Industrial Instrumentation Final Project Review

Automated Toll Collection System Using RFID & GPS Module

Under the guidance of
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Team Members

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Objective

The objective of this project is to automate the toll collection system using RFID sensor and GPS module.

ATCS is an Automated Toll Collection System used for collecting tax automatically. In this we do the identification with the help of RFID module(Radio Frequency Identification . 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. Also a GPS module will be installed in the vehicle. GPS module will help us determining the longitude and latitude of the vehicle. Amount will be deducted according to the distance travelled.

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.

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

Literature Survey

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

Components Required

- Hardware components required

1. MFRC522 RFID Module
2. IR Obstacle Sensor
3. GPS Module
4. DC Servo motor
5. Arduino UNO

- Software Required

1. Arduino

Methodology

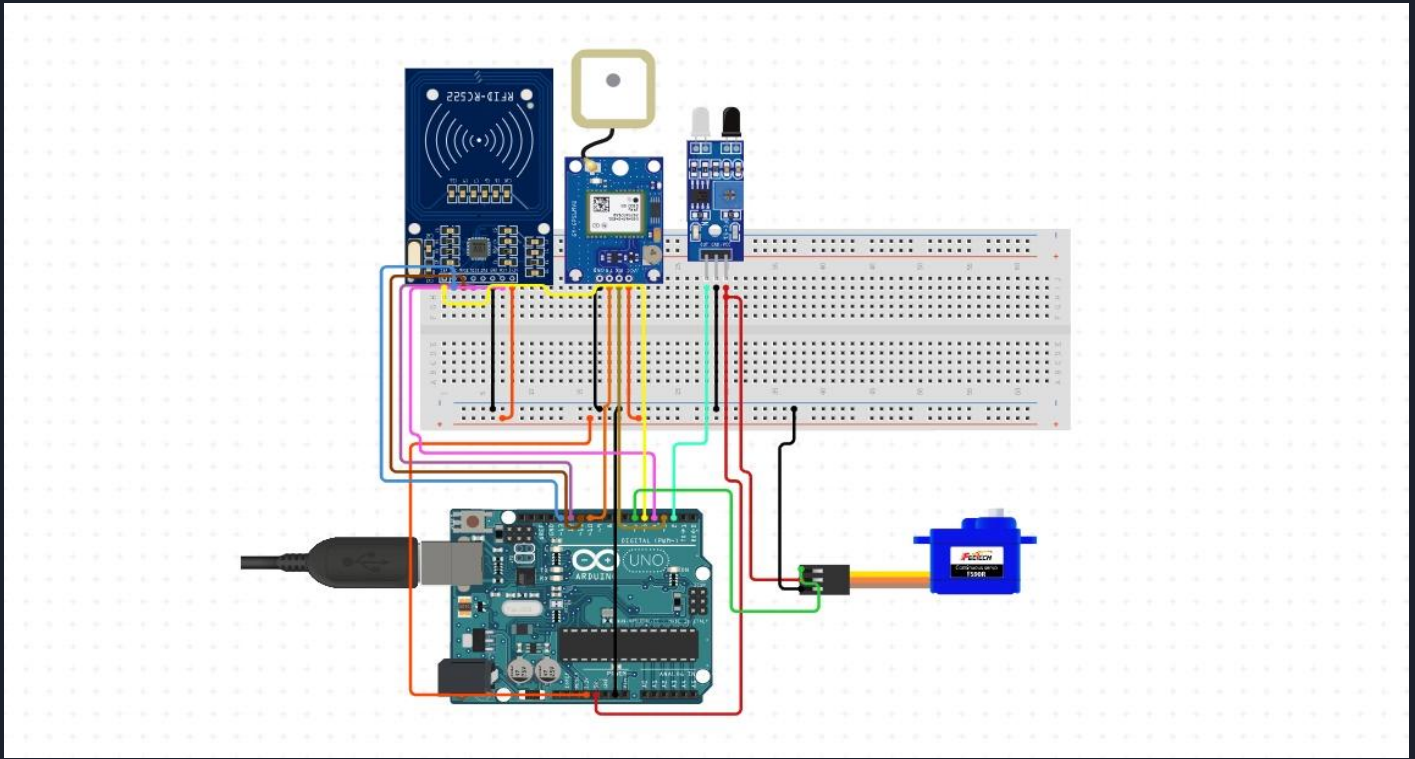
Whenever any person buys a vehicle, first he/she need to do her vehicle registered at the RTO office. RTO people will assign a number plate to it along with it they will give a RFID enabled tag. This card will have a unique ID feasible to use with that vehicle only. They will also create an account for 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. And the amount will be deducted from his/her wallet according to the distance traveled by the vehicle.

