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# Electronic Tolling System using Arduino

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***Abstract -*** *Toll is an amount of money paid for the use of a bridge or a road. Most countries use either the toll booth system or the RFID tag and scanner method. Recent studies have shown that not only does traffic congestion but also slow traffic or delay at toll booths also cost the country a lot of resources and indirectly money. The methods currently in place are neither efficient nor cost effective. In this paper, a new method of tolling is introduced which uses Arduino and is a much more cost effective method.*

**Key words: Electronic tolling, Arduino, GPS, GSM**

## 1.INTRODUCTION

Paying toll is something that every vehicle owner would have done at some point in their lives. One of the most well-known and widely used methods is the one using the toll booth. Though this method is extremely simple, it is very inefficient as it requires the owner to keep ready an exact amount or wait for the official at the booth to give them change. The other method which is popular is tolling through the use of RFID scanner and tag. Even though this is an improvement over the toll booth system, it is not very cost effective. Recent studies have shown that in India, delays at toll booths can cost the country up to Rs.60000 crore per annum. With the increased development in highways and the number of vehicles on the road, the number of toll booths required is increasing every year. Though the number of vehicles on road have increased each year, the number of vehicles paying toll has either remained same or increased only by a little which proves to be a loss to the government. The government is, therefore, willing to pay Rs.14000 crore every year to stop this tolling system. In this paper, we propose a new type of tolling that minimizes the need for toll booths and also helps to reduce slow traffic by a little.

The proposed system contains Arduino which takes the signal coming from GPS module and checks if the user has entered a specified range. This range is marked in the system using its latitude and longitude coordinates. If so, credits are deducted from the user's account and a message is sent to the user notifying them of the deduction.

## 2. LITERATURE SURVEY

### *[1]. RFID-based automated tollbooth system*

In this paper, each vehicle is installed with a passive RFID tag. When the vehicle enters the tollbooth, the tag is scanned using the RFID scanner. Once scanned, the system checks to see if the vehicle is present in the database. Once the details of account are available, the required amount is deducted from the user's account automatically.

### *[2]. Smart highway electronic toll collection system*

This research paper describes the automated toll collection system for toll gate based on RFID technology. There are three portions in toll collection system. They are RFID system, balance deduction system in host computer and toll gate control system. The microcontroller is also used to control the stepper motor and display the deposit on the LCD. The authorized person at the toll gate can check the ID numbers, vehicle numbers and the amount of balance with the database on PC. The new user can register and update the amount of balance via Graphical User Interface (GUI) easily. A number of deposits will also update simultaneously at the two databases of the toll gate because of LAN network. By using this system, it will save time, i.e. by avoiding long queue as no need to stop the vehicle and no need of manual transaction at the toll gate.

### *[3] High-Performance license plate recognition system*

The license plate recognition (LPR) system is one kind of Intelligent transportation systems (ITS) and is of considerable interest because of its potential applications in such areas as highway electronic toll collection, red-light violation enforcement, secure-access control at parking lots and so on. The paper introduces the system framework and work flow of LPR system which works based on web technique

## 3. EXISTING METHODS

There are currently two methods of toll collection which are in place. One is where the money is collected at the toll booths and the user is required to pay the toll at the booth. Though this method is extremely simple, it is highly inefficient.

Another method that is now gaining popularity is the one where a RFID tag is attached to the windshield of the vehicle and a RFID scanner present is used to scan the tag. This method is an improvement over the toll booth but it is expensive.

### 3.1 Disadvantages of existing methods

- In toll booth method, there would be a lot of expenditure in building the toll booth.
- It is inefficient as it delays traffic and wastes time RFID tag and scanner is relatively expensive

## 4. PROPOSED METHOD

Electronic tolling system using Arduino uses the signals coming from the GPS module to check if the vehicle has entered a certain latitude and longitude range. In an event where it has, the Arduino uses the GSM module and the SIM slot to send a text message to the user informing them of the amount to be deducted. A mobile application is also provided for the user where one is required to sign in using the email address and password. For the first time, they are required to register. The mobile application provides them the facilities of location tracking and viewing all transactions.

