader as shown in Figure 2 within 10 seconds of time, it is not counted a violation.

The following algorithm is used to detect the trafficviolation,

Algorithm: Traffic Violation Detection

Input: Vehicle Crossing Time (VCT1, VCT8) and Signal Information (S1, S2, S3, S4), Signal Status Time (TS1, TS2, TS3, TS4)

Output: Penalty/No Penalty

Start
if S1 == 1 then
if TS1 == VCT7 and VCT8
is updated within 10secs "NO PENALTY"
else
"PENALTY"

```
        if S2 == 1 then
                if TS2 == VCT1 and VCT2
is updated within 10secs “NO PENALTY”
                else
                        “PENALTY”
        if S3 = = 1 then
                if TS3 == VCT3 and VCT4
is updated within 10secs “NO PENALTY”
                else
                        “PENALTY”
        if S4 = = 1 then
                if TS4 == VCT5 and VCT6
is updated within 10secs “NO PENALTY
                else
                        “PENALTY”
End
```

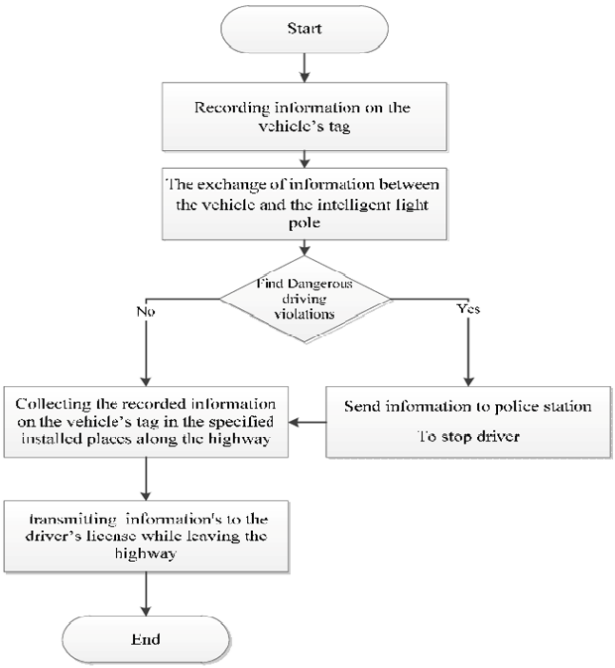

Figure 3. 1 Flow Chart

Components Used:

Microcontroller:

[1] Microcontroller, as the name suggests, are small controllers. They are like single chip computers that are often embedded into other systems to function as processing/controlling unit. For example, the remote control you are using probably has microcontrollers inside that do decoding and other controlling functions. They are also used in automobiles, washing machines, microwave ovens, toys etc, where automation is needed. Here we are using AVR AT Mega 328 microcontroller based on Arduino Platform.

Platform refers to hardware architecture with software framework on which other software can run.

Description

Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software running on a computer (e.g. Flash, Processing, MaxMSP).The boards can be built by hand or purchased preassembled; the software can be downloaded for free. The hardware reference designs (CAD files) are available under an open-source license, you are free to adapt them to your needs. Arduino received an Honorary Mention in the Digital Communities section of the 2006 Ars Electronica Prix. The Arduino team is: Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino and David Mellis.

Figure 3. 2 Types of Microcontrollers

Features

An Arduino board consists of an 8-bit Atmel AVR microcontroller with complementary components to facilitate programming and incorporation into other circuits. An important aspect of the Arduino is the standard way that connectors are exposed, allowing the CPU board to be connected to a variety of interchangeable add-on modules known as shields. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²Cserial bus, allowing many shields to be stacked and used in parallel. Official Arduinos have used the megaAVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and

ATmega2560. A handful of other processors have been used by Arduino compatibles. Most boards include a 5 volt linear regulator and a 16 MHz crystal oscillator (or ceramic resonator in some variants), although some designs such as the LilyPad run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions. An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external programmer.At a conceptual level, when using the Arduino software stack, all boards are programmed over an RS-232 serial connection, but the way this is implemented varies by hardware version. Serial Arduino boards contain a simple inverter circuit to convert between RS-232-level and TTL-level signals. Current Arduino boards are programmed via USB, implemented using USB-to-serial adapter chips such as the FTDI FT232. Some variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods. (When used with traditional microcontroller tools instead of the Arduino IDE, standard AVR ISP programming is used.)The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. The Diecimila, Duemilanove, and current Uno provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs. These pins are on the top of the board, via female 0.1-inch headers.