Flexibility of Implementation

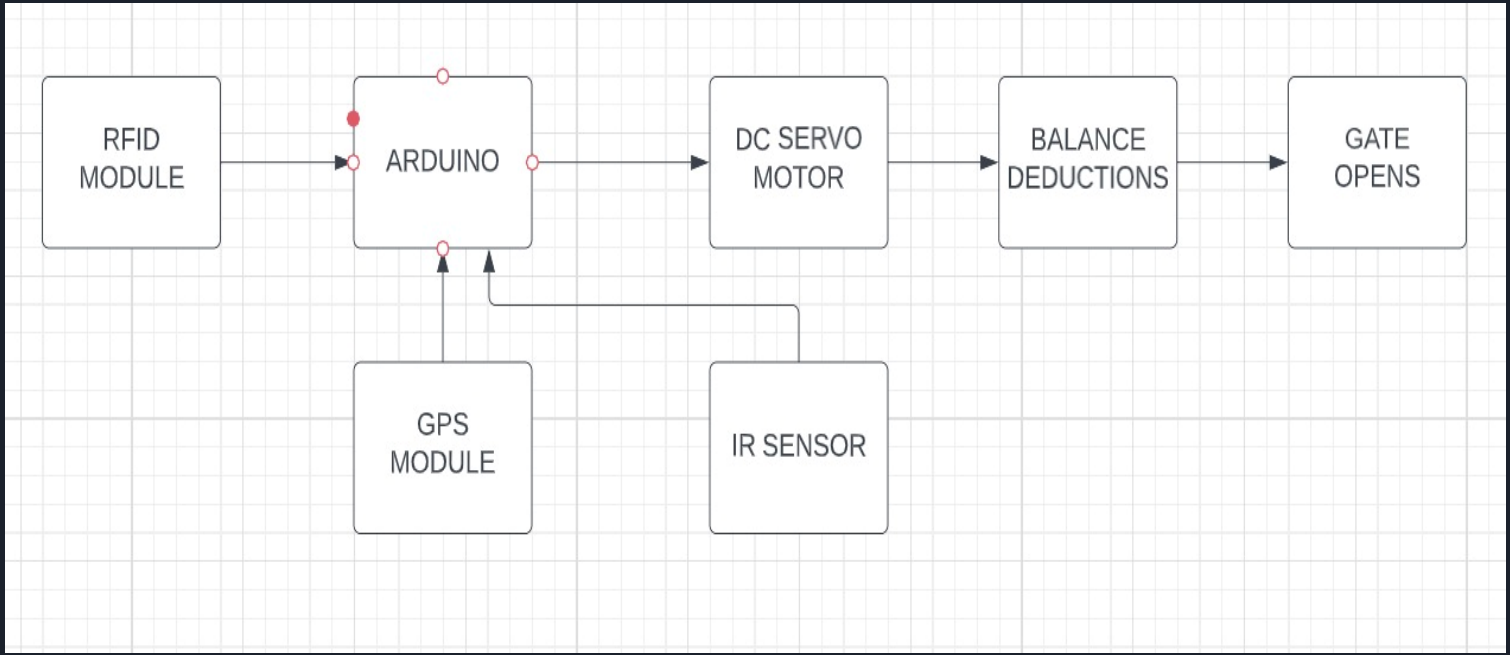
The main power of ATCS is the technology which is used, that is the RADIO FREQUENCY IDENTIFICATION. The basic power of this technology is that it's very flexible. Even with the slightest of change in ATCS, the product can be shaped into a completely different implementation and all that can be because RFID is independent of every other hardware that can be used to boost up the system's performance.

RADIO FREQUENCY has vast implementation areas in medical, defence and many latest products that are being developed is based on RFID solution. The main areas is animal tracking, human implants, vehicle tracking, speed tracking, physical implementation.

