Electronic Toll Collection System Using RFID Technology.

Submitted By,

Name: Forhad Hossain
Roll no: 1515032
Reg. no: 1166
Session: 2015-16
Dept. of EEE

Submitted To,

Dr. Md. Mahbubar Rahman
Professor
Dept. Of EEE

Dept. Of Electrical & Electronic Engineering
Islamic University, Bangladesh.

ABSTRACT

In this project I will discuss RFID based Smart Toll Collection System as a solution to solve the traffic problems and also 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.

INTRODUCTION

Our life is changing very fast and the role of automation in our day to day life is increasing at a very fast rate. This is the motive behind our project i.e. “Automation”. Day by day the number of vehicles passing over the road is increasing due to which the road condition is decaying rapidly. The government sponsors the price of road construction and road maintenance. The government has some source of money to build and maintain these roads & this source is the Toll Station. At the onset, the goal of our project group was to design an Automatic tolling system for collecting toll. After studying various techniques like weight-based systems, bar coding etc. we chose Radio frequency identification, which is an emerging technology applied for tracking and communication. RFID (Radio frequency Identification) is an area of automatic identification that has quickly been gaining momentum in recent years and has now being seen as a radical means of enhancing data handling processes, complimentary in many ways to other data capture technologies such as bar coding. In today’s era of technology, where machines are being extensively used in all the fields we are trying to emulate concept, which will be of great use in public transport systems. Today a person has to travel long distances into vastly unknown territories for job, business, or even for tourism. As the vehicles are increasing and roads are falling short, nowadays we see frequently traffic jams or long queues at the toll stations waiting for paying the toll. Paying the toll every-time through cash or checking the pass takes a lot of time. And today Time is more precious than money. Therefore our project is aimed at reducing time consumed for manual transactions and human effort.

Different Types of Electronic Toll Collection System

Barcode-based Electronic Toll Collection System:

Barcode-based Electronic Toll Collection System is a sub category under DSRC. In this a bar-coded sticker is attached to the vehicle and read by a laser scanner when it passes through the toll plaza illustrates working of a typical DSRC system for electronic tolling. It is the simplest

as well as oldest technology. It is used in various applications such as in library for managing book record, shopping plazas to take an account of sale and purchase, food industry to store food details and many more. Despite of all these it also has many drawbacks in order to be used for toll collection system such as lack of reliability, less accuracy in bad weather, lack of flexibility, slow data read rate, less storage information and easy to be theft.

ANPR (Automatic Number Plate Reader)

Another important technology is ANPR. It utilizes a stationary camera to record and identify the number plate of vehicles passing through toll plaza. The identified license numbers are matched in the database and toll is deducted. If the recorded number is not read properly or not found in the records, it issues an enforcement violation alarm to the alert the authorities. In this way, it simultaneously solves two objectives; identification of vehicle for deduction of toll tax and recording violation enforcement alert. The Indian government has started issuing —high security number plates. Thus this technology will also be helpful to detect the stolen vehicles and vehicles with fake number plates. It also has constraints of high cost and reduced accuracy under tempestuous environment conditions.

Calm active infrared

Calm active infrared is a relatively new technology. It is similar to RFID system, the only difference is that it has an active infrared unit installed on vehicle which contains all the information. If we compare to RFID, it has a faster data reading rate, reliability, accuracy, efficiency and it works well in all environment conditions. It also comes over the problem of interference. Lack of interoperability, vendor support and high cost are the roadblocks in usage of this technology.

VPS-technique (Vehicle Positioning System)

Another one is VPS-technique consists of worldwide satellite navigation system incorporation with a communication mechanism. It works with the help of a global positioning system (GPS) unit installed on vehicle attached to an on board unit (OBU) , which stores the coordinates of the vehicle and send the transaction information to the toll authorities via GSM. This system is highly reliable, accurate and efficient. The efficiency of this system is not affected by environmental conditions. It provides a payment option only for the distance travelled and is highly flexible in generating the corresponding payment details. It can also be used by the police petrol for highway surveillance and theft prevention of automobile. The associated shortcomings for this system are its excessively high installation, running and maintenance cost, careful handling, requirement of extra power and other accessories. Present study has made it very clear that there are no clear trade-offs among the above mentioned technologies. Due to this, it becomes an onerous task to move further to decide the best option among the existing ones or to develop a newer technology. In such a state of no space

for the question of adopting a hybrid technology. It also de-motivate the policy makers to adopt newer advanced technologies as a single wrong decision can bring up loads of problems for 20 coming generations with huge wastage of money and time. Therefore, it becomes essential to predict the best solution in terms of best alternative for such problems using a highly subjective decision making technique.

