Contactless Toll Collection System using RFID Technique

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Abstract: *Automated toll Collection System is used for collecting tax automatically. In this paper vehicle identification is done with the help of RFID tag. Each vehicle must be provided with an RFID tag. This tag is nothing but unique identification number allocated. In accordance with this number the basic information as about how much amount paid in advance for the toll charges. RFID reader will be correctly placed at toll collection centres. Whenever the vehicle passes the toll collection centre, the tax amount will be subtracted from the prepaid balance and new balance will be updated. As vehicles don't have to stop in a queue, it guarantees 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 urbanite cities in present days. It is one of the stress-free methods used to organize the heavy flow of traffic. Even if user don't have enough balance in his/her account he or she can easily recharge the by using the recharge machine which has been implemented.*

Key words: RFID, Backscattering, ATCS

I. INTRODUCTION

Transportation is the backbone of any country's economy. Improvement in transportation systems result into the good lifestyle in which extraordinary freedom for movement, immense trade in manufactured goods and services can be accomplished. In this paper an automated toll collection system using RFID is proposed. RFID is a wireless link to uniquely recognise tags. These systems communicate via radio signals that carry data either in unidirectional or bidirectional. The tag is energized by a time fluctuating electromagnetic radio frequency (RF) wave that is transmitted by the reader. When tag is energized, the information stored in the tag is transmitted back to the reader. This is often called backscattering. By detecting the backscattering signal, the information stored in the tag can be fully recognized. While both use radio frequency signals for communication between a tag and a reader, the method of powering the tags is different. Automatic toll collection is a technology that allows the computerised electronic collection of toll costs.

Automatic Toll Collection System (ATCS) is capable of determining whether the vehicle is registered or not, and then informing the management centre about to process violations, debits, and participating accounts. The most excellent advantage of this ATCS system is that it is capable of eliminating congestion in toll plazas, especially during the festival seasons when traffic seems to be higher than normal.

II. COMPONENTS

A. Arduino Uno

Fig. 1. Arduino Uno

Arduino is an free platform used for building electronics projects. Arduino consists of both programmable circuit board (often referred to as a Microcontroller) and a software,that runs on a computer, used to write and upload computer code to the physical board. Unlike most earlier programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board, o n e can simply use an USB cable.

The Arduino IDE uses a basic style of C++,

making it easier to code. The Arduino is a microcontroller board which uses ATmega328p processor. It has total 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 an USB cable or power it with an AC-to-DC adapter (5V) or battery to get started.

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. The Arduino development environment contains a text editor for writing a code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It associates to the Arduino hardware to upload programs and connect with them. Programs written in Arduino IDE are called sketches. These Sketches are saved with .ino extension.

B. RFID Module

Fig. 2. EM-18 RFID Reader module.

A radio frequency identification reader (RFID reader) is a device used to gather information from an RFID tag, which is used to track individual objects. Radio waves are used to transfer data from the tag to a reader. RFID is a technology similar to bar codes. However, the RFID tag does not have to be scanned directly, nor does it require line-of-sight to a reader. RFID tag must be within the range of an RFID reader. RFID technology allows several items to be quickly scanned and enables fast identification of a particular product, even when it is surrounded by several other items.

EM-18 module radiates out 125 KHz radio waves through the coils. When a 125 KHz RFID passive tag is bought into the field of module, it will get energized from the field. By the change in modulation current through the coils, the tag will be sending the information back to the program memory.

C. Liquid Crystal Display (LCD)

LCD is a flat display technology, stands for "Liquid Crystal Display," which is generally used in computer monitors, instrument panels, cell phones, digital cameras, TVs, laptops, tablets, and calculators. It is a thin display device that offers support for large resolutions and better picture quality. The older CRT display technology has replaced by LCDs, and new display technologies like OLEDs have started to replace LCDs. An LCD display is most commonly found in laptops and is available as an active-matrix, passive-matrix, or dual-scan display.
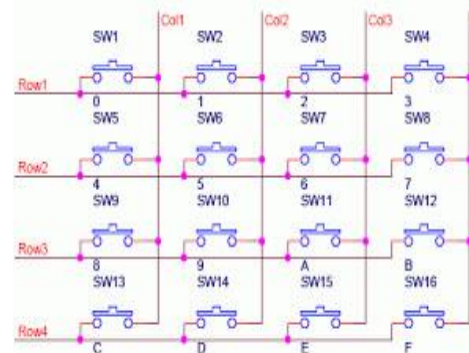

Fig. 3. LCD

D. 4 X 4 Keypad

Fig. 4. 4 x 4 Keypad internal diagram

A Matrix keypad is the most commonly used input device in many of the application areas like digital circuits, telephone communications, calculators, ATMs, and so on. A matrix keypad consists of a set of push button or switches which are arranged in a matrix format of rows and columns. These keypads are available in configurations like 3×4 and 4×4 based on the application it is implemented for. The working principle is very simple. Pressing a button, shorts one of the row lines to one of the column lines, allowing current to flow between them.

