RFID BASED AUTOMATED TOLL COLLECTION SYSTEM

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RFID Based Automated Toll Collection System

Abstract

RFID based Smart Toll Collection System as a solution to solve the traffic problems and to maintain transparency of the toll collection system. Our aim is to make a digital toll collection system which will be less time consuming and automated. This project focuses on an electronic toll collection (ETC) system using radio frequency identification (RFID) technology. The proposed RFID system uses tags that are mounted on the windshields of vehicles, through which information embedded on the tags are read by RFID readers; the proposed system eliminates the need for vehicle owners and toll authorities to manually perform ticket payments and toll fee collections, respectively. Data information are also easily exchanged between the vehicle owners and toll authorities, thereby enabling a more efficient toll collection by reducing traffic and eliminating possible human errors.

Project Overview

Working procedure in this project is with a RFID based System with Object detection sensor. In this Project, when IR detects a car, bar will open. Then in the toll, user has to punch the RFID smart card which has a unique ID with a registration number. Then the RFID reader will send the response to the Arduino system module. It will detect that the RFID is being punched is registered (Valid) or not. If the card is OK and the amount is available in the users account, the payment will be done by the process automatically from the user. When IR detects the vehicle, the bar will open. If payment amount is not available in the smart card, it will be added as a due & bar will open.

Drawbacks of traditional system

Traditional toll collection system is the simplest form of toll collection, where a collector operating from a booth collects the toll. This method is slower and sometimes workers make blunder as well. One or two persons sit in the toll collection booth and stop each vehicle to collect the toll manually. The collector gives a memo to the drivers as a record of toll payment. In our country, several corruptions cases are increasing in this sector. There is no central controlling system for the toll collection, all the information regarding payments ad vehicles are not saving in a database or website. As a result, corruption is happening and government is not getting all the toll money properly.

Problems of Traditional System

- Slower Manual System or Time delay
- Traffic Clogging
- Gets Corrupted
- Manpower Needed
- Not applicable for wide range application
- More Inaccuracy or Blunder
- More Fuel Loss

Advantages of Proposed Toll Collection System

Electronic toll collection system is a digital system of collection toll from vehicles without stopping them. By using this system, lanes can improve the speed and efficiency of traffic flow and save drivers' time. Operating cost saving & this system does not require any human interaction for the toll transaction.

- Cashless Payment
- Reduction of Manhour
- Faster Transit
- Increased Capacity
- Can be Updated with Different Methods; Ex: Recharge Option
- Works on simple and automatic mechanism
- Easy to Use

- Less Error
- Useable at any place & time

Disadvantages of Proposed Toll Collection System

- It cannot detect different weighted vehicles
- Investment cost is high
- No Payment Method Included