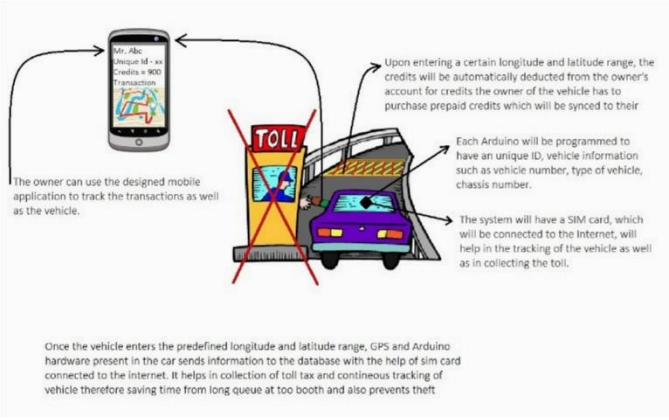


Fig 1. Overview of the proposed system

### 4.1 MODULES OF PROPOSED SYSTEM

*A. Arduino Board*

Arduino is an open source, computer hardware and software company and a user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),permitting the manufacture of Arduino boards and software distribution by anyone. It consists of a physical programmable circuit board and an integrated development environment which is run on the computer and is used to write and upload computer code to the physical board. In this project, Arduino is used for interacting with the GPS and the GSM module.

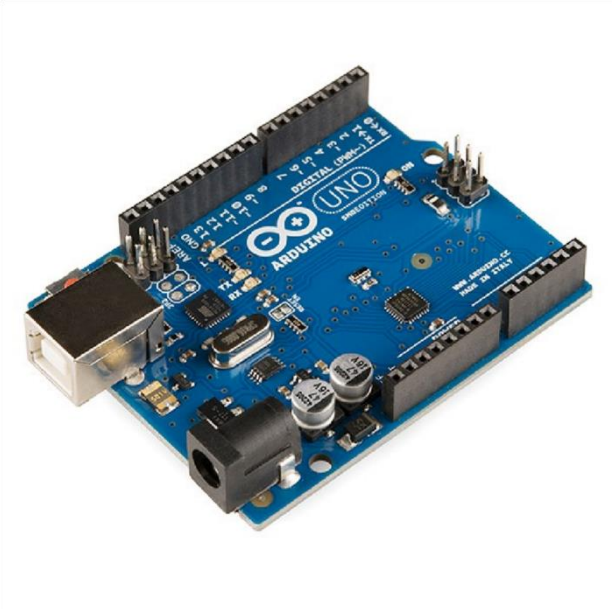


Fig 2. Arduino Board

*B. Global positioning system (GPS) module*

It is a global navigation satellite system that provides geolocation and time information to GPS receiver on Earth provided that there is no obstruction in the line of sight. Here we use NEO-6 module series is a family of stand-alone GPS receivers featuring the high-performance u-blox 6 positioning engine. Their compact architecture and power and memory options make NEO-6 modules ideal for battery operated mobile devices. The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix0(TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments thus providing the location of the vehicle.

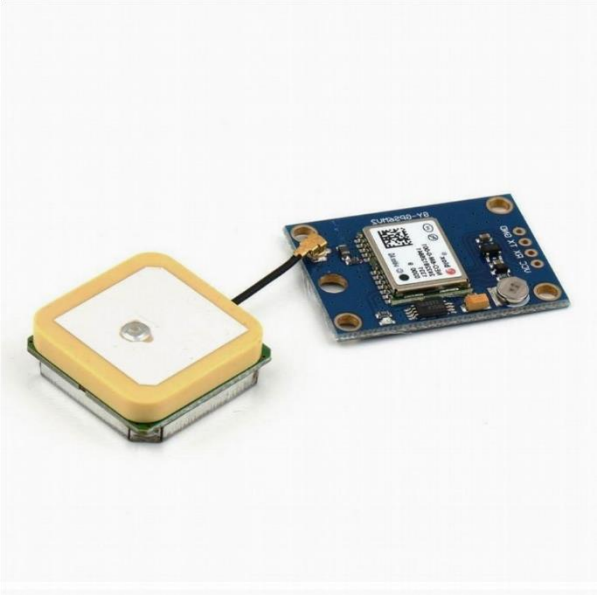

Fig 3. GPS module

C. *Global system for mobile communication (GSM) module*
GSM is a widely used digital mobile telephony system. In this project, SIM800 module is a GSM quad band module is used. It is based on the latest GSM/GPS module SIM808 from SIMCOM, supports GSM/GPRS Quad-Band network and combines GPS technology for satellite navigation.It has high GPS receive sensitivity with 22 tracking and 66 acquisition receiver channels. Besides, it also supports A-GPS that available for indoor localization. The module is controlled by AT command via UART and supports 3.3V and 5V logical level. the GSM module together with the GPS module is used to send message notifications to the user about them entering a certain specified location.