Some types of Arduino Boards available:

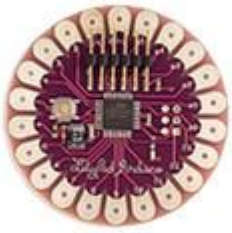

Figure 3. 3Ardunio Lily

Figure 3. 4 Arduino Micro

Figure 3. 5 Arduino Nano

Figure 3. 6 Arduino Leonardo

Figure 3. 7 Arduino Pro

Figure 3. 8 Arduino Fio

Hardware of Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). 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, 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 Uno 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. Revision 2 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

Figure 3. 9 Arduino UNO

Power Supply

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 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 supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five 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 7 to 12 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 can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** 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 pins bypasses 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 current draw is 50 mA.
- **GND.** Ground pins.

Memory:

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

16x2 Character LCD Display:

Figure 3. 10 LCD Display

Description:

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The

reasons being: LCDs are economical; easily programmable; have no limitation of displaying special even custom characters (unlike in seven segments), animations and so on.
A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. 16 Characters x 2 Lines Built-in HD44780 Equivalent LCD Controller Works directly with ATMEGA, ARDUINO, PIC ARM and 8051 many other microcontroller/kits.4 or 8 bit data I/O interface Low power consumption Datasheet available on the Internet.

This LCD has two registers, namely, Command and Data.Command register is used to insert a special command into the LCD. While data register is used to insert a data into the lcd. Command is a special set of data which is used to give internal command to lcd. Like clear screen, move to line 1character, setting up the cursor etc.

Pin Description:

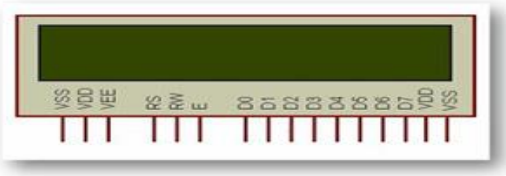

Figure 3. 11 LCD Pin Description

Table 3. 1 LCD Pin Description

Sr. No	Pin No.	Pin Description
1	Pin 1 (GND)	This is a ground pin to apply a ground to LCD.
2	Pin 2 (VCC)	This is the supply voltage pin to apply voltage to LCD.
3	Pin 3 (VEE)	This is the pin for adjusting a contrast of the LCD display by attaching a veriable resistor in between VCC and GND.
4	Pin 4 (RS)	RS stands for Register Select. This pin is used to select command/data register. If RS=0 then command register is selected. If RS=1 then data register is selected.
5	Pin 5 (R/W)	R/W stands for Read/Write. This pin is used to select the operation Read/Write. If R/W=0 then Write operation is performed. If R/W=1 then Read operation is performed.
6	Pin 6 (EN)	En stand for Enable signal. A positive going pulse on this pin will perform a read/write function to the LCD.
7	Pin 7-14 (DB0-DB7)	These 8 pinsare used as a Data pin of LCD.
8	Pin 15 (LED+)	This pin is used with pin 16(LED-) to setting up the illumination of back light of LCD. This pin is connected with VCC.
9	Pin 16 (LEC-)	This pin is used with pin 15(LED+) to setting up the illumination of back light of LCD. This pin is connected with GND.

RFID Reader

EM-18 RFID Reader Module is the one the most commonly used module for Radio Frequency Identification Projects. It features Low Cost, Small Size, Low Power Consumption and Easy to use. It can be directly interfaced with microcontrollers using UART communication. Software UART can be used for microcontrollers having no UART modules. In this tutorial we will see How to Interface EM-18 RFID Reader Module with PIC 16F877A Microcontroller. By understanding the basic idea, you will be able to interface it with any microcontrollers.

Working of RFID

The EM-18 RFID Reader module generates and radiates RF Carrier Signals of frequency 125KHz through its coils. When a 125KHz Passive RFID Tag (have no battery) is brought in to this field, will get energized from it. These RFID Tags are usually made using a CMOS IC EM4102. It gets enough power and master clock for its operations from the electromagnetic fields produced by RFID Reader.

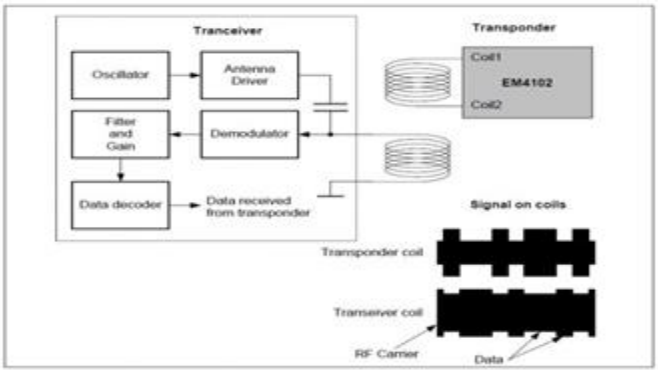

Figure 3. 12 Overview of RFID Reader

By changing the modulation current through the coils, tag will send back the information contained in the factory programmed memory array.