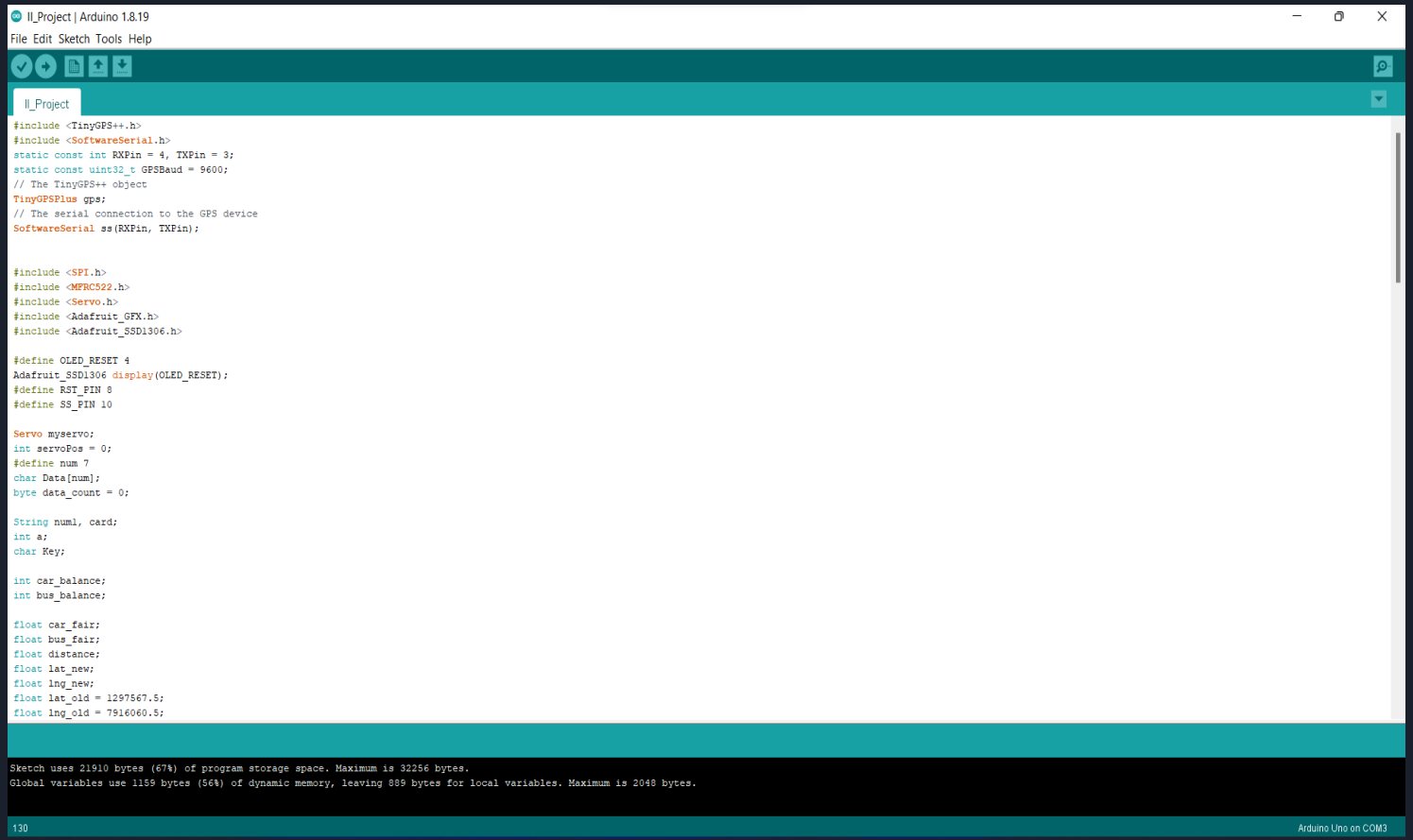
Circuit Diagram



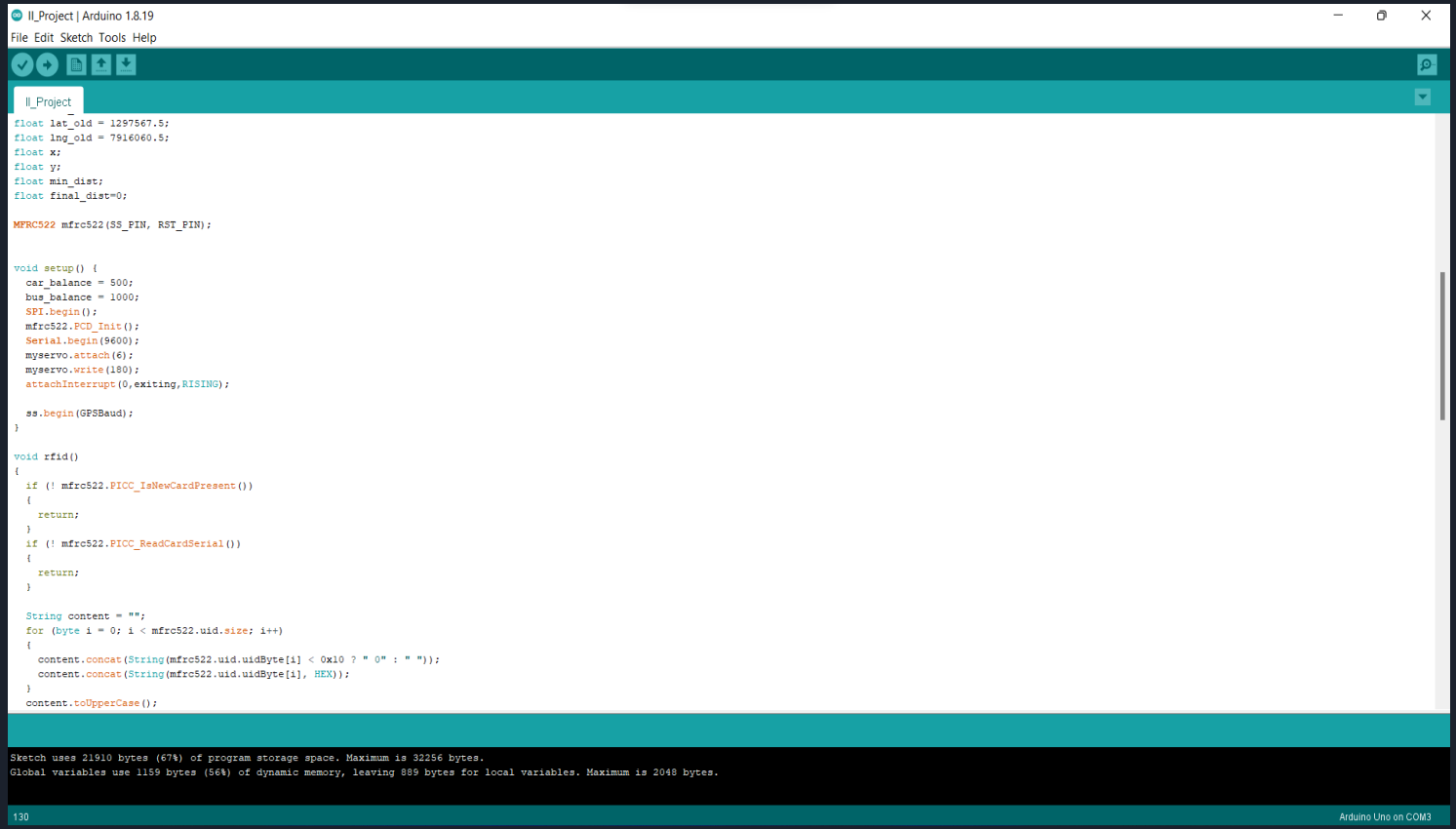
Block Diagram



Code


ll_Project | Arduino 1.8.19
File Edit Sketch Tools Help
ll_Project
#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 = 1297567.5;
float lng_old = 7916060.5;
Sketch uses 21910 bytes (67%) of program storage space. Maximum is 32256 bytes.
Global variables use 1159 bytes (56%) of dynamic memory, leaving 889 bytes for local variables. Maximum is 2048 bytes.
130
Arduino Uno on COM3

