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Smart Toll Taxation Using RFID

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***Abstract*: The use of automated toll collection system in many metropolitan cities would be an efficient step towards the overcrowding of the city highways in heavy congestion of traffic. As we all know, transportation is the strength of our country's economy. There are various implementation, protocols in wireless sensor network such as leach-c and components such as RFID, NFC thus enabling reduction in operation costs and motivating cashless transactions. In case of manual toll collection system time consumption is much far worse as well as fuel depletion and most important is the environment, the amount of air pollution that is created at the toll booth site is at high level, so our developed system will reduce time wastage and not only reduce air pollution but also conserve fuel. The sole purpose of this paper is to reduce the hardships caused by manual toll collection system and pass the subject's vehicle through toll barrier in a matter of few seconds without halt.**

***Keywords*: RFID, Card, Reader, Microcontroller, LCD**

1. Introduction

As we all know that transportation is the important sector 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. As it is studied by researchers and also applied in various expressways, bridges, and tunnels require such a process of Automatic Toll Plaza. ATP is capable of determining if the vehicle is registered or not, and then informing the management center about to process violations, debits, and participating accounts .The most excellent advantage of this ATP system is that it is capable of eliminate congestion in toll plaza, especially during those seasons when traffic seems to be higher than normal.

Fig. 1. RFID based toll gate collection

2. Proposed system

This paper gives the simplified procedure to passengers to pay toll at toll booths by making them automated, vehicle burglary detection, preventing signal violation, tracking vehicles with high speed. All these activities are carried using single RFID tag thus saving the efforts of carrying money and records manually.

A. Smart Toll Taxation

The RFID Readers mounted at toll booth will read the prepaid RFID tags fixed on vehicle's front glass and automatically respective amount will be deducted. If the tag is removed from the windshield then cameras fixed at two sites at toll plaza take snaps of the front and back number plate. Since every vehicle registration ID is linked to users account, toll can be deducted from the account bank directly.

B. Vehicle Burglary Detection

When vehicle is stolen the owner registers complaint on the website with its registration ID and unique RFID tag number. Now when stolen vehicle passes by the toll plaza, the tag fixed on it is matched with the stolen vehicle's tag in the database at the toll booth.

C. Preventing signal violation

The vehicle ignoring the traffic signal will be detected by the RFID readers fixed at signal crossing and will be notified to the traffic police. This can reduce the rate of signal violation.

D. Tracking vehicles with high speed

Vehicle travelling above speed limit can be tracked with 100 % accuracy. It prevents problems with toll evaders.
The following are the major advantages over current system.

- Record Maintenance
- Free flow of traffic.
- Time saving.
- Smart toll collection
- Problems with pursuing toll evaders

3. Methodology

Flow of RFID based toll tax are:

- Detects the vehicle.
- Detection of RFID card.
- Display of toll.
- Payment through RFID card.

Whenever any person buys a vehicle, first he/she need to do her vehicle registered at the RTO office. This card will have a unique ID to use with that vehicle, which has a separate account and it maintains transaction history in it's database. He/She needs to maintain minimum balance in the card. Whenever a registered vehicle approaches the toll booth, first the Infrared sensors will detect the presence of the vehicle. This in turn activate the RFID circuit to read the RFID card fixed on the windscreen of the vehicle. Transaction will start, based upon the balance available toll will be deducted directly. The software will update the details in database, which sends the bill to owner via 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. All the toll plazas will be connected to each other along with centralized server in the form of LAN. Updates of any sort of transaction will be immediately updated to local database and centralized server. So that, the system has a great extent of flexibility.

4. Block diagram

The following are the brief explanations of the working principle of the various major blocks or sections used in the system.

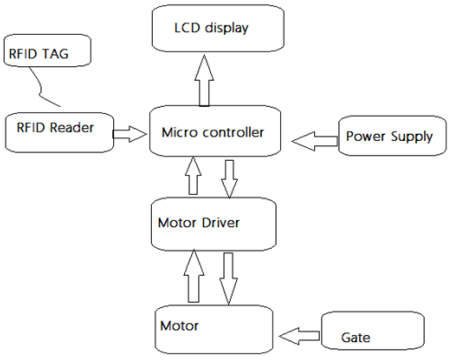

Fig. 2. Block diagram of RFID tool tax

A. RFID card

RFID is an acronym for "radio-frequency identification" and refers to a technology whereby digital data encoded in RFID tags or smart labels (defined below) are captured by a reader via radio waves. RFID is similar to bar coding in that data from a tag or label are captured by a device that stores the data in a database. RFID, however, has several advantages over systems that use barcode asset tracking software. The most notable is that RFID tag data can be read outside the line-of-sight, whereas barcodes must be aligned with an optical scanner.

B. RFID reader

A RFID reader is a device which is used to interrogate an RFID tag. It reads the unique number from the RFID cards and sends it to the microcontroller. RFID reader is highly expensive, so that it can't be replaced with barcodes.

Fig. 3. RFID reader

C. Microcontroller

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of In System Programmable Flash memory. Microcontroller is the main part of the complete system. It is used to monitor & control components connected in the system. This unit requires +5V DC for it proper operation. Thus the complete execution of the system depends on the code dumped in it. Initially it helps to read the data by using RFID reader. This information is displayed at LCD display. Depending on the balance availability in the RFID card the control gate raises or the buzzer beeps.

D. Programming AT89S52 Microcontroller

Arduino, Keil uVision can be used as better platforms for programming in Atmel Microcontroller. We need an IDE to program in Atmel Microcontroller. A compiler can be used to convert our program into MCU readable form called HEX files. An IPE is used to dump our hex file into our MCUs. We can use proteus to stimulate our program.