Block Diagram of Proposed System

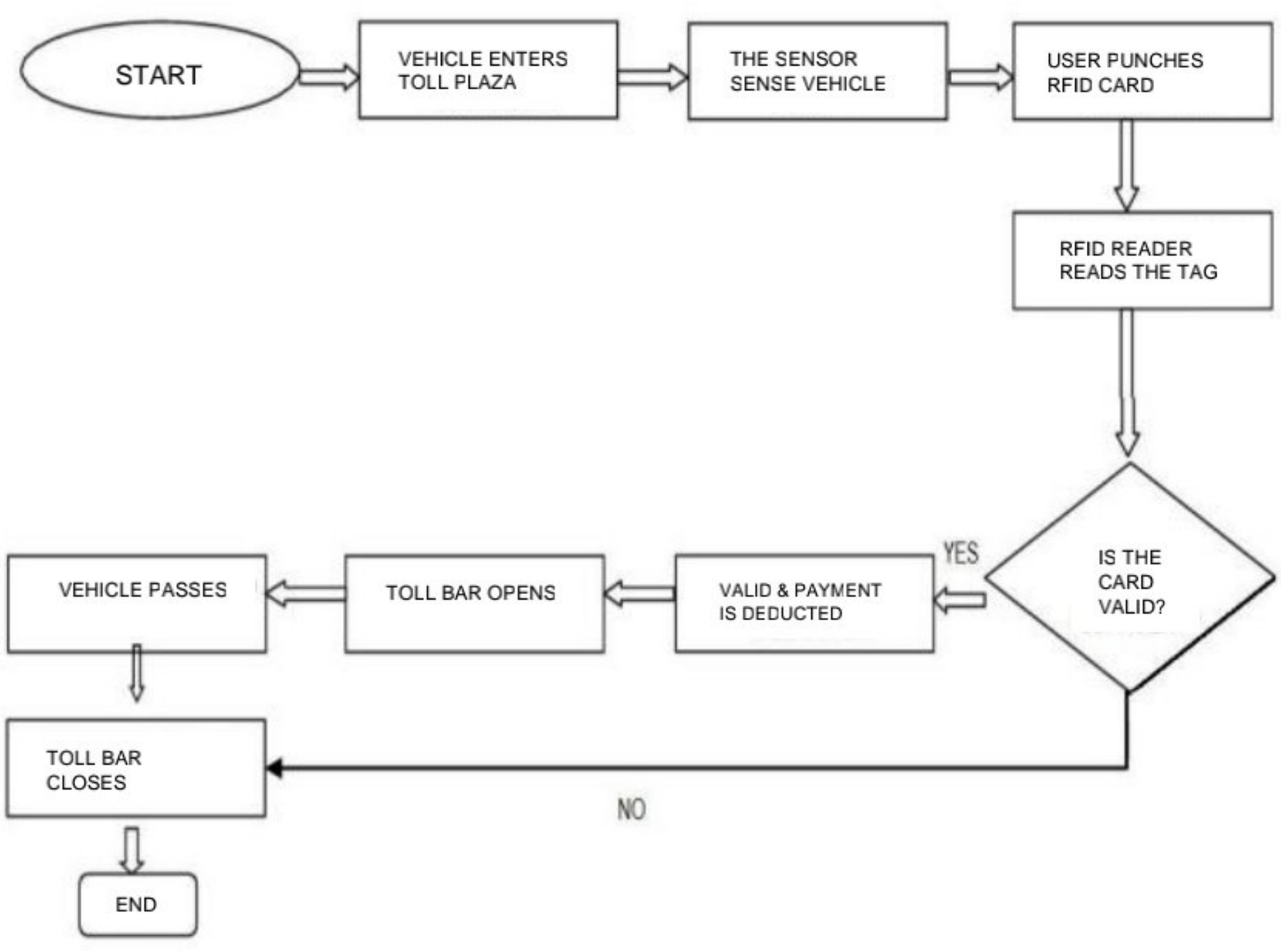


Fig: Block Diagram of RFID Based Toll Collection System

HARDWARE-SPECIFICATIONS

Arduino UNO

- Micro-controller: ATmega328.
- Operating Voltage: 5V.
- Input Voltage (recommended): 7-12V.
- Digital I/O Pins: 14 (of which 6 provide PWM output).
- Analog Input Pins: 6

The Arduino Uno is a microcontroller board based on the ATmega328. 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 an AC-to-DC adapter or battery to get started.

RC522 RFID Card Reader Module

This is RFID Reader/Writer RC522 SPI S50 CARD AND KEYCHAIN which works on non-contact 13.56mhz communication. An RFID or radio frequency identification system consists of two main components, a tag attached to the object to be identified, and a reader that reads the tag.

A reader consists of a radio frequency module and an antenna that generates a high frequency electromagnetic field. Whereas the tag/card is usually a passive device. It consists of a microchip that stores and processes information, and an antenna for receiving and transmitting a signal.

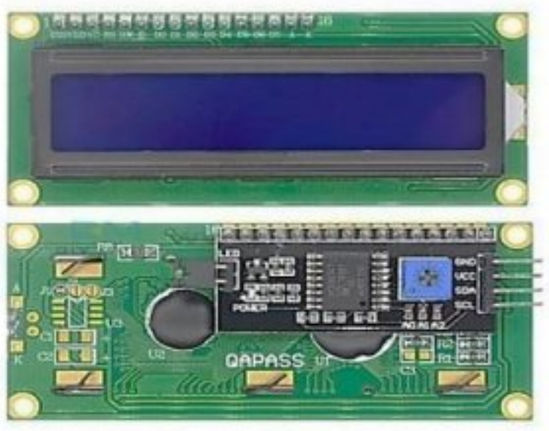
Jumper Wires

20CM Dupont Wire Color Jumper Cable is a type of electrical cable commonly used in electronics projects. It consists of two or more wires (often color-coded) that are connected to form a single cable. These cables are used to make connections between components, such as connecting a sensor to an Arduino board. The 20CM length of the cable provides ample length to make connections between components within a project, while still being compact and easy to handle.

RFID NFC Smart Card 13.56MHz

The RFID Card is used for Contactless transmission of data and supplies energy with no battery needed. Its Operating distance is Up to 100mm depending on antenna geometry. Operating frequency is 125KHz and Data transfer speed is 106 kbit/s. Contactless smart cards also have memory that can both be read from and written to.

Standard LCD 16x2 Display with i2c module



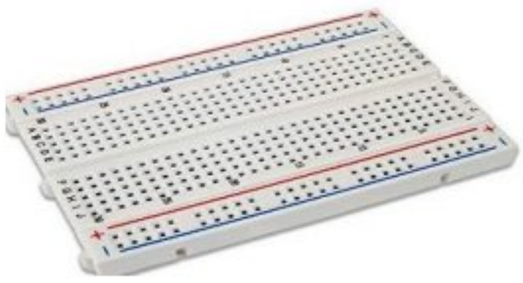
This LCD Display utilizes an I2C interface, which means that fewer pins are necessary to use this product that would be needed with a regular 16x2 LCD Display (just four connections, VCC, GND, SDA & SCL are required). It provides a simple and cost-effective solution for adding a 16×2 Black on RGB Liquid Crystal Display into your project. The display is 16 character by 2-line display that has a very clear and high contrast black/white text upon a yellow/Blue background/backlight. The values shown on the display can be either simple text or numerical values read by the sensors, such as temperature or pressure, or even the number of cycles that the Arduino is performing.

