EEE4033
Industrial Instrumentation

Under the supervision of

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SCHOOL: SELECT

AUTOMATED TOLL COLLECTION SYSTEM USING RFID

by

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ABSTRACT

ATCS is an Automated Toll Collection System used for collecting tax automatically. In this we do the identification with the help of radio frequency. A vehicle will hold an RFID tag. This tag is nothing but unique identification number assigned. This will be assigned by RTO or traffic governing authority. In accordance with this number we will store, all basic information as well as the amount he has paid in advance for the TOLL collection. Reader will be strategically placed at toll collection center. Whenever the vehicle passes the toll collection center, the tax amount will be deducted from his prepaid balance. New balance will be updated. In case if one has insufficient balance, his updated balance will be negative one. To tackle this problem, we are alarming a sound, which will alert the authority that this vehicle doesn't have sufficient balance and that particular vehicle can be trapped. As vehicles don't have to stop in a queue, it assures time saving, fuel conservation and also contributing in saving of money. Automatic Toll Collection systems have really helped a lot in reducing the heavy congestion caused in the metropolitan cities of today. It is one of the easiest methods used to organize the heavy flow of traffic.

INTRODUCTION

As we all know that transportation is the backbone of any country's economy. Improvement in transportation systems result into the good lifestyle in which we achieve extraordinary freedom for movement, immense trade in manufactured goods and services, as well as higher rate of employment levels and social mobility. In fact, the economic condition of a nation has been closely related to efficient ways of transportation. Increasing number of vehicles on the road, result into number of problems such as congestion, accident rate, air pollution and many other . All economic activities for different tasks use different methods of transportation. For this reason, increasing transportation is an immediate impact on productivity of nation and the economy. Reducing the cost of transporting resource at production sites and transport completed goods to markets is one of the important key factors in economic competition. Automatic toll collection is a technology allows the automated electronic collection of toll costs. As it is studied by researchers and also applied in various expressways, bridges, and tunnels require such a process of Automatic Toll Plaza. ATP is capable of determining if the vehicle is registered or not, and then informing the management center about to process violations, debits, and participating accounts .The most excellent advantage of this ATP system is that it is capable of eliminate congestion in toll plaza, especially during those seasons when traffic seems to be higher than normal.

The Benefits of this System are:

- Shorter queues at toll plazas by increasing toll booth service rates
- Faster and more efficient service
- The ability to make payments by keeping a balance on the card itself and
- The use of postpaid toll statements
- Other general advantages include minimization of fuel wastage and reduced emissions by reducing deceleration rate, waiting time of vehicles in queue, and acceleration.

For Toll Operators, the benefits include:

- Lowered toll collection costs
- Better audit control by centralized user account
- Expanded capacity without building more infrastructures.

Thus, the ATP system is useful for both the motorists and toll operators, this is the reason of extended use of ATP system throughout the world.

OBJECTIVES

The base idea behind implementing RFID Based Toll System is to automate the toll collection process and their by reducing manual operation in toll booths and the long queues at toll booths using RFID tags installed on the vehicles. In addition to we can not only help the vehicle owners and system administrators from vehicle theft detection but also can track over speeding vehicles, and crossing the signals. Here we are going to see some points regarding to purpose behind choosing this topic & what is the requirement of this type of the project in our day to day life.

- Automatic collection of toll tax.
- Free flow of traffic.
- Time saving.
- Record maintenance.
- Problems with pursuing toll evaders.
- Avoid the fuel loss.
- Saving of time in collecting toll.
- Avoid financial loss.
- To monitor the traffic.

According to the survey of Karnataka Government, in Sept.2012 they have proposed to get the annual toll collection about 2500 crores/year .But in the present situation they are able to collect only 900 crores of the toll value. Means there is loss of 600 crores due to human errors. So, in this situation we have to control this leakage. Now the present system we have with us on the high ways takes 1 minute to complete the toll collection process for one vehicle. With this automatic process, it will take just less than a minute. to complete the whole process. As there is reduction in time for completion of the process so indirectly there will be no traffic as such & as there is no traffic so no fuel wastage takes place & the purpose of designing the highways is achieved i.e. reduction in journey time & also the money loss will be reduced.

PROBLEM STATEMENT

Whenever the matter of Integration of systems comes to mind, we think of a system having the following important features viz.

Accuracy: All the functionally bonded logical dependencies must be integrated.

Efficiency: The whole system should work under all circumstances and on a long run it should work efficiently irrespective of their proprietary format.

Cost Effectiveness: As our software do not require any special software for implementation hence is less costly as compared to other existing system.

Any Prerequisite for the use: As the existing systems are not altered, and integration is done at the background hence there is no need for any training.