RFID-based Electronic Toll Collection System:

The best and easy technology is RFID-based Electronic Toll Collection System, which has an IVU (In-vehicle unit) installed on the front windshield of the vehicle. This IVU contains a cash card for payment of road tax. At toll plaza, this is read by the RFID frequency reader or antenna. It can be either prepaid or postpaid, with gate or without gate illustrates working of RFID-based Electronic Toll Collection System. It contains more information as compared to barcode, has faster reading rate, tough to be fraudulent and also comparatively more reliable. As the number of features increases we have to compromise with the cost, simplicity and ease to use. It is also observed that sometimes it show the problem of interference among frequency of devices (mobile phones, other IVU, walkie-talkies, FM radio or other electronic gadgets) in vicinity of the toll plaza or passing vehicles. Angle of installation and alignment plays an important role for reliability and high accuracy of these systems provides a brief idea about working mechanism of RFID-based ETC technology.

Comparison between RFID-based Electronic Toll Collection System and existing toll system:

In our country the existing toll collection system have lots of bad sides. As money has to hand over by hand manually in the existing system, it takes more time then the electronic way to take the money. In existing system time wasting is a big issue because no one wants to waste their valuable time. On the other hand our proposed system is very time saving because it takes money automatically and give the passenger a text in his phone that how much money has deducted from his card, so passenger needs not to waste their time in giving money and asking for receipt. While waiting in a queue makes big jam in existing system because the high way roads are very busy and so many vehicles passes in every minutes but in proposed system there is no chance of waiting in a queue as the system is designed in such a way that it will be so smooth system to pay in toll plaza Proposed toll system has no chances of corruption as it’s done totally by an electronic device but in manual system chances of corruption is so high because that is totally done by hand to hand. Our proposed system is really environment friendly because vehicles have not to wait to pay for toll and that is why less number of toxic gas are effecting environment. On the other hand existing system has a big hand to effect environment, as vehicles have to wait in queue for long time and that is why lots of toxic gas is coming out to pollute the air and cause the damage of

environment. Existing system allows all vehicles to pass through the bridge, as the person collecting the toll doesn't care whether heavy vehicles may cause damage to the bridge. In the proposed system there is a sensor which will sense vehicles weight and if the sensor found over weighted vehicle it will give an alarm, so that the vehicle cannot pass the bridge. Moreover in our country we hardly think about bridges capability of taking weight. In manual system the management of bridge authorities does not worry about if this heavy load will hamper the bridge or not. In our project we do care about the bridge so we have added a weight sensor in front of toll plaza. So if any over weighted vehicle wants to get into the bridge the weight sensor will not allow it, by this the bridge will be safe and secured from any kind of threads.

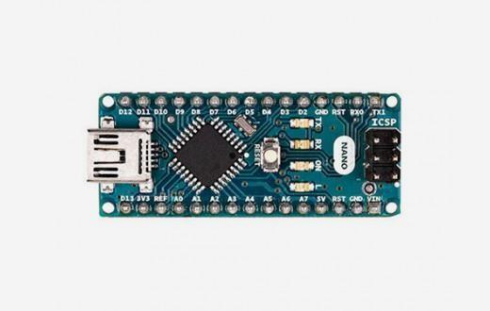
Hardware components

We have used lots of hardware and software components in our project. Now let's discuss about those components in below:

- Arduino Nano ATmega328P
- LCD1602 with Blue backlight
- 4X4 Flexible Matrix Keypad with ABC Black & Red Color.
- RC-522 13.56 MHz RFID Reader
- SG90 Mini Gear Micro Servo Motor 9g
- IR Obstacle Avoidance Module
- 3.3-5V Continuous Tone Active Buzzer
- 400 Tie Points Breadboard White
- Male To Male and Male to female Jumper Wires
- 10k potentiometer

Arduino Nano ATmega328p

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.