Active Buzzer 5V

- Input Voltage (Max.): 5V
- Resistance: 90 Ω
- Resonance Frequency: 2048 Hz
- Sound pressure(dB(A)/10cm) min: 80
- Body Size: 12 x 9.5mm
- Pin Pitch: 6mm
- External Material: Plastic;
- Color: Black

This is a Small PCB Mountable 5V Active Electromagnetic Buzzer. It is great to add Audio Alert to your electronic designs. It operates on 5V supply, uses a coil element to generate an audible tone.

Breadboard



A breadboard, solderless breadboard, or protoboard is a construction base used to build semi-permanent prototypes of electronic circuits. A breadboard is used for building temporary circuits. It is useful to designers because it allows components to be removed and replaced easily.

Servo Motor

A servo motor is a rotary actuator that allows for precise control of angular position. Usually a servomotor turns 90° in either direction, i.e. maximum movement can be 180°. A normal servo motor cannot rotate any further due to a built-in mechanical stop. Three wires are taken out of a servo: positive, ground and control wire. A servo motor is controlled by sending a Pulse Width Modulated (PWM) signal through the control wire. A pulse is sent every 20 milliseconds. Width of the pulses determine the position of the shaft. For example, a pulse of 1ms will move the shaft anticlockwise at -90°, a pulse of 1.5ms will move the shaft at the neutral position that 0° and a pulse of 2ms will move the shaft clockwise at +90°.

LED lights

- Size: 5mm
- Color: Green & Red
- Head Shape: Round
- Lens Appearance: Transparent

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. It looks transparent and it illuminates Green light. The series is specially designed for applications requiring higher brightness. The led lamps are available in different colors, intensities.

IR sensor

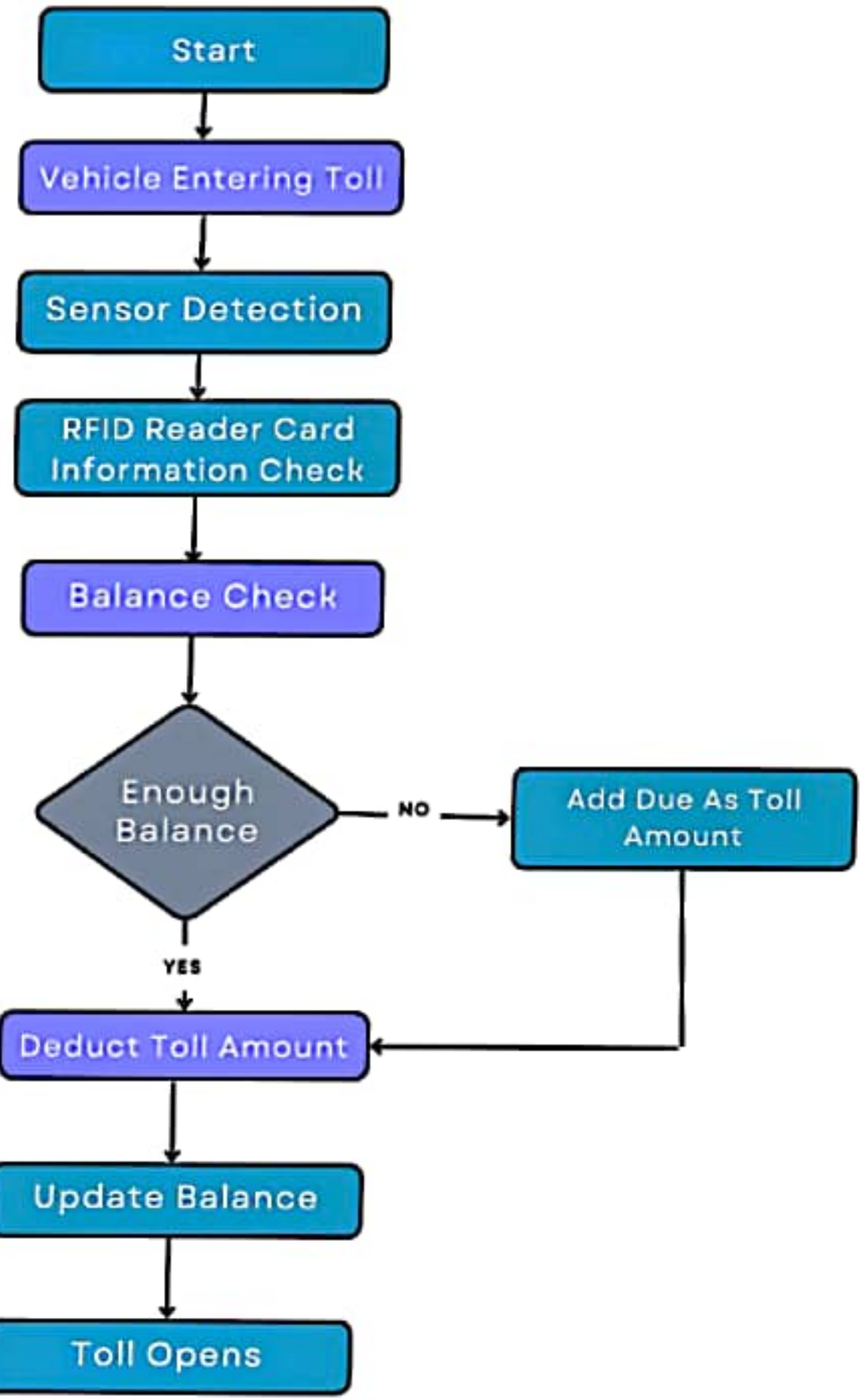
Infrared Obstacle Avoidance IR Sensor Module (Active Low) has a pair of infrared transmitting and receiving tubes. An infrared (**IR**) **sensor** is an electronic device that measures and detects infrared radiation in its surrounding environment. When the transmitted light waves are reflected back, the reflected IR waves will be received by the receiver tube. The onboard comparator circuitry does the processing and the green indicator LED comes to life.