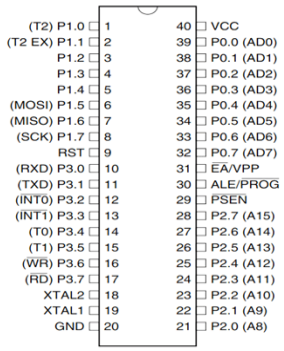

Fig. 4. Pin configuration of AT89S52

E. Power Supply

This unit will supply the various voltage requirements of each unit. This will be consists of transformer, rectifier, filter and regulator. The rectifier used here will be Bridge Rectifier. It will convert 230VAC into desired 5V/12V DC.

F. LCD

It is called Liquid Crystal Display. We are going to use 16x2 character LCD. This will be connected to microcontroller. The job of LCD will be to display all the system generated messages coming from the controller. It acts as an interactive user interface. This unit requires +5VDC power supply. This unit displays the present state of the system.

Fig. 5. 16*2 LCD module

Generating custom characters on LCD is easy by having a basic knowledge on Custom Generating Random Access Memory. (CG-RAM) of LCD and the LCD chip controller.CG-RAM size is 64 byte providing the option of creating eight characters at a time. Each character is eight bytes in size. CG-RAM address starts from 0x40 (Hexadecimal) or 64 in decimal. Once we generate our characters at these addresses, now we can print them on the LCD at any time by just sending simple commands to the LCD.

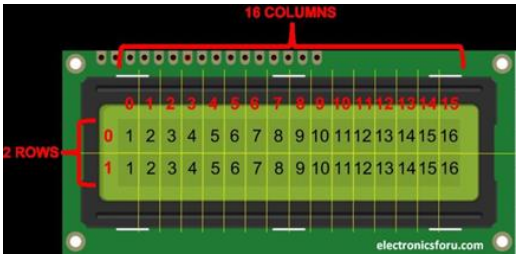

Fig. 6. LCD layout pin diagram.

G. Motor driver

Motor driver is an IC which is used to drive the motor. A motor driver IC is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver ICs act as an interface between microprocessors and the motors in the robot. The most commonly used motor driver IC's are from the L293 series such as L293D. Here we are using L293D motor driver, which consists of H bridge to control flow of current in in. The L293D IC receives signals from the microprocessor and transmits the relative signal to the motors. It has two voltage pins, one of which is used to draw current for the working of the L293D and the other is used to apply voltage to the motors. The L293D switches it output signal according to the input received from the microprocessor.

For Example:

If the microprocessor sends a 1(digital high) to the Input Pin of L293D, then the L293D transmits a 1(digital high) to the motor from its Output Pin. An important thing to note is that the L293D simply transmits the signal it receives. It does not change the signal in any case.

5. Implementation

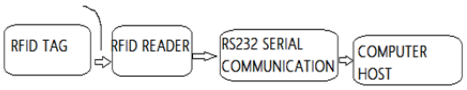

Fig. 7. Hardware assembly

RFID based toll collection system is used as a technology for fast and efficient collection of toll at the toll booths. This is possible for the vehicles passing through the toll plaza need not stop to pay toll and the payment automatically is deducted from the account of the driver. The electronic toll lanes are setup with special antennas that will send out signals continuously. These signals are used to identify the vehicles that travel through them. To use the electronic toll facility the drivers need to setup an electronic transponder (tag) fixed in the vehicle. These transponders (tags) are fitted on the windshield of the vehicle [6]. The tags have all the information regarding the users account. The antennas continuously send radio frequency pulses which returns only when hits a tag. These pulses are returned back from the tag and are received by the antenna. These reflected pulses from the tags contain information about the driver number, drivers account, balance etc. After encrypting the contents of this pulse the unit uses cellular modems or wireless transmitters to send it off to a central location where computers use the unique identification number to identify the account from which the cost of the toll should be deducted

The main system components are as follows:

1. RFID tagged vehicle
2. Centralized database
3. Cameras
4. Toll booth equipped with RFID scanners
5. Vehicle Registration plate
6. Laser transponders

These components of the RFID based Smart toll Taxation system technology work as follows:

- *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.
- *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

- *Video Enforcement Systems:* When used for electronic toll collection, the video enforcement system (VES) captures images of the license plates of vehicles that pass through an electronic tollbooth without a valid electronic tag. Although the deployment of these technologies makes the initial cost of installation very high, but there exist huge benefits accompanied with such high investment. These benefits are discussed in the upcoming section.

6. Working of the RFID based Smart Toll Taxation system

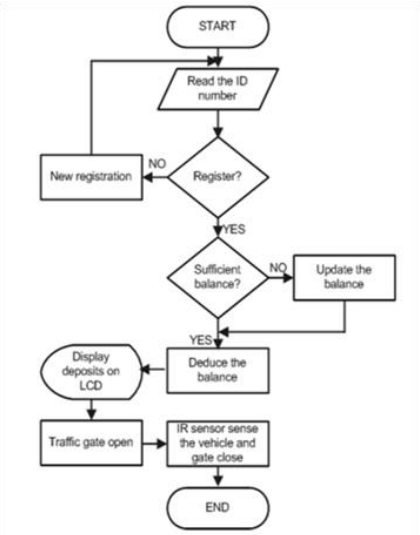

Fig. 8. Flowchart of automatic RFID based toll collection

7. 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 improves the passage ability of expressway but also improve 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 ecofriendly 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.

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