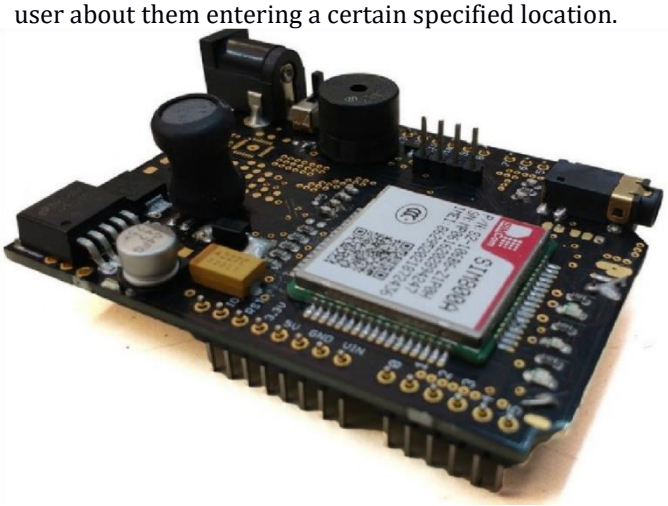

Fig 4. GSM module

*D. Mobile application*
The mobile application is designed specifically for the user to view their transactions and also help in location tracking. The application requires the user to sign in with email address and password once they have registered. In an event where the registration has not taken place, the user is required to enter details such as name, email address, postal address, phone number, chassis number and a password. Once logged in, the user can view the profile which provides 3 options: settings, map or view transaction. The map option can be used for location tracking, the settings option allow the user to change banking details and profile information. The view transaction allows the user to view the previous transaction.

### 4.2. ADVANTAGES OF PROPOSED SYSTEM

- It is much cheaper as the hardware is available for low price and the software is available free of cost as it is open source
- There is also no need for construction of toll booths
- It will not delay or slow the traffic in any way

## 5. IMPLEMENTATION

To implement this idea of electronic tolling system using Arduino, Android Studio and Arduino IDE has been used. Arduino IDE is a cross-platform application and it allows the user to write code to enable the Arduino board and the connecting sensors/modules. Once the connection is established it is linked to the server. On the other side Android Studio is platform for building the android application. The android application is linked to the server with the help of the mobile network connection. Now both the device and the Arduino board is linked to an IoT cloud platform.