The module features a 3 wire interface with Vcc, GND, and an OUTPUT pin on its tail. It works fine with 3.3 to 5V levels. Upon hindrance/reflectance, the output pin gives out a digital signal (a low-level signal). The onboard preset helps to fine-tune the range of operation, the effective distance range is 2cm to 80cm.

Power Adapter (AC/DC 9V 2A)

This AC to DC Power Adapter is used to power up your 12-volt appliances. It allows high-power 9-Volt DC items to operate on 110 to 240 Volt AC power which makes it ideal for traveling also. In our project it is used as the main power supply source for Arduino Uno Atmega328.

Flowchart


Start
Vehicle Entering Toll
Sensor Detection
RFID Reader Card Information Check
Balance Check
Enough Balance
NO
Add Due As Toll Amount
YES
Deduct Toll Amount
Update Balance
Toll Opens

Circuit Simulation

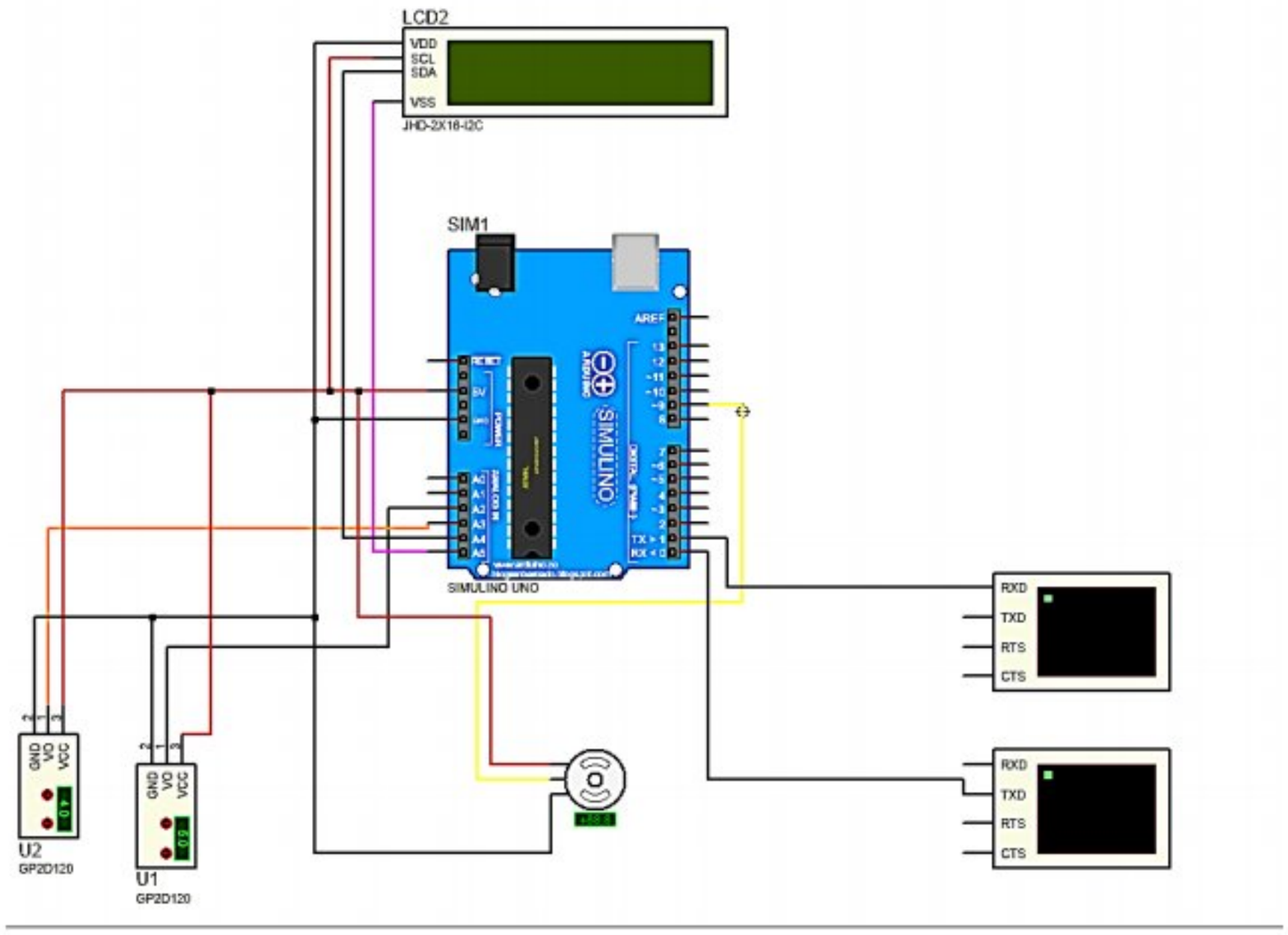
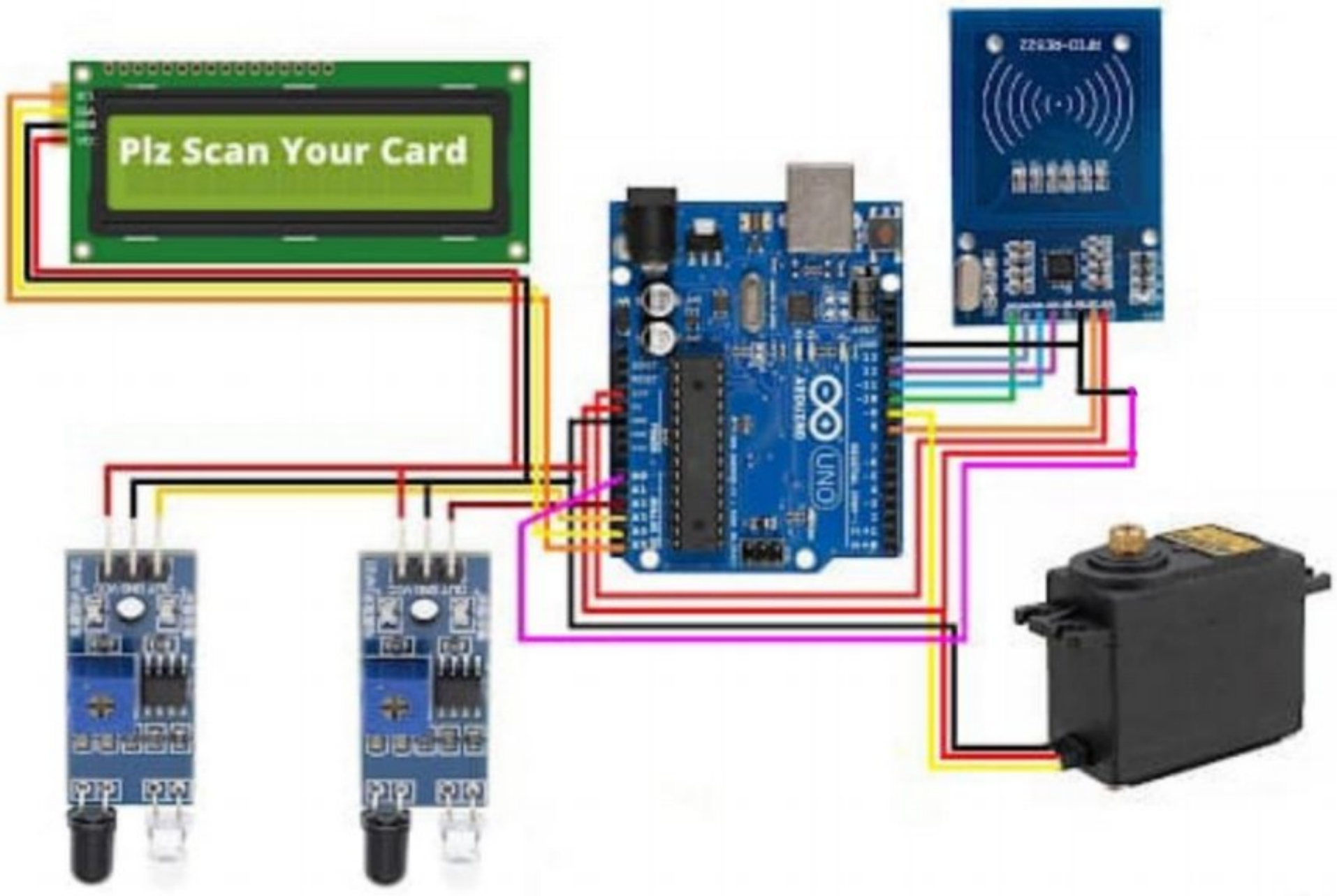