Literature Survey

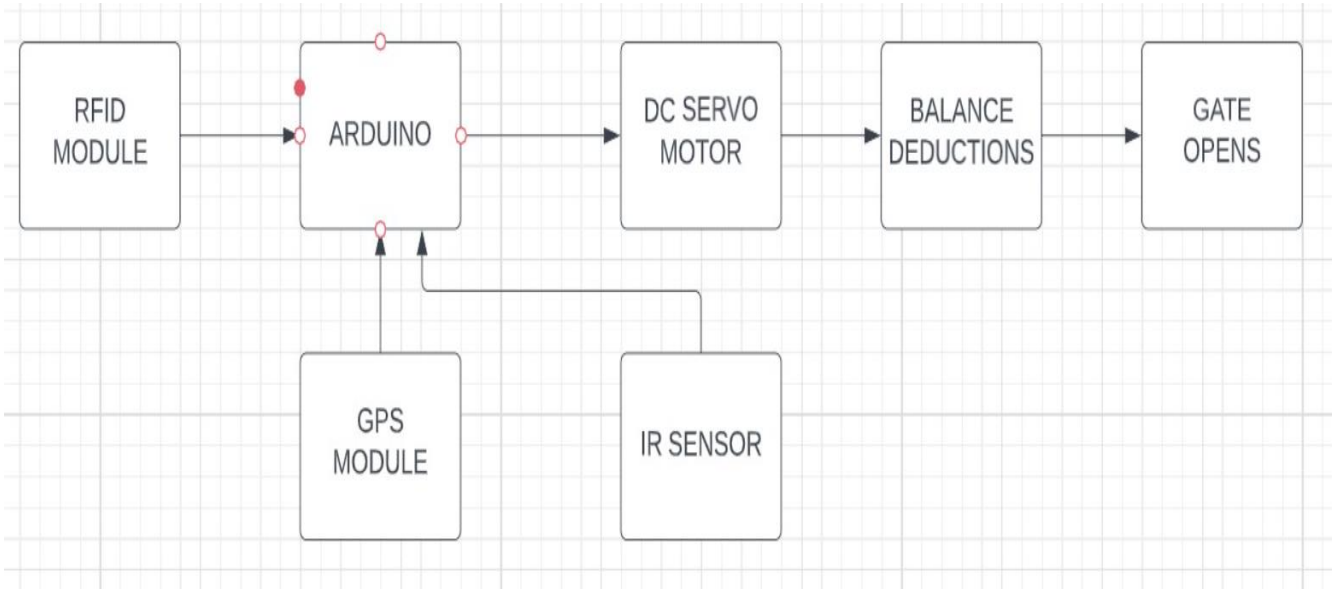
Automatic check-post and fast track Toll system using RFID and GSM module with security system	In present situation vehicle checking is huge trouble to the people with regard to license, insurance and RC book. It brings on traffic bother and also in toll gate system traffic jam occurs, time and fuel absorption is elongated. The automated toll accumulation system is very successful right now. This paper has to do with Automated Toll collection and Check-Post system using Radio Frequency Identification (RFID) and Global System for Mobile communications (GSM) module.	https://ieeexplore.ieee.org/abstract/document/8341461
Automated Toll Tax Collection System using Cloud Database	Every vehicle is tagged with a RFID tag, which has vehicle's registration number in it, which can be sensed by RFID reader present at tollbooth. RFID reader will send this information to IoT controller (Arduino). Sensed registration number can looked in to cloud database for getting wallet balance and if sufficient balance is there, and then toll charges can be deducted automatically	https://ieeexplore.ieee.org/abstract/document/8519929
Automated Toll Collection System Based on RFID Sensor	In this paper, RFID based Automated Toll Collection System is introduced as a solution of the traffic problems and also to maintain transparency in the toll collection system. The proposed system aims to make a digital toll collection system which can eliminate the delay on toll roads, toll bridges and toll tunnel without cash and without requiring cars to stop.	https://ieeexplore.ieee.org/abstract/document/8888429
Gateless Electronic Toll Collection using RFID	An effective and efficient utilization of communication link between RF Modems over a wireless channel to facilitate monitoring, authentication and automated toll collection of vehicles on the highways is proposed in the paper.	https://www.researchgate.net/profile/Darshan-Ingle/publication/269750843_Gateless_Electronic_Toll_Collection_using_RFID/links/58ad0f21a6fdccac900b16fa/Gateless-Electronic-Toll-Collection-using-RFID.pdf
Smart Highway Electronic Toll Collection System	The system produced is microcontroller based system with embedded c coding, and the hardware is interfaced with java base coding. The softwares used are netbeans and jdk for hardware, mysql for database and mikro c for interfacing microcontroller.	https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1057.1066&rep=rep1&type=pdf
RFID Based Toll Collection System	The automated toll collection system using passive Radio Frequency Identification (RFID) tag emerges as a convincing solution to the manual toll collection method employed at tollgates. Time and efficiency are a matter of priority of present day. In order to overcome the major issues of vehicle congestion and time consumption RFID technology is used	https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.636.7019&rep=rep1&type=pdf