The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

LCD1602 with Blue backlight

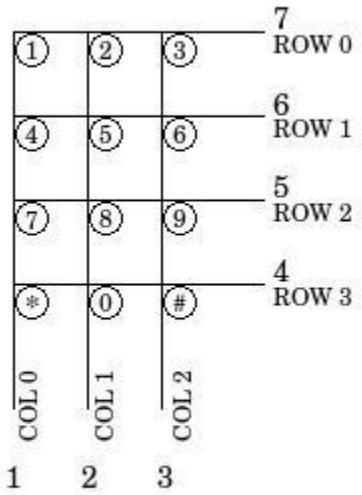
LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. This 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

Features:

- LCD display module with blue blacklight.
- Wide viewing angle and high contrast.
- Built-in industry standard HD44780 equivalent LCD controller.
- Commonly used in: copiers, fax machines, laser printers,
- industrial test equipment, networking equipment such as routers and storage devices.
- LCM type: Characters
- Can display 2-lines X 16-characters.
- Voltage: 5V DC.
- Module dimension: 80mm x 35mm x 11mm.

4X4 Flexible Matrix Keypad with ABC Black & Red Color

The Keypad library allows your Arduino to read a matrix type keypad. You can scavenge these keypads from old telephones or you can get them from almost any electronics parts store for less than $5 USD. They come in 3x4, 4x4 and various other configurations with words, letters and numbers written on the keys. This library is capable of supporting all of those.



Procedure

- Connect your Ohm meter leads to pins 1 and 2.
- Press all the buttons until the meter indicates a closure.
- Write down the pin numbers next to the column and row for the key you just found. Example: Your meter is connected to pins 1 and 5. When you pressed the number 7 your meter reacted. Write 1 under COL0 and 5 next to ROW2.
- If the meter didn't react then move the meter lead from pin 2 to pin 3 and repeat steps 2 and 3 above.
- Now, keep moving the lead to the next pin and repeat steps 2 and 3 for each pin.
- Once you have reached the end move the first meter lead from pin 1 to pin 2 and repeat steps 2 and 3 while connecting the second meter lead to pins 3 through the highest pin.
- Once you have completely identified all the pins on the diagram then you can safely ignore any unused keypad pins. You are now ready to wire the keypad to your Arduino.

INTRODUCTION TO RFID

WHAT IS RFID?

RFID (Radio Frequency Identification) means providing electronic identity to any object. Electronic information about the object is stored in RFID chip embedded or attached to the object. It's an area of automation which has quickly been gaining momentum in recent years and is now being seen as a radical means of enhancing data handling processes, complementary in many ways to other data capturing technologies such as bar-coding. A range of devices and associated systems are available to satisfy even broader range of applications which will change the course of industry particularly in the supply-chain area. The objective of any RFID system is to carry data in suitable transponders, generally known as tags, and to retrieve data, by machine at a suitable time and place to satisfy particular needs.

Data within a tag may provide identification for an item in manufacturing, goods in transit, or the identity of a vehicle. By including additional data the prospect is provided for supporting applications through item specific information or instructions immediately available on reading the tag. With an RFID reader, the electronic identity (code in the form of several bits) can be read wirelessly. This is where RFID differs from other e-tagging technologies such as barcoding which use optical recognition. Since RFID uses radio waves, it does not require any line of sight.

Transponder:

A transponder is generally known as RFID tags stores the data according to the application and are available in a variety of shapes and sizes according to the application. RFID tags are mainly classified in two categories:

Active tags:

Active tags are powered by an internal battery and typically read/write, i.e. tag can be rewritten and/or modified. Active RFID are designed to actively transmit the data to the reader using the power of a battery attached to the tag. The radio frequency received from the Transreceiver is used for communication only.

Passive tags:

Operates without external power source and obtain the operating power from the reader. Passive tags are consequently much lighter than the active tags. They offer a virtually unlimited operational lifetime. They are designed to transmit the data by reflecting or backscattering, the RF energy back to the reader. No battery is required to read the data that has been stored on the RFID tag. The receiver becomes both communication device and provides energy for the tags.

RC-522 13.56 MHz RFID Reader

This low cost MFRC522 based RFID Reader Module is easy to use and can be used in a wide range of applications. RC522 is a highly integrated transmission module for contactless communication at 13.56 MHz this transmission module utilizes an outstanding modulation and demodulation concept completely integrated for different kinds of contactless communication methods and protocols at 13.56 MHz The MFRC522 is a highly integrated reader/writer IC for contactless communication at 13.56 MHz

Features:

- MFRC522 chip based board Operating frequency: 13.56MHz Supply Voltage: 3.3V
- Current: 13-26mA
- Read Range: Approx 3cm with supplied card and fob SPI Interface
- Max Data Transfer Rate: 10Mbit / s
- Dimensions: 60mm × 39mm

SG90 Mini Gear Micro Servo Motor 9g

A servo motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use of servomotors. Servo Motor is a closed-loop servomechanism that uses position feedback to control it's motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.