Code


II_Project | Arduino 1.8.19
File Edit Sketch Tools Help
II_Project
float lat_old = 1297567.5;
float lng_old = 7916060.5;
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();
Sketch uses 21910 bytes (67%) of program storage space. Maximum is 32256 bytes.
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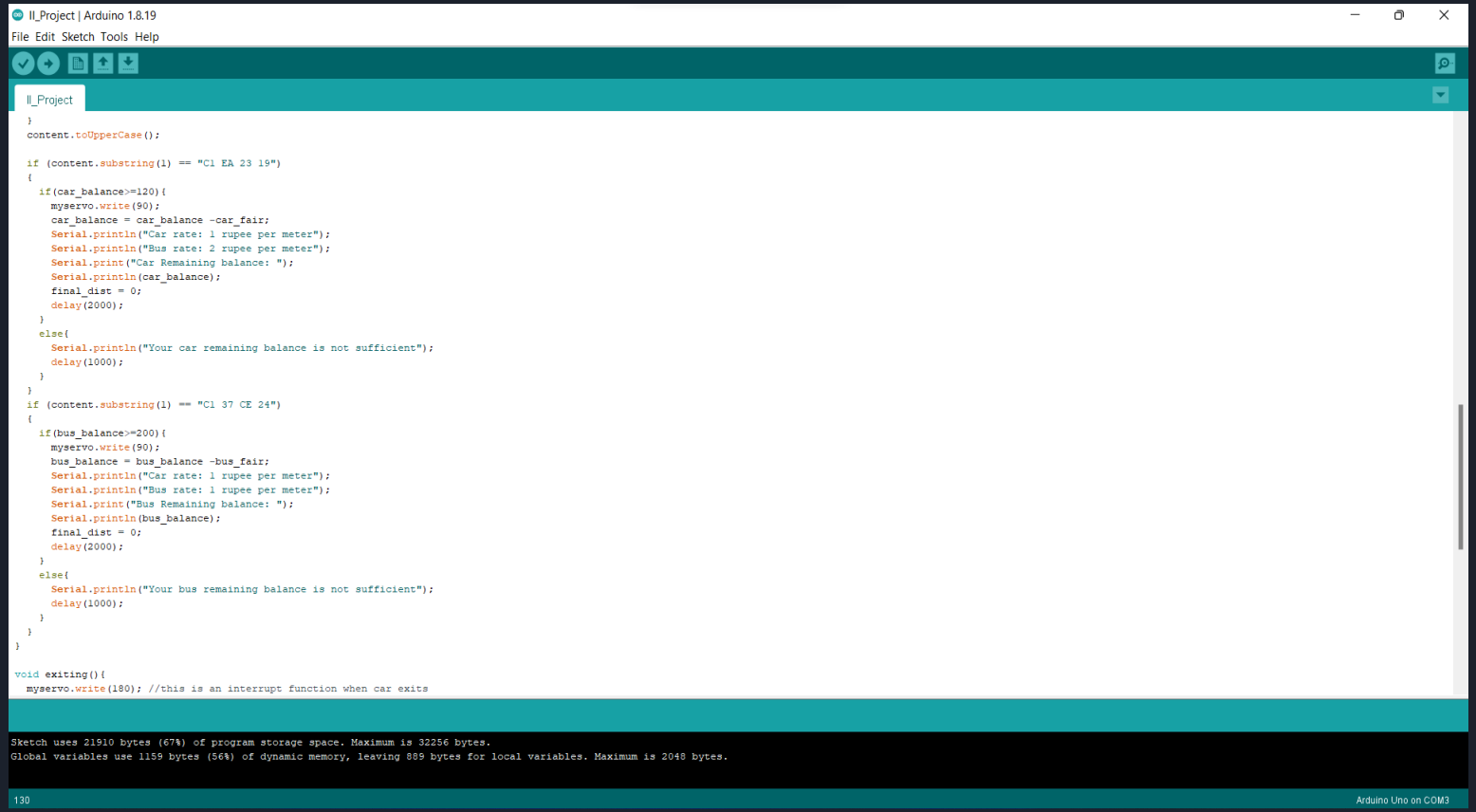
Code