Figure: Circuit simulation on Proteus software

Circuit Diagram



Project Overview

After completing of the whole framework, our venture has worked flawlessly amid explore. We have done a few tests to decide the working capacity and proficiency of the extend .The point of this computerized toll controlling and assess collection which is based on RFID. When a client will purchase a vehicle he will get a RFID keen card amid the vehicle enlistment. When the vehicle will come in front of the toll bar the client ought to punch the RFID keen card which has an interesting ID with it's enrolment number. At that point the RFID peruse has sufficient balance in his card then the toll fee will be deducted and the card balance will be updated. If the RFID pursuer has insufficient balance then the toll fee would be deducted as due and the card balance will be updated. The bar will open. The vehicle can pass through the toll. In case of unregistered vehicle or Invalid RFID the toll bar will not allow the vehicle to pass. It'll not open the toll and the transport can't pass after that in case adjust is deficiently.

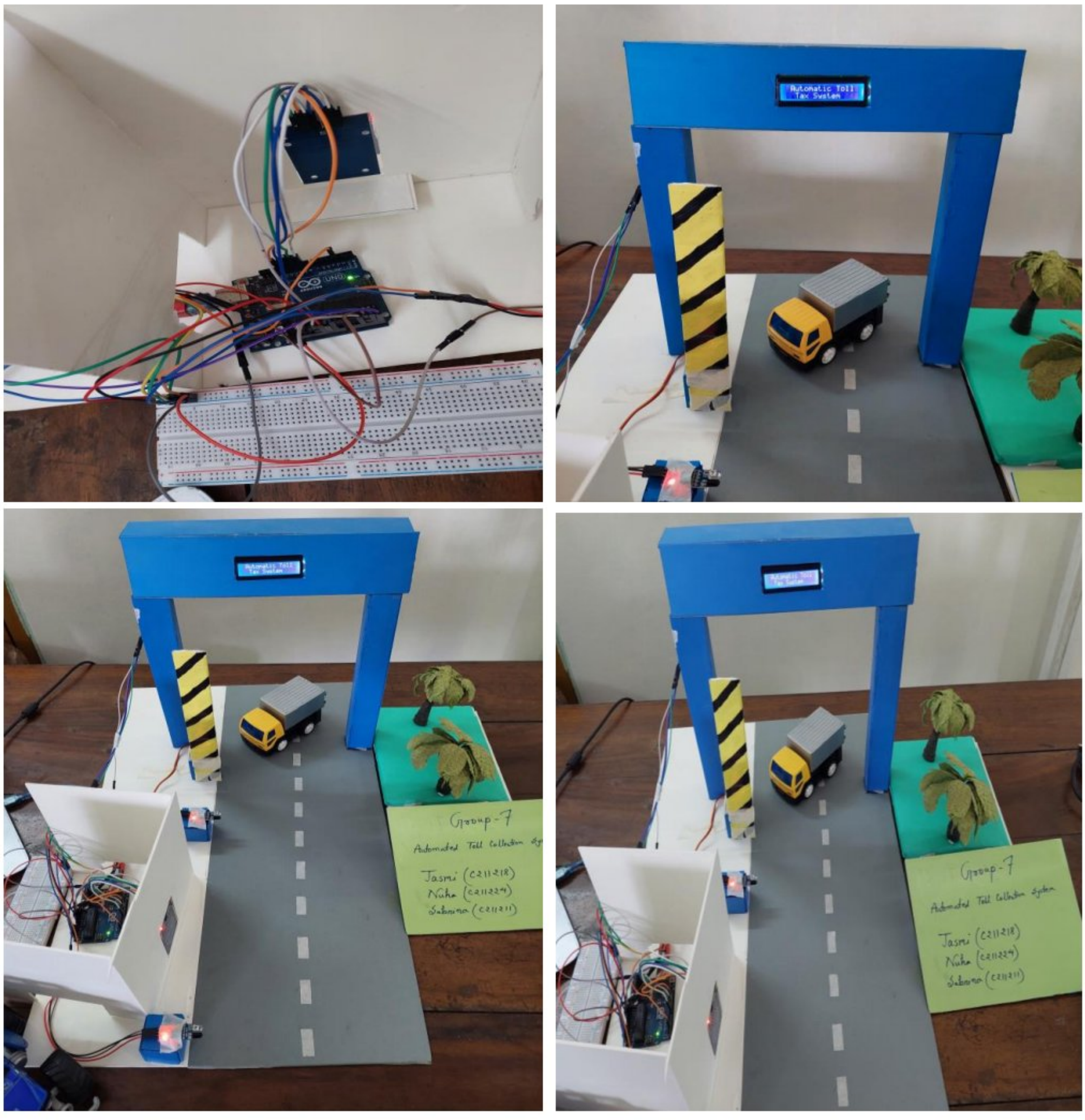


Figure: A pictorial overview of RFID Based Automated Toll Collection System project