Specifications

- Stall torque 1.8kg/cm(4.8V)
- Operating speed 0.1sec/60degree(4.8v)
- Operating voltage 4.8V
- Temperature range0 -55C
- Dead band width 10us Dimension 23x12.2x29mm

Infrared obstacle avoidance sensors

This Infrared Obstacle Avoidance Sensor returns a signal when it detects an object in range. The range of the sensor is around 2-40 cm is distance. It operates at 3.5 to 5 volts at around 20 milliamps. The Obstacle Avoidance Sensors usually come in two types - with 3 and 4 pins. The 3 pin version does not have the ability to be enabled/disabled. The 4 pin version has optional Enable pin. Infrared obstacle avoidance sensor is designed to detect obstacles or the difference in reflective services. One application is to help a wheeled robot avoid obstacles with a sensor to react to adjustable distance settings. This device has an infrared transmitter and receiver, that forms the sensor pair. The transmitter LED emits a certain frequency of infrared, which the receiver LED will detect. The receiving LED will detect some of the signal back and will trigger the digital on/off “signal” pin when a specific threshold “distance” has been detected. Most boards will have 2 potentiometers, one of which is to adjust how sensitive the sensor is. You can use it to adjust the distance from the object at which the sensor detects it. Typically, the other potentiometer, which changes the transmitter IR frequency is not adjusted.

Specifications

- Working voltage: DC 3.3V-5V
- Working current: ≥ 20mA
- Operating temperature: -10 ℃ - +50 ℃
- detection distance :2-40cm
- IO Interface: 4-wire interfaces (- / + / S / EN)
- Output signal: TTL level (low level there is an obstacle, no obstacle high)
- Adjustment: adjust multi-turn resistance
- Effective angle: 35 °
- Size: 28mm × 23mm
- Weight Size: 9g

5V Continuous Tone Active Buzzer

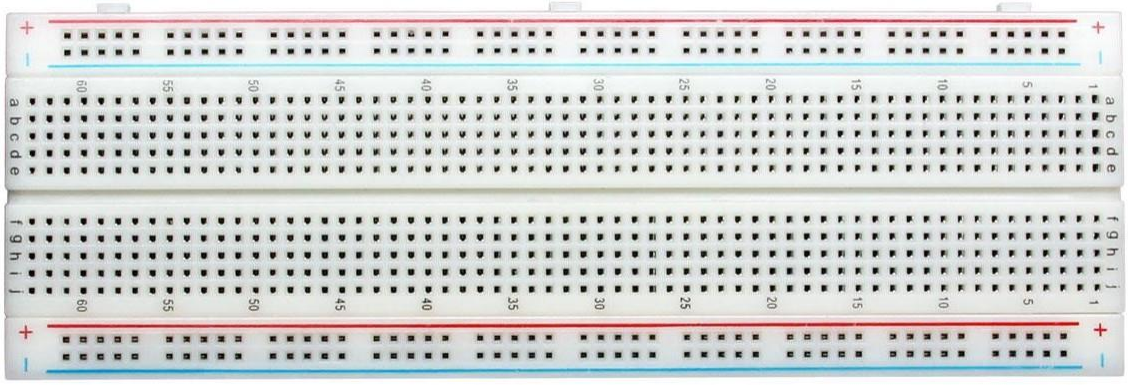
These 5v Active Buzzer generate Continuous Beep / Tone when powered by a DC source. This type of buzzer only required ON/OFF type of input. The Active buzzers are different from passive buzzers which require AC or Square Wave signal. In passive Buzzers the tone frequency is fixed and can not be changed.

Jumper Wires

The best part is they come in a 40-pin ribbon cable. we can always pull the ribbon wires off to make individual jumpers, or keep them together to make neatly organized wire harnesses.