METHODOLOGY

Flow of RFID based toll tax are:

- Detection of vehicle
- Display of toll
- Payment through RFID card

Whenever any person buys a vehicle, first he/she need to do her vehicle registered at the RTO office. RTO people will assign a number plate to it along with it they will give a RFID enabled tag. This card will have a unique ID feasible to use with that vehicle only. They will also create an account for that particular smart card and maintain transaction history in database. Owner of the vehicle needs to deposit some minimum amount to this account. Every time a registered vehicle approaches the toll booth, first the Infrared sensors will detect the presence of the vehicle which in turn activates the RFID circuit to read the RFID enable smart card fixed on the windscreen of the vehicle. Transaction will begin, depending upon the balance available toll will be deducted directly or the vehicle will be directed towards another lane to pay tax manually. The software further updates the details in the Centralized database server. It also triggers mechanism to generate the bill and will be sent to user as a text message. On the other hand, whenever any vehicle owner registers a complaint at the RTO office regarding theft of the vehicle respective entry is made in the database. Now any vehicle arriving at toll booth with same ID as already present in stolen vehicle category will be easily identified as the ID assigned with it is unique. All the toll plazas will be connected to each other along with the centralized server in the form of LAN. Updates of any sort of transaction will be immediately updated to local database and centralized server.



EQUIPMENTS REQUIRED:

HARDWARE:

- Arduino Uno (Atmega 328P Microcontroller)
- MFRC522 RFID Module
- IR Obstacle Sensor
- DC servo motor
- GPS Neo-6M

SOFTWARE:

- Arduino IDE

Atmega 328P Microcontroller:

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.