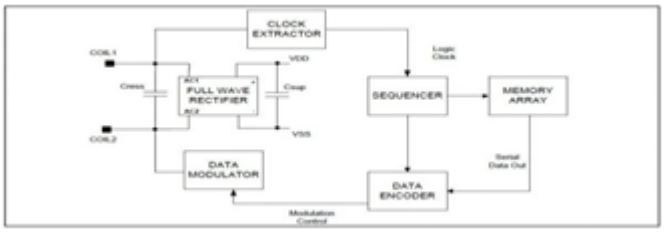

Figure 3. 13 RFID Transponder

GSM Module (SIM900 Overview)

Designed for global market, SIM900 is a quad-band GSM/GPRS engine that works on frequencies GSM 850MHz, EGSM 900MHz, DCS 1800MHz and PCS 1900MHz. SIM900 features GPRS multi-slot class 10/ class 8 (optional) and

supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. With a tiny configuration of 24mm x 24mm x 3mm, SIM900 can meet almost all the space requirements in your applications, such as M2M, smart phone, PDA and other mobile devices.

The physical interface to the mobile application is a 68-pin SMT pad, which provides all hardware interfacesbetween the module and customers' boards.

- The keypad and SPI display interface will give you the flexibility to develop customized applications.
- Serial port and Debug port can help you easily develop your applications.
- One audio channel includes a microphone input and a speaker output.
- Programmable General-Purpose Input & Output.

The SIM900 is designed with power saving technique so that the current consumption is as low as 1.5mA in SLEEP mode. The SIM900 is integrated with the TCP/IP protocol; extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily, which is very useful for those data transfer applications.

Functional Diagram

The following figure shows a functional diagram of the SIM900 and illustrates the mainly functional part:

- The GSM baseband engine
- Flash and SRAM
- The GSM radio frequency part
- The antenna interfaces.
- The Other interfaces

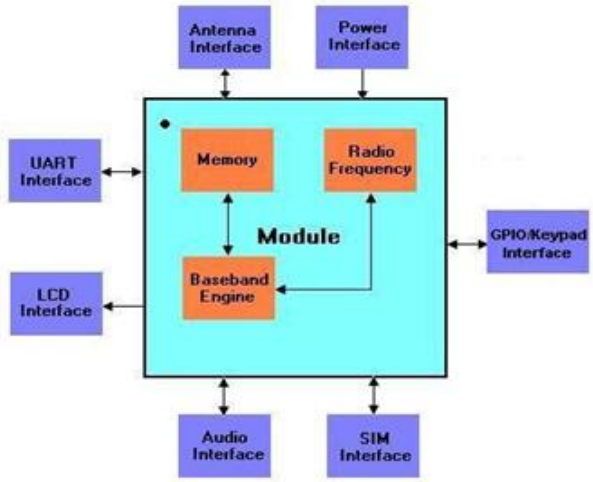

Figure 3. 14GSM Module Functional Diagram

SIM900 Hardware Design

In order to help you on the application of SIM900, SIMCom can supply an Evaluation Board (EVB) thatinterfaces the SIM900 directly with appropriate power supply, SIM card holder, RS232 serial port, handset port,earphone port, line in port, antenna and all GPIO of the SIM900.

Figure 3. 15 Top view of SIM900 EVB

Software:

Introduction to Arduino IDE:

IDE stands for "Integrated Development Environment": it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this software that is an open source and is readilyavailable to install and start compiling the code on the go.In this article, we will introduce the Software, how we can install it, and make it ready for developing applications using Arduino modules.