SL.	HARDWARE	QUANTITY	COST(BDT)	MODEL	FUNCTION
1	Microcontroller (Arduino UNO)	1	1100	Atmega328	Controlling all the connected modules.
2	RFID Card Reader Module	1	180	MFRC522	To read nearby RFID card
3	RFID Card (13.56mhz)	3	3*30=90	Card type	To provide unique ID to every vehicle
4	Servo motor	1	150	(SG90)	To Rotate the toll bar in 180° angle
5	Standard i2c 16x2 LCD Display	1	360	LCD1602	To show the output.
6	IR Sensor	2	130*2=260	HC- SR04	To detect vehicle from a fixed distance
7	Active Buzzer 5V	1	10	Electro mechanical	Indicator
8	Breadboard	1	150	__	To design circuit
9	LED Lights (2pcs)	2	2	3.5 volt	Indicator
10	Jumper Wire	3	3*40=120	20CM Dupont	To make connections between component
11	Power Adapter (AC/DC 9V 2A)	1	500	AC/DC 9V 2A	Power supply
12	EXTRA		300	__	__
Total cost =2502 Taka					

Budget statement

Conclusion

In arrange to actualize the modern framework of “Automatic Toll Collection utilizing RFID” the inserted framework plat shape has been utilized. This toll collection system using RFID, where sensors will detect vehicles, and check the RFID Cards validation to pass toll, will be useful in real life as well. By doing mechanization of toll square we are able to have the finest arrangement over money misfortune at the toll square by lessening the man control required for the collection of cash additionally can diminish the activity in a roundabout way coming about the diminishment of time toll square. The major benefits are time expending, fuel investment funds and activity lessening. It has moreover the most excellent advantage that the government isn't losing any income from toll collection. On the off chance that we think almost the harbor city Chittagong parcels of send out and purport item passes by the thruways and bridges. This activity-free toll framework will include a great impression on the individuals and they can appreciate the travel within a brief time. The most objective of this venture is managing with RFID labels and keeping all the vehicles beneath enrollment, so that no unregistered car can be utilized and do unscrupulous work against the law.

Future Improvements

Some future works are proposed here;

- ## Smart Road System using Speed Meter

  Road accidents; a dangerous problem that occurs too often in our country. One of the main reasons is high speed. If user would limit their speed according by the speed meter than 90% of accident can be reduced. If any vehicle goes beyond the speed limit which it is not supposed to then the speed meter will trace the car.

- ## Alerting Message Service

  When there will be no sufficient balance or the balance is below 100 taka it will be better to send them an alert message.

- ## Usage of Picture Handling or CCTV Camera for Centralize Information Recording

  In this framework, we are able settle a camera at the beat which is able take the picture of the vehicle and taken after by the RFID to record the information related to the vehicle. This application will help in identifying the vehicles within the wrongdoing scene like fear-based oppression and sneaking of products and it'll diminish the stack on check posts.

- ## A Full Database with Image Processing System

  If all records can be saved with all the respective records of each vehicles with image processing than it can give strongest security to the Government.

Reference

[1] Ahmad Zubair, Sourav Mahmood Sagar, Pran Kanai Saha, Shaikh Anowarul Fattah, " A design for low cost electronic toll collection system with secured data communication," International Conference on Electrical & Computer Engineering (ICECE 2010), Dhaka, Bangladesh, 18-20 Dec. 2010;

[2] K. Balamurugan, Dr. R. Mahalakshmi, Dr. S. Elangovan and R. Pavithra, "Automatic CheckPost and Fast Track Toll System Using RFID and GSM Module with security System," IEEE International Conference on Advances in Electrical Technology for Green Energy 2017 (ICAETGT' 2K17), Coimbatore, India, 23-23 Sept. 2017;

[3] https://en.wikipedia.org/wiki/List_of_roads_in_Bangladesh

[4] https://en.wikipedia.org/wiki/Electronic_toll_collection

[5] https://how2electronics.com/automated-toll-collection-system-using-rfid-arduino/