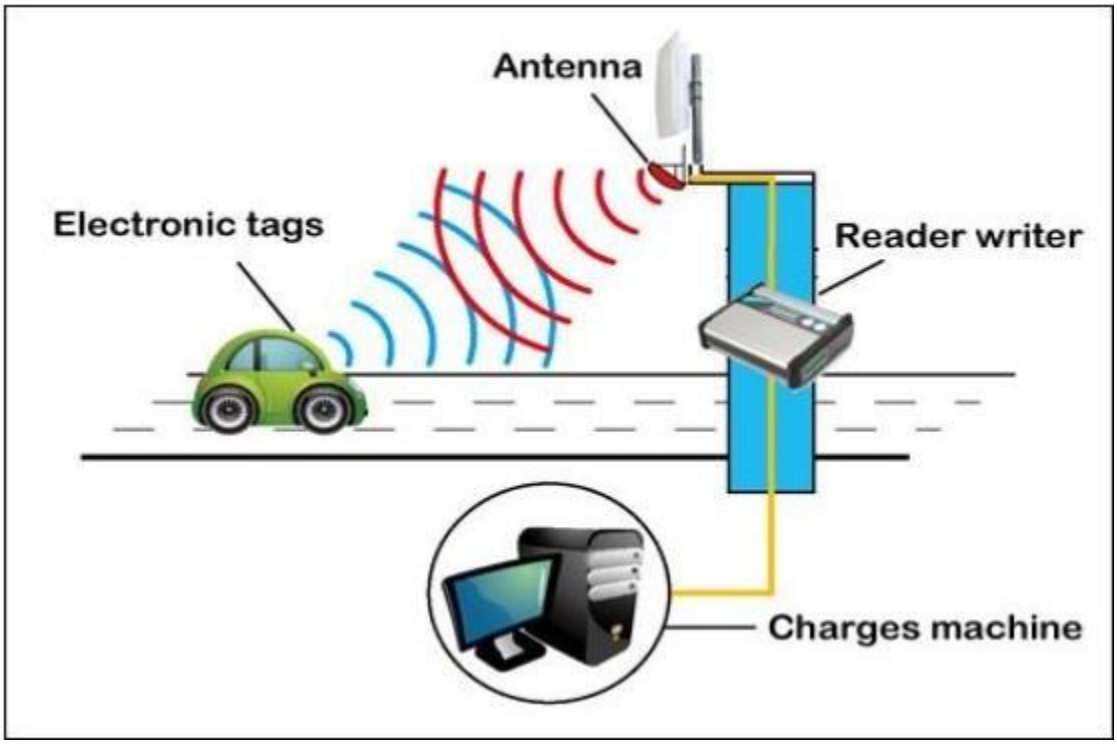
Solder less Breadboard

A breadboard is a construction base for prototyping of electronics. Originally it was literally a bread board, a polished piece of wood used for slicing bread. In the 1970s the solder less breadboard (AKA plug board, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these. "Breadboard" is also a synonym for "prototype".



Working principle of this project

We have designed our project in such a manner that it will be very much easy and comfortable to use for all kind of people. In front of toll plaza there will be a display where it will show welcome to the bridge. After a vehicle enters to the bridge he will go ahead to the toll plaza. When the vehicle will enter to the toll plaza then vehicle detected by detector sensor. The toll gate is closed until the toll is paid by the vehicle owner. Servo motor helps the gate to open up when it gets the signal from Arduino. Arduino will only get the signal to servo motor if the actual toll is given for that vehicle. There will be RFID tag in every vehicles by which we can easily detect them. This RFID will also used as a registration of each car. All the vehicles will have an account as a general where they will keep certain amount of money to use the bridge every time. This account will be internally connected through each vehicles registration respectively. So that when ever that vehicle will pass only that vehicle will be entertained. When a vehicle will pay toll with his registered card then the amount of his toll will be deducted from his account. The message will be shown in the display of the toll gate and toll he has paid and his remaining amount in his account. So there will be no issues of over toll taking or no waste of time in changing the money. As the passenger pay the toll he will be allowed to use the bridge.