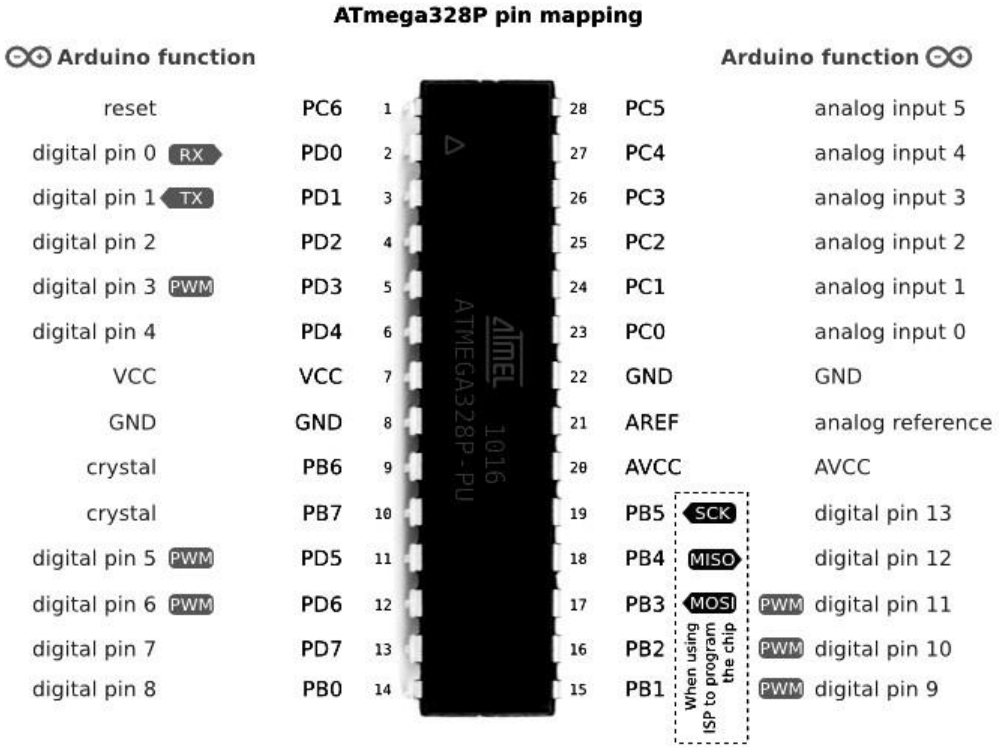


FIGURE 2: Pin diagram of Atmega 328P Microcontroller

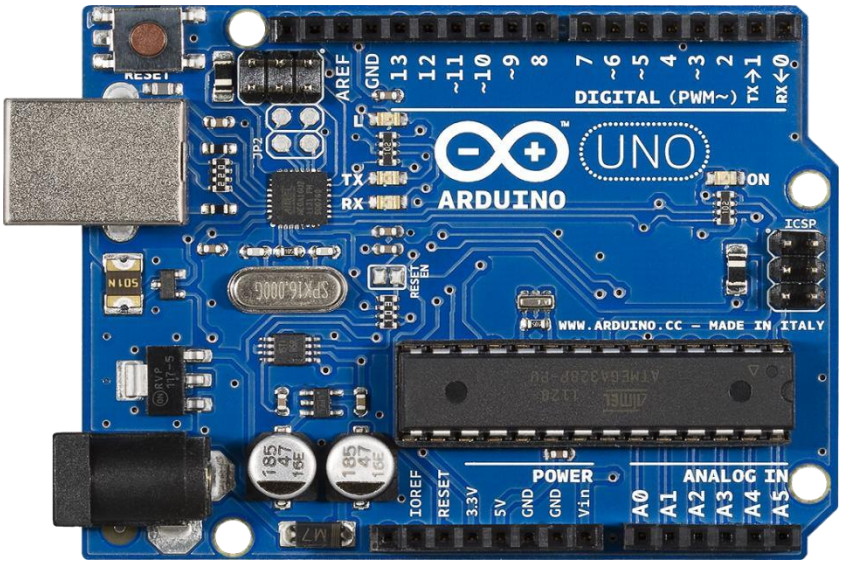


FIGURE 3: Arduino Uno(Atmega 328P Microcontroller)

Specifications:

- Microcontroller ATmega328
- Operating Voltage 5V
- Input Voltage (recommended) 7-12V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6 DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 32 KB of which 0.5 KB used by boot loader
- SRAM 2 KB
- EEPROM 1 KB
- Clock Speed 16 MHz

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). We can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.

Input Output Pins:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL

Serial chip.

- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- The Uno has 6 analog inputs, each of which provides 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:
- I 2C: 4 (SDA) and 5 (SCL). Support I2C communication using the Wire library. There are a couple of other pins on the board:
- AREF. Reference voltage for the analog inputs. Used with analog Reference().
- Reset. Bring this line LOW to reset the microcontroller.

MFRC522 RFID Module:

Mifare RC522 is the high integrated RFID card reader which works on non-contact 13.56 MHz communication, is designed by NXP as low power consumption, low cost and compact size read and write chip, is the best choice in the development of smart meters and portable hand-held devices.

MF RC522 use the advanced modulation system, fully integrated at 13.56MHz with all kinds of positive non-contact communication protocols. Support 14443A compatible answer signal. DSP deal with ISO14443A frames and error correction. Furthermore, it also supports rapid CRYPTO1 encryption to validate Mifare series products. MFRC522 support Mifare series higher speed non-contact communication, duplex communication speed up to 424 kb/s. As a new family member in 13.56MHz RFID family, MF RC522 has many similarities to MF RC5200 and MF RC530, and also has more new features.

This module can fit directly in hand held devices for mass production. Module use 3.3V power supply, and can communicate directly with any CPU board by connecting through SPI protocol, which ensure reliable work, good reading distance.

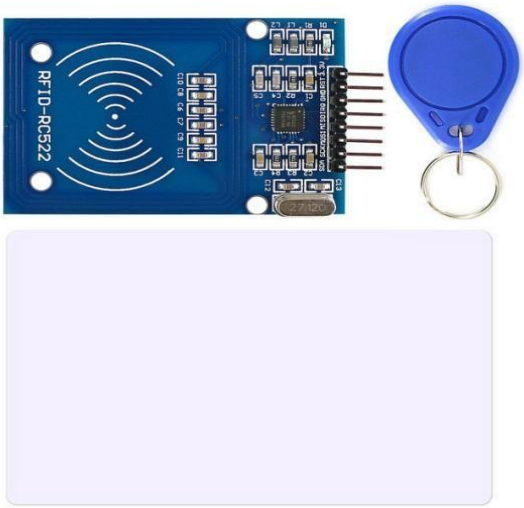
Specifications

- Voltage: DC 3.3V
- Operating Current :13-26mA
- Idle Current :10-13mA

- Sleep current: <80uA
- Peak current: <30mA
- Operating Frequency: 13.56MHz
- Supported card types: mifare1 S50, mifare1 S70, mifare UltraLight, mifare Pro, mifare Desfire
- Dimensions: 40mm × 60mm
- Module Interface SPI Data Transfer Rate: Max. 10Mbit/s
- Card reading distance ：0～30mm （Mifare1 card）

RFID Technology:

The RFID reader is one kind of wireless module used for transferring the data to identify and track tags which are connected to objects. The RFID tag mainly includes the stored information. Some of the RFID tags are run by electromagnetic induction from magnetic fields formed nearby the reader. RFID reader comprises an RF module that works as a transmitter as well as a receiver of RF (radio frequency) signals.