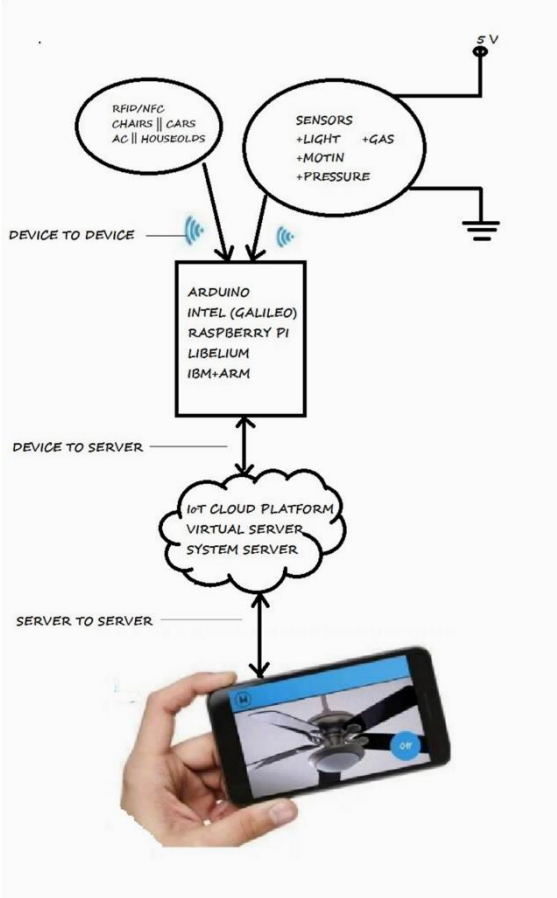


Fig 5. Working of Arduino

The code for GPS is:

```
#include <SoftwareSerial.h>
//Create software serial object to communicate with GPS
SoftwareSerial GPS(4, 3);
void setup() {
 //Begin serial comunication with Arduino and Arduino IDE
(Serial Monitor)
Serial.begin(9600);
while(!Serial);

 //Being serial communication witj Arduino and GPS
Module //Important rate must be 9600
gps.begin(9600);
 delay(1000);

 Serial.println("Setup Complete!");
}

void loop() {
 //Read SIM800 output (if available) and print it in Arduino
IDE Serial Monitor
if(gps.available()){
Serial.write(gps.read());
 }
 //Read Arduino IDE Serial Monitor inputs (if available)
and
send them to SIM800
 //if(Serial.available()){
 //gps.write(Serial.read());
 //}
}
```

There is a need to link the GPS and GSM modules. The code for that is:

```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
/*
 This sample sketch demonstrates the normal use of a
TinyGPS++ (TinyGPSPlus) object.
 It requires the use of SoftwareSerial, and assumes that
you have a
 4800-baud serial GPS device hooked up on pins 4(rx)
and 3(tx). */ 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);

void setup()
{
 Serial.begin(9600);
ss.begin(GPSBaud);

 Serial.println(F("DeviceExample.ino"));
 Serial.println(F("A simple demonstration of TinyGPS++
with an attached GPS module"));
 Serial.print(F("Testing TinyGPS++ library v. "));
Serial.println(TinyGPSPlus::libraryVersion());
 Serial.println(F("by Mayank"));
 Serial.println();
}

void loop()
{
 // This sketch displays information every time a
new sentence is correctly encoded. while
(ss.available() > 0) if (gps.encode(ss.read()))
displayInfo();

 if (millis() > 5000 && gps.charsProcessed() < 10)
 {
  Serial.println(F("No GPS detected: check wiring."));
  while(true);
 }
} void
sendSMS() {
```

```
 ss.write("AT+CMGF=1\r\n");
delay(1000);

 //Send new SMS command and message number
ss.write("AT+CMGS=\"09591079144\"\r\n");
 delay(1000);

 //Send SMS content
ss.write("TESTGPSSMS");
delay(1000);

 //Send Ctrl+Z / ESC to denote SMS message is complete
 ss.write((char)26);
delay(1000);

 Serial.println("SMS Sent!");
}                void
displayInfo()
{
 Serial.print(F("Location:  "));
if (gps.location.isValid())
 {
  Serial.print(gps.location.lat(), 6);
  Serial.print(F(","));
  Serial.print(gps.location.lng(), 6);
  sendSMS();
 }
else
{
  Serial.print(F("INVALID"));
 }

 Serial.print(F("      Date/Time:
"));  if (gps.date.isValid())
 {
  Serial.print(gps.date.month());
  Serial.print(F("/"));
  Serial.print(gps.date.day());
  Serial.print(F("/"));
  Serial.print(gps.date.year());
 }
else
 {
  Serial.print(F("INVALID"));
 }

 Serial.print(F("   "));
if (gps.time.isValid())
 {
  if (gps.time.hour() < 10) Serial.print(F("0"));
  Serial.print(gps.time.hour());
Serial.print(F(":"));
  if (gps.time.minute() < 10) Serial.print(F("0"));
  Serial.print(gps.time.minute());
Serial.print(F(":"));
  if (gps.time.second() < 10) Serial.print(F("0"));
  Serial.print(gps.time.second());
Serial.print(F("."));
  if (gps.time.centisecond() < 10) Serial.print(F("0"));
  Serial.print(gps.time.centisecond());
 }
else
 {
  Serial.print(F("INVALID"));
 }

 Serial.println();
}
```

Android studio is used to develop the mobile application needed. It consists of 4 pages:

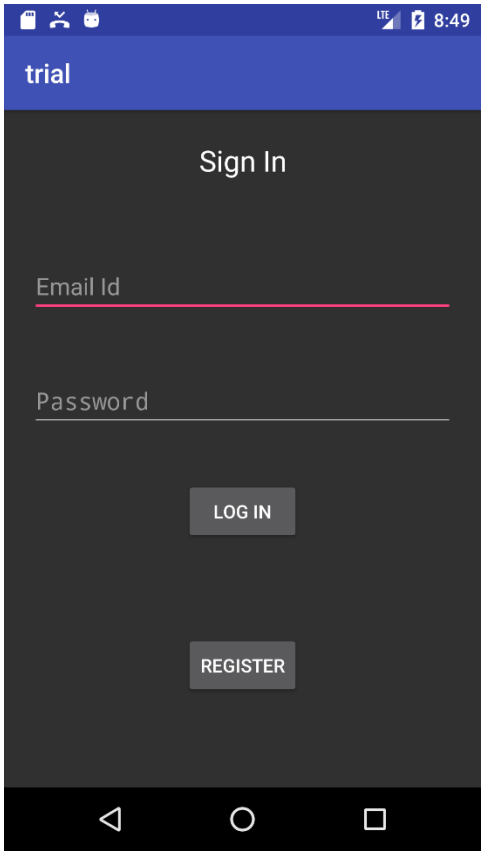


Fig 6. Sign-in page

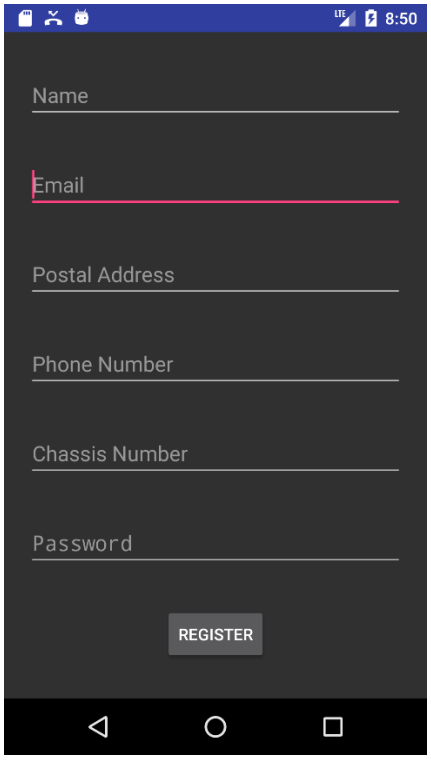


Fig 7. Registration page

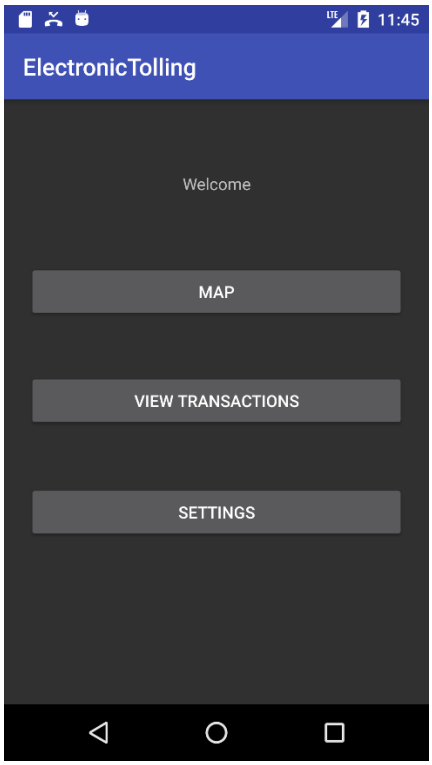


Fig 8. Profile page

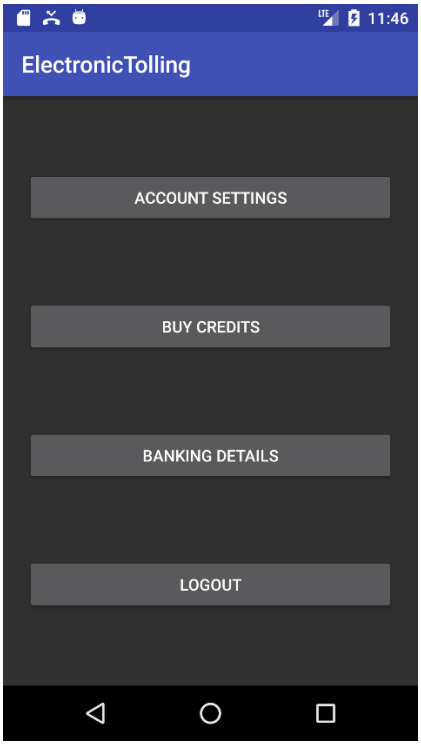


Fig 9.Settings page

## 6 .CONCLUSION

The electronic tolling system using Arduino is therefore a much more cost effective system than the ones in place and it also helps in reducing the need for slowing down the traffic at certain junctions.

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