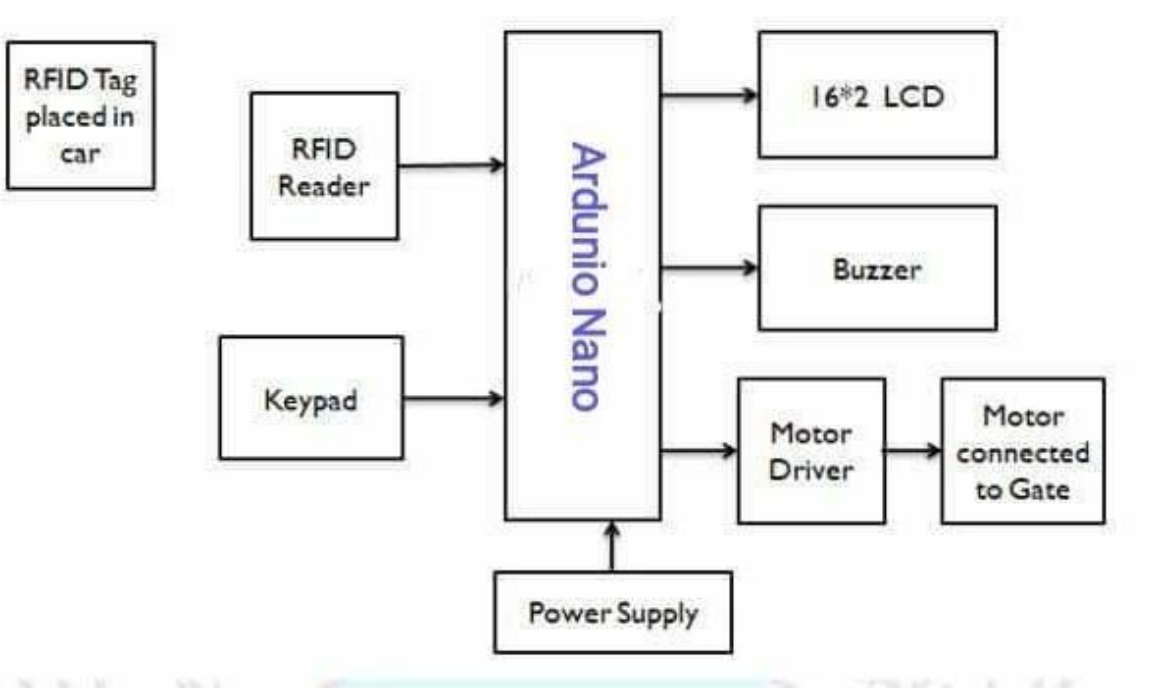
Sufficient amount in account

Any of the vehicles using bridge will always need to have sufficient amount of money in his account. As the system is fully designed in a digital way so payment should be in online basis. In our prototype we are giving a sufficient amount of money in some vehicles to see the actual way of toll taking system.

Insufficient amount in account

It is always mandatory for any vehicle to have sufficient amount in his account but sometimes people may not remember how much money they have in their account. If any vehicle wants to use the bridge but don't have sufficient balance in his account then he will have to face a problem. He has to pay the money manually in hand and it will really take our project to that old manual system which we don't want. So, we ask all the vehicles to have sufficient amount in his account to have a simple smooth use of toll plaza. In our prototype we have kept a vehicle on this condition to see how it handles the situation. When the vehicle punch the card and the system finds that it has no sufficient balance in his account, the system gives an alarm and a massage gone to passenger that he has less amount of money then what we required for. Then the passenger has to pay the money manually by hand and use the bridge.