The TX of the RF module is inbuilt with an oscillator to make the carrier frequency. A modulator to intrude commands upon this carrier signal and an amplifier to raise the signal sample to wake the tag. The RX (receiver) of the RFID module contains a demodulator to remove the returned information and also grips an amplifier for supporting the signal of processing. A microprocessor is used for forming the control unit, which uses an operating system, a memory of the module filter and also stores the data.

What are Real Time Clocks?

Real time clocks (RTC), as the name recommends are clock modules. The DS1307 real time clock (RTC) IC is an 8 pin device using an I2C interface. The DS1307 is a low-power clock/calendar with 56 bytes of battery backup SRAM. The clock/calendar provides seconds, minutes, hours, day, date, month and year qualified data. The end date of each month is automatically adjusted, especially for months with less than 31 days.

They are available as integrated circuits (ICs) and supervise timing like a clock and also operate date like a calendar. The main advantage of RTC is that they have an arrangement of battery backup which keeps the clock/calendar running even if there is power failure. An exceptionally little current is required for keeping the RTC animated. We can find these RTCs in many applications like embedded systems and computer mother boards, etc. In this article we are going to see about one of the real time clock (RTC), i.e. DS1307.

SERVO MOTOR

Servo motors have three wires: power, ground, and signal. The power wire is typically red, and should be connected to the 5V pin on the Arduino board. The ground wire is typically black or brown and should be connected to a ground pin on the board. The signal pin is typically yellow or orange and should be connected to PWM pin on the board. In these examples, it is pin number 9.

Infrared Sensor (IR Sensor)

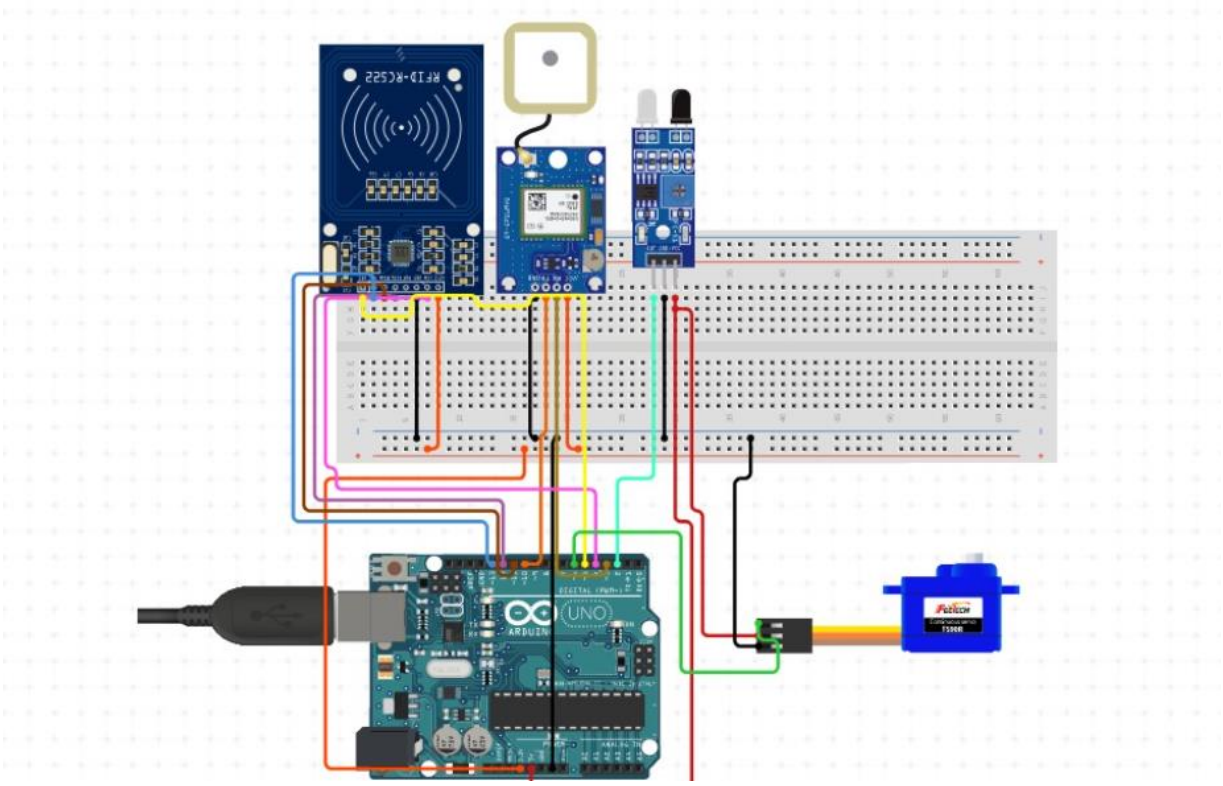
IR Proximity Sensor are used to detect objects and obstacles in front of sensor. Sensor keeps transmitting infrared light and when any object comes near, it is detected by the sensor by monitoring the reflected light from the object. It can be used in robots for obstacle avoidance, for automatic doors, for parking aid devices or for security alarm systems, or contact less tachometer by measuring RPM of rotation objects like fan blades.