Arduino IDE Definition:

Arduino IDE is an open source software that is mainly used for writing and compiling the codeinto the Arduino Module. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital rolefor debugging, editing and compiling the code in the environment. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more. Each of them contains a microcontroller on the board that is actually programmed and accepts theinformation in the form of code. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and

uploaded in the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

Libraries:

Libraries are very useful for adding the extra functionality into the Arduino Module. There is a list of libraries you can add by clicking the Sketch button in the menu bar and going to Include Library. As you click the Include Library and add the respective library it will on the top of the sketch with a #include sign.Suppose,I include the EEPROM library, Temperature sensors DHT11/22, LCD or I2C library it will appear on the text editor as

#include <EEPROM.h>.
#include <dht.h>
#include <I2Cdev.h>

Most of the libraries are preinstalled and come with the Arduino software. However, we can also download them from the external sources. Making Pins as Input or Output The digitalRead and digital Write commands are used for addressing and making the Arduino pins as an input and output respectively. These commands are text sensitive i.e. you need to write them down the exact way they are given like digitalWrite starting with small "d" and write with capital "W". Writing it down with Digitalwrite or digitalwrite won't be calling or addressing any function.

Example:

If we want to use Pin D13 as output, the code will be;pinMode(13, OUTPUT);
followed by
digitalWrite(13,HIGH);

If we want to use Pin D13 as input, the code will be: pinMode(13, INPUT);
followed by
x=digitalRead(13);

Selecting Board of Arduino

In order to upload the sketch, we need to select the relevant board we are using and the ports for that operating system. As we click the Tools on the Menu, it will open. Just we go to the "Board" section and select the board we would like to work on. Similarly, COM1, COM2, COM4, COM5, COM7 or higher are reserved for the serial and USB board. we can look for the USB serial device in the ports section of the Windows Device Manager.

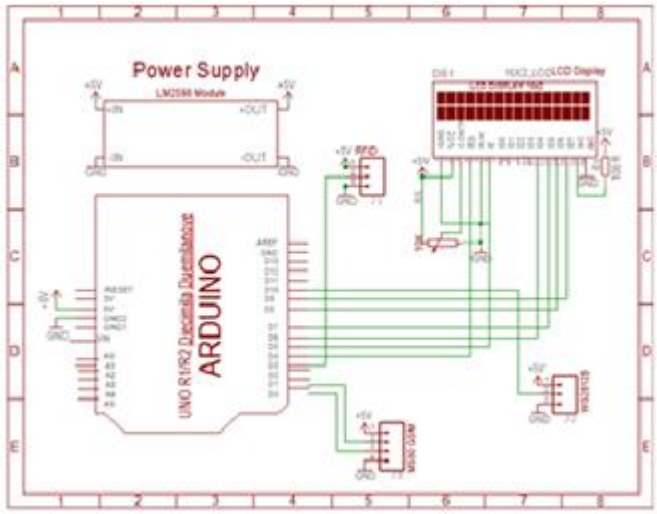

Figure 3. 16 PIN Configuration

IV. RESULTS

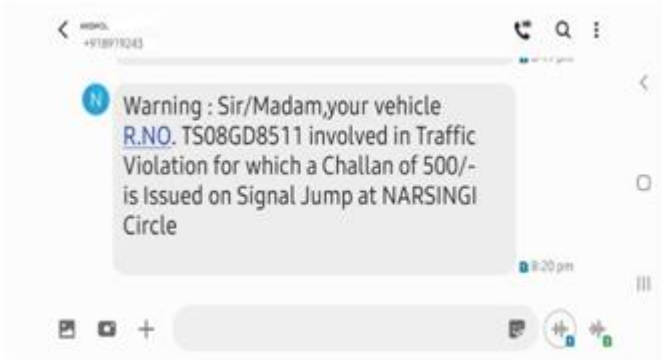

Figure 4. 1 Output Message -1

In This output Screen when vehicle jumps signal at Narsingh Circle by violation the rules Automatic Traffic Ticket will been issued and Message is Immediately Sent to Owner Register number.

Figure 4. 2 Output Message - 2

V. CONCLUSION AND FUTURE SCOPE

We have proposed a system for automatic detection and penalty management of signal violation which will in turn help to decrease the number of accidents. The system also analyzes the traffic flow on a given road at a given time according to the circumstances of the road. The proposed architecture is portable, accurate and can be installed at a reasonable cost. The system alleviates the need for traffic police at every signal to manually identify the violations. The system shows promising results on automatic detection, since the detection of the tag identification is more precise, reliable and efficient in active RFID, leading to implement corrective actions. The experiments are done using four test vehicles. The frequency of RFID reader is 125 Hz and the range of the RFID reader is 1 meter. In real time environment, if the average road lane is 3.5m, then approximately two 125 Hz readers are required for one road lane. Many vehicles may be moving nearby and possibly blocking or attenuating some of the RFID signals, especially with large vehicles like trucks. A possible solution is the use of RFID readers of higher frequency range since their reading range is high.

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