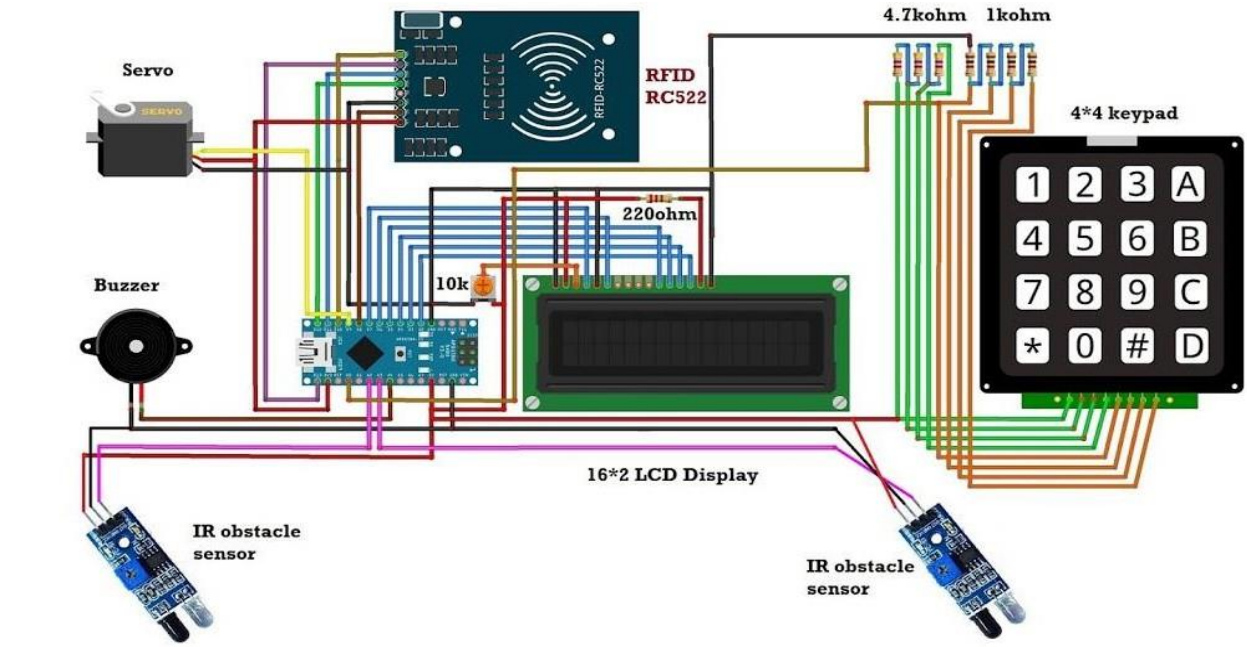
Block Diagram of the Project



Procedure

1. The “RFID based Toll Collection System” basically consists of following main blocks
2. RFID card: RFID cards have diverse range of functions, while provides convenience, as the cards must simply be waived or tapped in front of a reader rather than swiped. These cards are 31 used for applications as access control in security
3. systems, time and attendance, network login security, biometric verification, cashless payment, and even event management.
4. RFID reader: An RFID reader is a device that is used to interrogate an RFID tag. The reader has an inbuilt antenna that emits radio waves; the tag responds by sends back its data.
5. Micro controller: Micro controller senses the signal given from switches and decides the mode of operation i.e. recharge mode or toll collection mode. It fetches data from memory location and sends it to output devices like display, motor driver and buzzer. At the same time it can accept data from Keypad for recharging options and from IR receiver to sense that vehicle has passed from toll collection booth.
6. Liquid crystal Display: It consists of Liquid Crystal display (LCD).The display is various messages like valid card, invalid card, access allowed, manual access etc. We are going to use 16x2 alphanumeric displays.
7. Motor Driver: Microcontroller output is 5 volts and DC motor requires 12 volts supply. Motor driver IC is used to convert 5v to 12v, which is required to drive the motor.

8. DC Motor: DC Motor is used to open the Gate barrier. This will be done when user has successfully performed the RFID swap operation with sufficient balance.
9. Buzzer: Buzzer will be turned on when invalid card is shown at the RFID reader.
10. Switch: If some user doesn't have the RFID card and he doesn't want to purchase the card then he can pay the cash to the government authority persons at the toll plaza. Authority person will then press the manual switch to open the Gate.
11. Keypad: Keypad is provided for the recharge option. Authority person can recharge the RFID cards using this keypad.



CONCLUSION

Finally the automatic toll collection project using by RFID using Arduino Nano Atmega328P is working successfully. Although some problem was drawn but it was shooted as said in the discussion. Times are changing and even this Manual Technique for Taxation at toll station has to change and seeing a change in mind set of every individual this technology would also be taken whole heartedly. And we would see that paying Toll at the Toll station won't be that time consuming and much accurate and preferred across every nook and corner of the globe wherever there would be a toll station. And as described above about the merits of this Toll station we don't think that its not that far enough when we would see this technology being used in India and in terms benefiting the whole society as well as the company whose is involved in Toll taxation. RFID

is a powerful technology, and it is likely to see world-wide deployment within the coming years. Continuous technological advancements of RFID have resulted in reduced cost of installation and maintenance of devices across different market segments. Comparing advantages and limitations of our system we can conclude that our system is beneficial for daily travellers and Toll station authorities to lessen the burden. And finally, while RFID may seem to be a fairly simple and innocuous technology on the surface, a wide range of issues and choices need to be explored and resolved for its successful, wide-scale deployment. We are seeing great promise and signs that the RFID and future upcoming sensor network technologies will help to change the way we think about our manufacturing processes and the interactions with the people and customers. On the concluding node we can say that we have successfully implemented one of the phase of our project but still have some improvements and advancements to be done.

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