GPS NEO-6M

At the heart of the module is a GPS chip from U-blox – NEO-6M. The chip measures less than a postage stamp but packs a surprising amount of features into its tiny frame.

The NEO-6M GPS module is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability. With the power and signal indicators, you can monitor the status of the module.

CIRCUIT DIGRAM



ARDUINO CODE:

```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
static const int RXPin = 4, TXPin = 3;
static const uint32_t GPSBaud = 9600;
// The TinyGPS++ object
TinyGPSPlus gps;
// The serial connection to the GPS device
SoftwareSerial ss(RXPin, TXPin);


#include <SPI.h>
#include <MFRC522.h>
#include <Servo.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define OLED_RESET 4
Adafruit_SSD1306 display(OLED_RESET);
#define RST_PIN 8
#define SS_PIN 10

Servo myservo;
int servoPos = 0;
#define num 7
char Data[num];
byte data_count = 0;

String num1, card;
int a;
char Key;

int car_balance;
int bus_balance;
```

```
float car_fair;
float bus_fair;
float distance;
float lat_new;
float lng_new;
float lat_old = 1297102.0;
float lng_old = 7915932.5;
float x;
float y;
float min_dist;
float final_dist=0;

MFRC522 mfrc522(SS_PIN, RST_PIN);


void setup() {
  car_balance = 500;
  bus_balance = 1000;
  SPI.begin();
  mfrc522.PCD_Init();
  Serial.begin(9600);
  myservo.attach(6);
  myservo.write(180);
  attachInterrupt(0,exiting,RISING);

  ss.begin(GPSBaud);
}

void rfid()
{
  if (! mfrc522.PICC_IsNewCardPresent())
  {
    return;
  }
```