II_Project | Arduino 1.8.19
File Edit Sketch Tools Help
II_Project
}
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
Sketch uses 21910 bytes (67%) of program storage space. Maximum is 32256 bytes.
Global variables use 1159 bytes (56%) of dynamic memory, leaving 889 bytes for local variables. Maximum is 2048 bytes.
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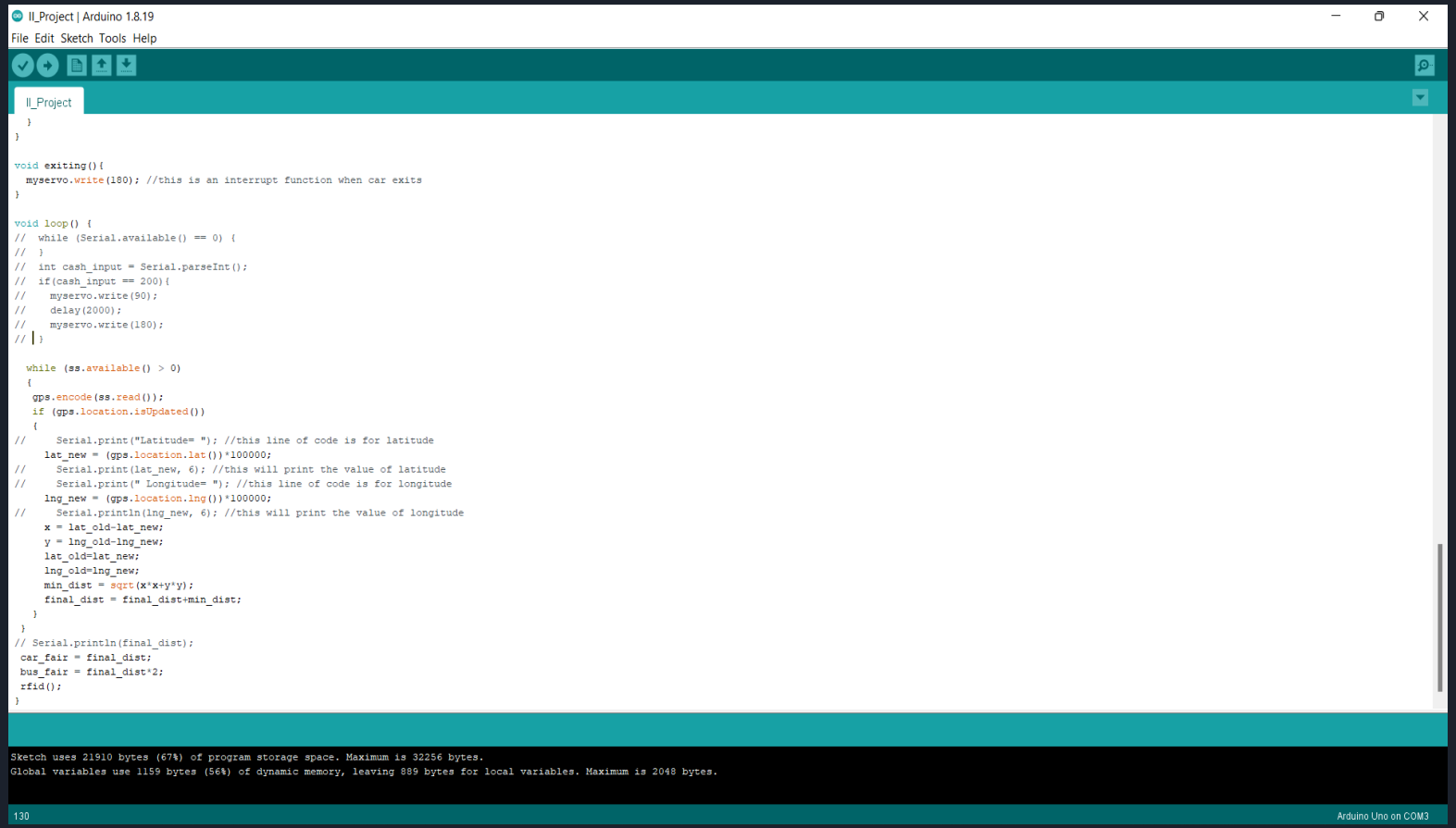
Code