CODE :

```
#include <BitBool.h>

#include <OnewireKeypad.h>

#include <SPI.h>

#include <MFRC522.h>

#include <Servo.h>

#include<LiquidCrystal_I2C.h>


#define SS_PIN 10 //MOSI of RFID

#define RST_PIN 9 //RST of RFID

#define LED_DENIED_PIN 7

#define LED_ACCESS_PIN 6

#define sensorPin1 A2

#define sensorPin2 A3


int senval1=0;

int senval2=0;

int card1Balance = 2000;

int card2Balance = 400;

int due1=0;

int due2=0;


String num1, num2, card, card2;

int a, b;

char Key;


bool recharge = true;
```

```
LiquidCrystal_I2C lcd(0x3F, 16, 2);

MFRC522 mfrc522(SS_PIN, RST_PIN);   // Create MFRC522 instance.

Servo myservo; //define servo name

int state=0;


void setup()

{

lcd.init();

lcd.backlight();


Serial.begin(9600);   // Initiate a serial communication

SPI.begin();      // Initiate  SPI bus

mfrc522.PCD_Init();   // Initiate MFRC522


pinMode(sensorPin1, INPUT);

pinMode(sensorPin2, INPUT);


pinMode(LED_DENIED_PIN, OUTPUT);

pinMode(LED_ACCESS_PIN, OUTPUT);


myservo.attach(3); //servo pin

myservo.write(90); //servo start position


Serial.println();

lcd.setCursor(1, 0);

lcd.print("Automatic Toll");
```

```
  lcd.setCursor(2, 1);
  lcd.print("Tax System");
  delay(2000);
}
void loop()
{
  // lcd.clear();
  // lcd.setCursor(0, 0);
  // lcd.print("   Welcome!!");
  // delay(1000);
  // lcd.clear();
  // if(recharge==0)
  // {
  //   reCharge();
  // }
  // else
  // {
  sensorRead();
  rfid();
  if(senval1==0)
  {
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("Vehicle Detected");
   myservo.write(0);
   delay(1000);
   lcd.clear();
```

```
  lcd.setCursor(0, 0);
  lcd.print("Scan your card");
  delay(1000);
}
else if(senval2==0 && state==1){
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Have a safe");
  lcd.setCursor(0, 1);
  lcd.print("journey");
  myservo.write(90);
  delay(4000);
  myservo.write(0);
  delay(1000);
  lcd.clear();
  state=0;
}
else if(senval2==0 && state==0){
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("     NOT");
  lcd.setCursor(0, 1);
  lcd.print("   ALLOWED");
  delay(1000);
  lcd.clear();
  state=0;
}
```

```
  //}
}
void sensorRead()
{
  senval1 = digitalRead(sensorPin1);
  senval2 = digitalRead(sensorPin2);
}

void rfid()
{
  // Look for new cards
  if ( ! mfrc522.PICC_IsNewCardPresent())
  {
    return;
  }
  // Select one of the cards
  if ( ! mfrc522.PICC_ReadCardSerial())
  {
    return;
  }
//Show UID on serial monitor
Serial.print("UID tag :");
String content= "";
byte letter;
for (byte i = 0; i < mfrc522.uid.size; i++)
{
   Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
```

```
    Serial.print(mfrc522.uid.uidByte[i], HEX);
    content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
    content.concat(String(mfrc522.uid.uidByte[i], HEX));
  }
  Serial.println();
  Serial.print("Message : ");
  content.toUpperCase();
  if (content.substring(1) == "1C BA 59 4A") //change here the UID of the card/cards that you
want to give access
  {
    digitalWrite(LED_ACCESS_PIN, HIGH);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Authorized");
    lcd.setCursor(0, 1);
    lcd.print("Vehicle");
    delay(1000);
    lcd.clear();
  if(card1Balance>=500)
  {
  card1Balance = card1Balance-500;
  lcdPrint();
  lcd.setCursor(9, 1);
  lcd.print(card1Balance);
  //delay(1000);
  //lcd.clear();
  state=1;
```

```
}
else
{
  card = content.substring(1);
  LcdPrint();
  //lcd.setCursor(9, 1);
  due1+=500;
  lcd.print(card1Balance);
  lcd.print(" Tk");
  // delay(1000);
  // lcd.clear();
  lcd.setCursor(0, 1);
  lcd.print("Due: ");
  lcd.print(due1);
  lcd.print(" Tk");
  //delay(2000);
 // lcd.clear();
  state = 1;
 }
}
else if(content.substring(1) == "33 9E 20 0F")
{
  digitalWrite(LED_ACCESS_PIN, HIGH);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Authorized");
    lcd.setCursor(0, 1);
```

```
  lcd.print("Vehicle");
  delay(1000);
  lcd.clear();
if(card2Balance>=500)
{
  card2Balance = card2Balance-500;
  lcdPrint();
  due2+=500;
  lcd.setCursor(9, 1);
  lcd.print(card2Balance);
  //delay(1000);
  //lcd.clear();
  state=1;
}
else
{
  card = content.substring(1);
  due2+=500;
  LcdPrint();
  //lcd.setCursor(9, 1);
  //ekhaneeeeeeeeee
  lcd.print(card2Balance);
  lcd.print(" Tk");
  // delay(1000);
  // lcd.clear();
  lcd.setCursor(0, 1);
  lcd.print("Due: ");
```

```
    lcd.print(due2);
    lcd.print(" Tk");
   // delay(1000);
    //lcd.clear();
    state = 1;
  }
}

 else{
   Serial.println(" Access denied");
   digitalWrite(LED_DENIED_PIN, HIGH);
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("Access denied..");
   delay(1000);
   lcd.clear();
   state=0;
  }
}

void lcdPrint()
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("  Successfully");
  lcd.setCursor(0, 1);
```

```
  lcd.print(" paid your bill");
  delay(2000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Your Remaining");
  lcd.setCursor(0, 1);
  lcd.print("Balance: ");
}

void LcdPrint()
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("  Your balance");
  lcd.setCursor(0, 1);
  lcd.print(" is insufficent");
  delay(2000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Due Added!!");
  lcd.setCursor(0, 1);
  lcd.print("to your account");
  delay(2000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Balance: ");
}
```