Buzzer is used for alerting when any vehicle is unauthorized or if there is inadequate balance in the user's card.
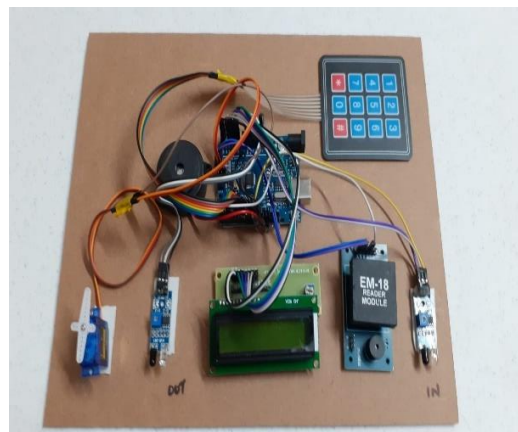

Fig. 6. Circuit design of system

IV.   WORKING

Whenever any person buys a vehicle, first he/she need get their vehicle registered at the RTO office. RTO 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 credit 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.
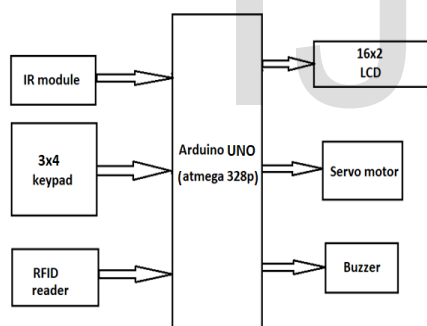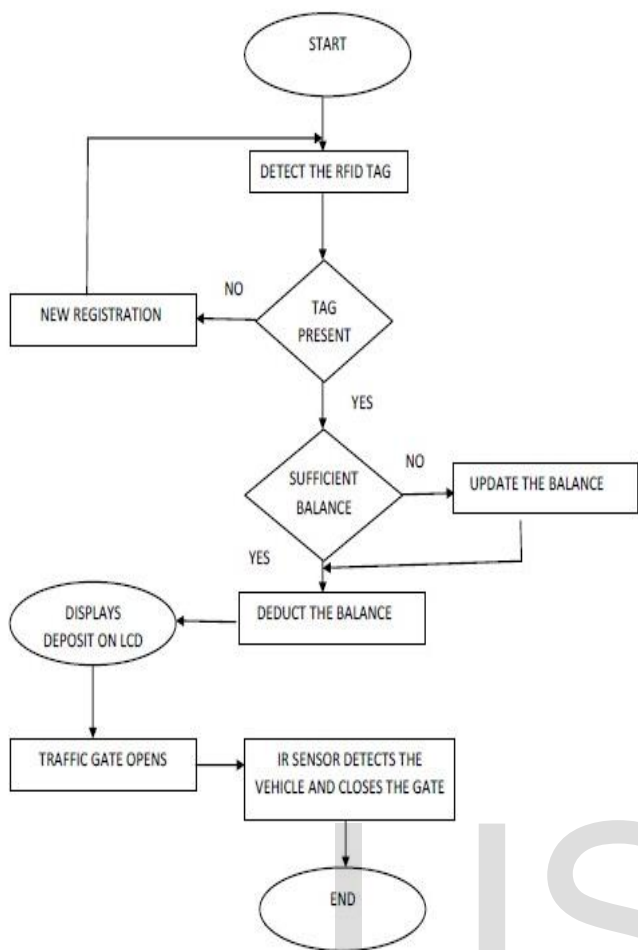
III.   DESIGN

Fig. 5. Design outline of project

In the above diagram the IR module, Keypad and RFID reader act as input devices to Arduino and Servo motor, buzzer and LCD act as output device. The IR sensor is used for detecting the vehicles when approaching towards gates. RFID reader is used for scanning the RFID tag which is attached to the vehicle in order to identify it. Keypad is used for recharging the RFID card and for checking the balance in the card. Servo motor acts as the toll gate in the circuit. LCD acts as the screen while recharging and interfacing with recharge machine.

Fig. 7. Work Flow of the project

Transaction will begin, depending upon the balance available. Toll will be deducted directly or the vehicle will be directed towards another lane to recharge the card. 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. Updates of any sort of transaction will be immediately updated to local database and centralized server.

V. RESULTS

RFID based automated toll collection system is successfully implemented using Arduino and its operation is verified. Whenever vehicle arrives, it is detected by IR sensor placed at the starting of the toll. After scanning the RFID card, if the user is authorised and has sufficient balance then the toll gets deducted automatically from the user's account and the gate will be opened but if user is not authorised then the gate won't open for that user and if user has insufficient balance, then he can divert to recharge his card.
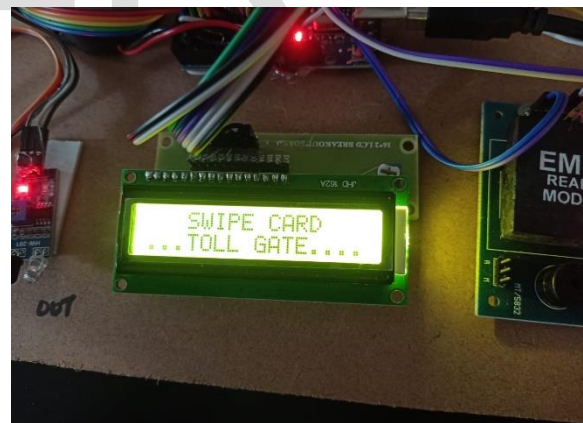

Fig. 8. Default message displayed on the LCD.

Fig. 9. Message displayed after successful transaction.

VI.   CONCLUSION

RFID is the best technology among all automated access control technologies. As it has high durability and low maintenance cost it is efficient to use. Finally, this system can reduce traffic congestion near toll gates by a great percentage and as there is COVID pandemic out there, contactless transactions help in reducing contact with the others as everything is automated and digitalized. It is low cost, high security and efficient. Automated toll collection using RFID can reduce management costs, at the same time, greatly reduces sound and air pollution at the toll gate. Labour costs can be reduced as there is no need for multiple workers at the toll booth.

VII.   FUTURE SCOPE

In future, vehicles going with over speed can be detected using this system such that any over speeding vehicle can be caught automatically with the help of this RFID tag. Finding and tracking vehicle which is stolen can be added as additional features in this system which will make the transportation system smarter and secured.

The RFID based toll collection technique is so efficient and cheap such that it can be used in many other applications like paid parking etc.

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