II_Project | Arduino 1.8.19
File Edit Sketch Tools Help
II_Project
}
}
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();
}
Sketch uses 21910 bytes (67%) of program storage space. Maximum is 32256 bytes.
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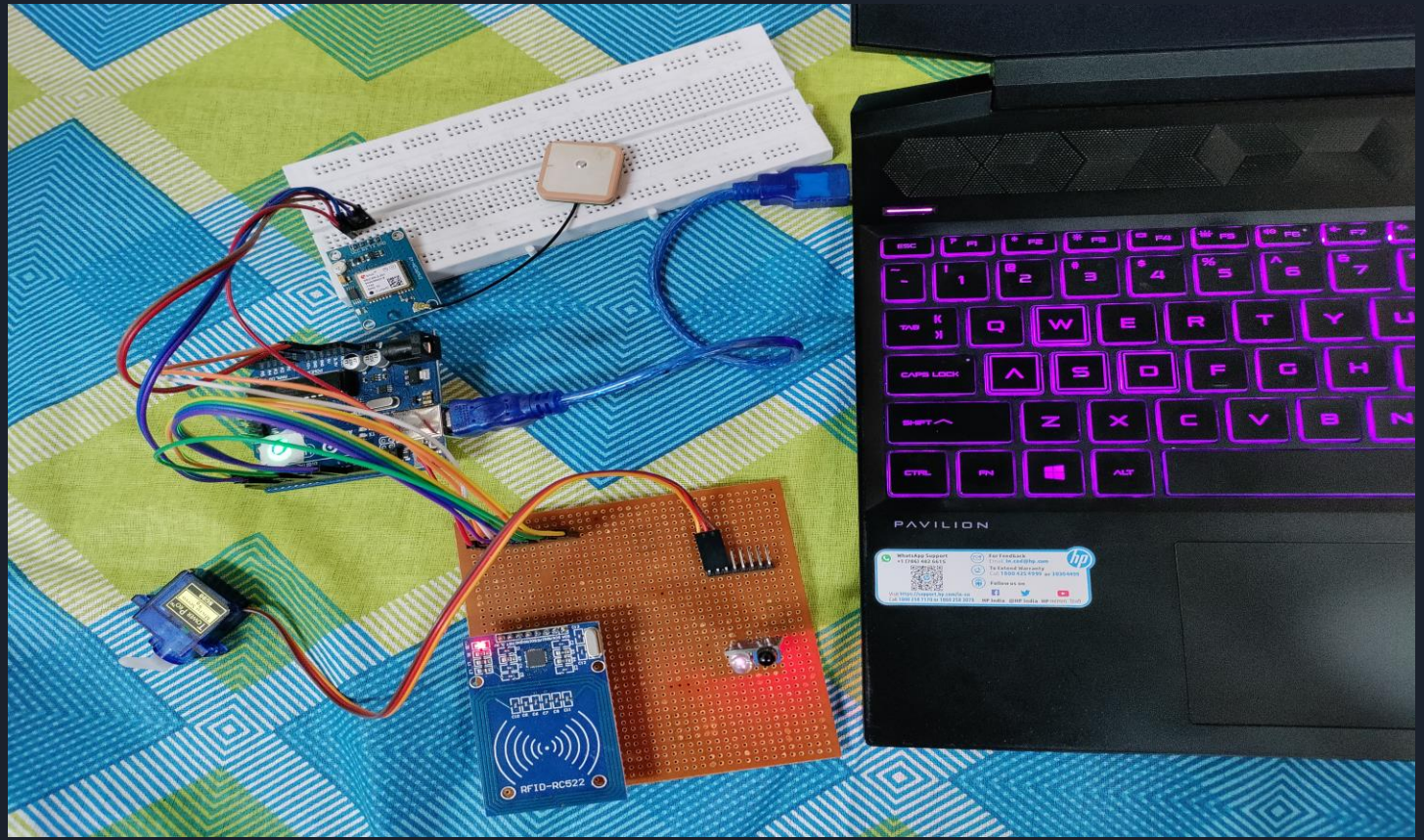
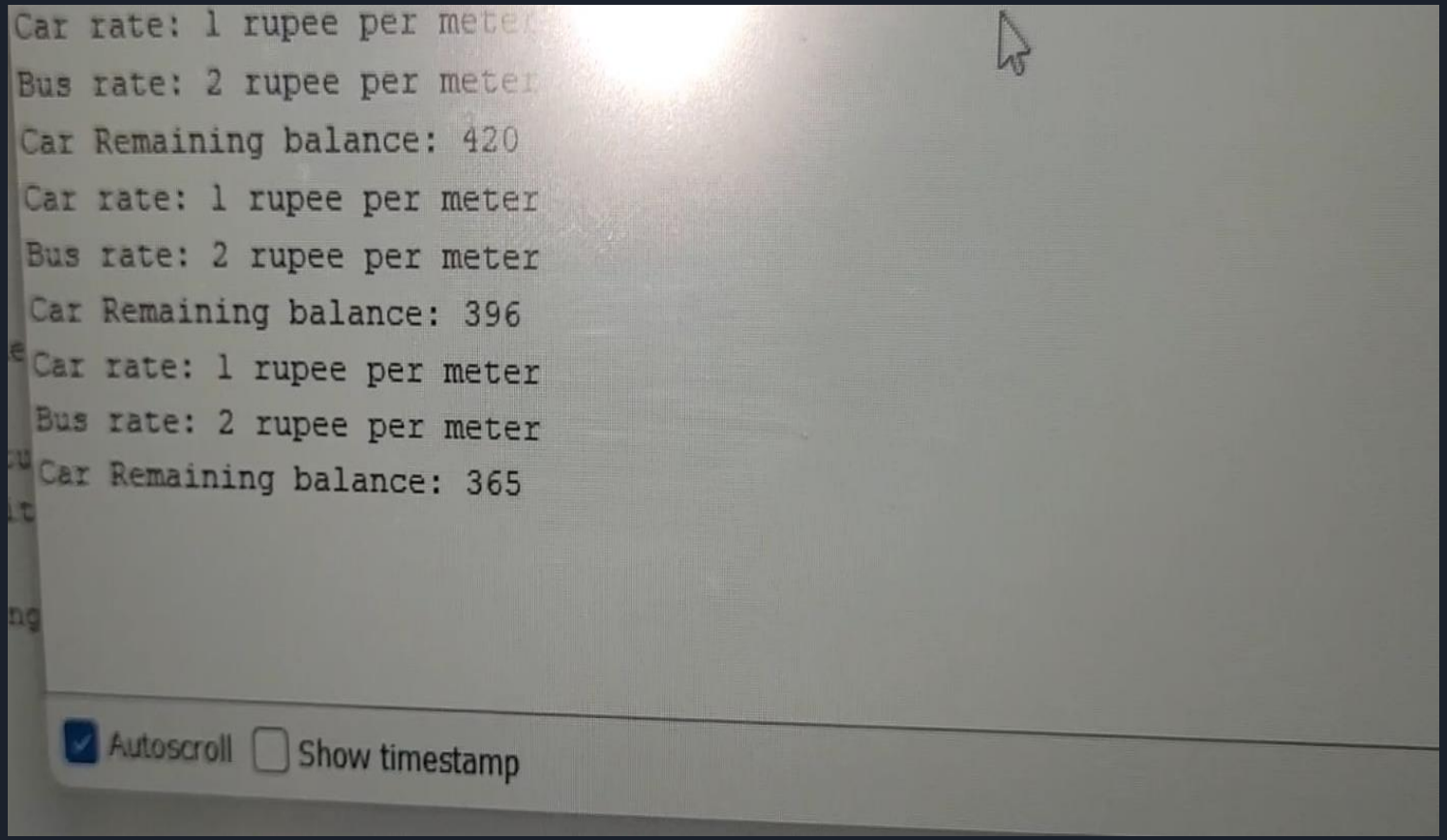
Hardware Implementation



Screenshot of Serial Monitor



Future Scope

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 toll booth 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.

Google drive link of the video

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

References

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2) Automated Toll Collection: A review Authors: Ms Tarannum Sheikh , Dr Naveen Hemrajani , Ms Nilam Choudhary, Mr Gaurav Bagaria
3) Automated Toll Collection System Using RFID Authors: Khusboo Singh, Purbayan Saha, Souvik Kumar Dutta
4) A Systematic Review of Electronic Toll Collection System Authors: Md Khorshadul Haque, Mahir Shahrier, Armana Sabiha Ha

THANK YOU