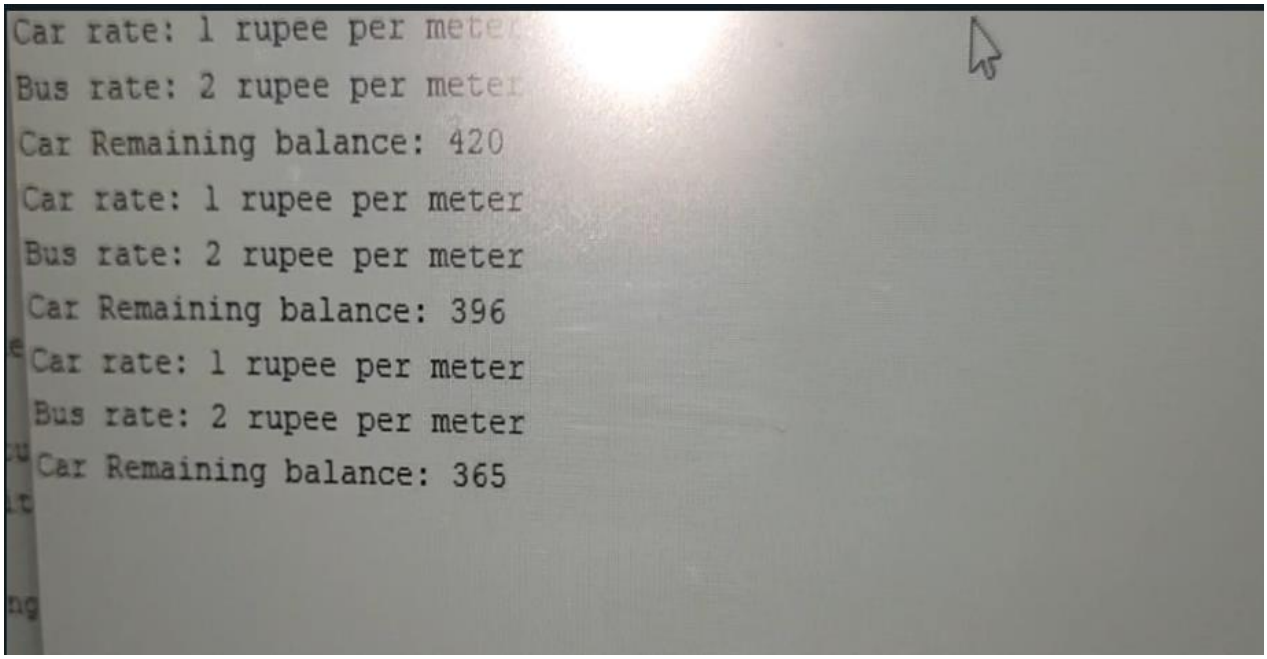
```
if (! mfrc522.PICC_ReadCardSerial())
{
  return;
}

String content = "";
for (byte i = 0; i < mfrc522.uid.size; i++)
{
  content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
  content.concat(String(mfrc522.uid.uidByte[i], HEX));
}
content.toUpperCase();

if (content.substring(1) == "C1 EA 23 19")
{
  if(car_balance>=120){
    myservo.write(90);
    car_balance = car_balance -car_fair;
    Serial.println("Car rate: 1 rupee per meter");
    Serial.println("Bus rate: 2 rupee per meter");
    Serial.print("Car Remaining balance: ");
    Serial.println(car_balance);
    final_dist = 0;
    delay(2000);
  }
  else{
    Serial.println("Your car remaining balance is not sufficient");
    delay(1000);
  }
}
if (content.substring(1) == "C1 37 CE 24")
{
  if(bus_balance>=200){
    myservo.write(90);
    bus_balance = bus_balance -bus_fair;
```

```
      Serial.println("Car rate: 1 rupee per meter");
      Serial.println("Bus rate: 1 rupee per meter");
      Serial.print("Bus Remaining balance: ");
      Serial.println(bus_balance);
      final_dist = 0;
      delay(2000);
    }
    else{
      Serial.println("Your bus remaining balance is not sufficient");
      delay(1000);
    }
  }
}

void exiting(){
  myservo.write(180); //this is an interrupt function when car exits
}

void loop() {
//  while (Serial.available() == 0) {
//  }
//  int cash_input = Serial.parseInt();
//  if(cash_input == 200){
//    myservo.write(90);
//    delay(2000);
//    myservo.write(180);
//  }

  while (ss.available() > 0)
  {
   gps.encode(ss.read());
   if (gps.location.isUpdated())
   {
//     Serial.print("Latitude= "); //this line of code is for latitude
       lat_new = (gps.location.lat())*100000;
```

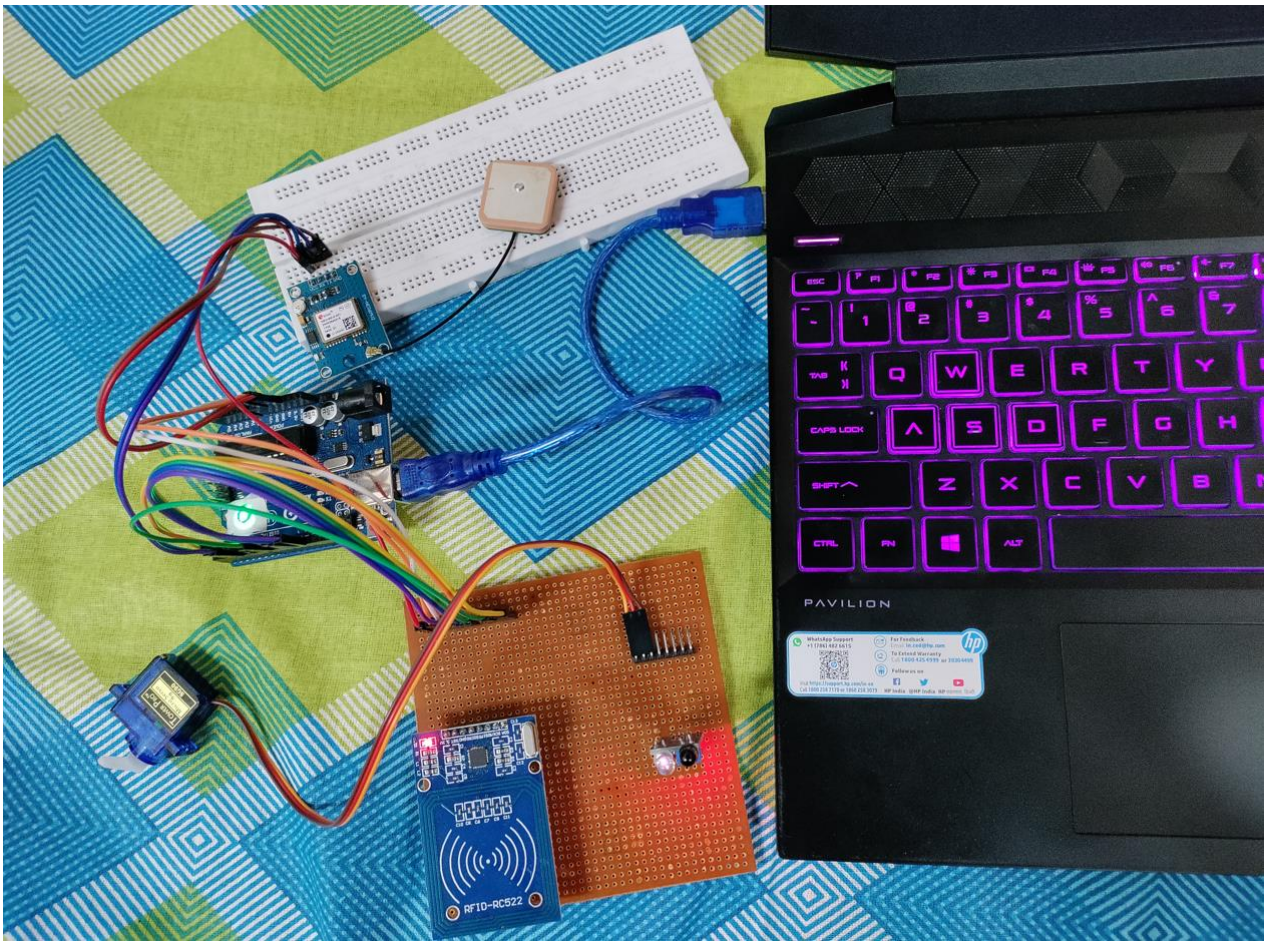
```
//     Serial.print(lat_new, 6); //this will print the value of latitude
//     Serial.print(" Longitude= "); //this line of code is for longitude
       lng_new = (gps.location.lng())*100000;
//     Serial.println(lng_new, 6); //this will print the value of longitude
      x = lat_old-lat_new;
      y = lng_old-lng_new;
      lat_old=lat_new;
      lng_old=lng_new;
      min_dist = sqrt(x*x+y*y);
      final_dist = final_dist+min_dist;
    }
  }
// Serial.println(final_dist);
  car_fair = final_dist;
  bus_fair = final_dist*2;
  rfid();
}
```

RESULT

SERIAL MONITOR



Hardware Implementation



FUTURE SCOPE OF THE PROJECT

1. **Automatic Vehicle Identification:** The automatic vehicle identification (AVI) component of this system refers to the technologies that determine the identification or ownership of the vehicle so that the toll will be charged to the corresponding customer.

2. **Automatic Vehicle Classification**: Vehicle type and class may have differentiated toll amount. The vehicle type may include light vehicles like the passenger car or heavy vehicles like recreational vehicles. A vehicle's class can be determined by the physical attributes of the vehicle, the number of occupants in the vehicle, the number of axles in the vehicles and the purpose for which the vehicle is being used at the time of classification

3. **Video Enforcement System:** When used for electronic toll collection, the video enforcement system (VES) captures images of the license plates of vehicles that pass through an electronic tollbooth without a valid electronic tag. Although the deployment of these technologies makes the initial cost of installation very high, but there exits huge benefits accompanied with such high investment. These benefits are discussed in the upcoming section.

CONCLUSION

The Electronic Toll Collection system in expressway based on RFID, a design scheme was put forward. It is low cost, high security, far communication and efficiency, etc. It not only improves the passage ability of expressway but also improves the technology level of charge. Electronic toll collection system using RFID is an effective measure to reduce management costs and fees, at the same time, greatly reduce noise and pollutant emission of toll station. In the design of the proposed Electronic toll collection (ETC) system, real time toll collection and anti-theft solution system have been designed. This reduces the manual labour and delays that often occur on roads. This system of collecting tolls is eco friendly and also results in increased toll lane capacity. Also an anti-theft solution system module which prevents passing of any defaulter vehicle is implemented, thus assuring security on the roadways.

DEMONSTRATION VIDEO LINK

https://drive.google.com/file/d/1UsqtgmC0Phd2C6Sq7rUMSBfrgVGRUQzl/view?usp=drivesdk

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