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RFID Based Toll Collection System

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***Abstract*— 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. RFID reader fixed at tollgate frame (or even a hand held reader at manual lane, in case RFID tagged vehicle enters manual toll paying lane) reads the tag attached to windshield of vehicle. The object detection sensor in the reader detects the approach of the incoming vehicle's tag and toll deduction takes place through a prepaid card assigned to the concerned RFID tag that belongs to the owners' account. This makes tollgate transaction more convenient for the public use.**

Keywords- RFID, Reader, Prepaid Card.

1. INTRODUCTION

The main idea behind implementing RFID BASED TOLL COLLECTION SYSTEM is to automate the toll collection process their by reducing the long queues at toll booths using the RFID tags installed on the vehicle. In addition to this, it can not only help in vehicle theft detection but also can track vehicles crossing the signal and over speeding vehicles. This system is used by vehicle owners, system administrator. Other general advantages for the motorists include fuel savings and reduced mobile emissions by reducing or eliminating deceleration, waiting time and acceleration. Meanwhile, for the toll authorities also get the benefits mentioned below[2]: The benefits for the motorists include:

1. Fewer or shorter queues at toll plazas by increasing toll booth service turnaround rates.
2. Faster and more efficient service (no exchanging toll fees by hand)
3. The ability to make payments by keeping a balance on the card itself
4. The use of postpaid toll statements (no need to request for receipts)
5. Lowered toll collection costs
6. Better audit control by centralized user account and
7. Expanded capacity without building more infrastructures.

2. EXISTING SYSTEM

Active wave Inc [3] has currently deployed a system of active tag vehicle monitoring solution. Active wave vehicle products have a range of 30 meters and operate in the 916 – 927 MHz for the transmit operations and 433 MHz for the receive link. Active wave products are currently equipped with 256 Kbits of fixed memory. The tag is powered with a replaceable 3V battery and the total weight is 14 grams. Elementary signals are shown with the help of blinking LEDs and beeping sounds. Smart key Access Control Systems [4] have a client – server model based system with an SQL server handling multiple vehicle monitoring systems. They have designed a user interface using the Microsoft .NET Framework. Smart key also operate in the 900MHz band but have a small range of 30 meters. RFID based toll collection system [1] uses active
RFID tag which uses car battery power. The implementation is divided into the design of two modules- the Vehicle Module (Active Tag) and the Base Module. The two modules communicate via RF modem connected to each module. These RF modules communicate over the ISM Frequency Range of 902 – 928 MHz.

3. PROPOSED SYSTEM

This project deals with the simplification of procedure followed by passengers to pay toll at toll collection booths, like making it automated, vehicle theft detection etc. All these activities are carried out using single smart card (RFID tag), thus saving the efforts of carrying money and records manually [5].

Automatic Toll Collection: The RFID Readers mounted at toll booth will read the prepaid RFID tags fixed on vehicles' windshield 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.

Vehicle Theft 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.

Signal Breaking Avoidance: 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 be done efficiently and great accuracy.

Tracking Over speeding Vehicle: Vehicle travelling above speed limit can be tracked with 100 % accuracy.

4. METHODOLOGY

Whenever any person buys a vehicle, one first needs to get his or her vehicle registered at the RTO office. RTO officials will not only assign a number plate to it but also

will give a RFID enabled smart card or a tag. This card will have a unique ID feasible to use with that vehicle only. They will also create an account for the use of that particular smart card and maintain transaction history in database. User 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. It will in turn activate the RFID circuit to read the RFID enable smart card fixed on the windscreen of the vehicle. Transaction will begin, depending upon the balance available toll will be deducted directly or the vehicle will be directed towards another lane to pay tax manually. 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[7].

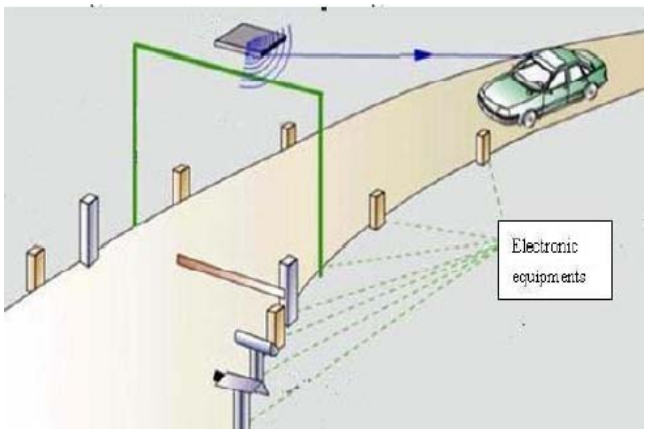

Figure 1: Working module

On the other hand, whenever any vehicle owner registers a complaint to RTO office regarding theft 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 the centralized server in the form of LAN. Updates of any sort of transaction will be immediately updated to local database and centralized server[8].

5. IMPLEMENTATION

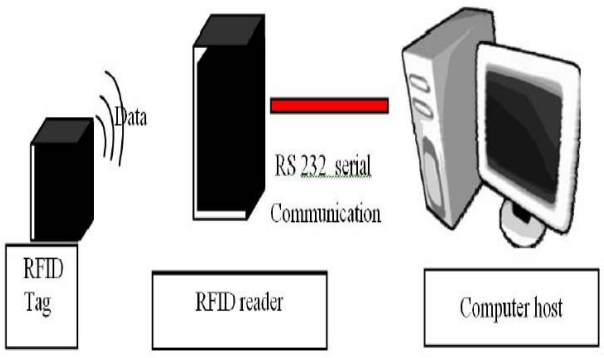

Figure 2: Hardware assembly

EM-18 RFID CHIP

Figure 3: EM-18 RFID reader module

Features

Table 1: features of RFID chip EM-18

RF transmit frequency	125KHz
Supported standards	EM4001 64-bit RFID tag compatible
Communications Interface	TTL Serial Interface,Weigand output
Communications Protocol	Specific ASCII
Communications Parameter	9600 bps,8,N,1
Power Supply	4.6V-5.5V DC +/- 10% regulated
Current Consumption	50mA<10mA at power down mode
Reading Distance	Up to 100mm,depending on tag
Antenna	Integrated
Size(L*W*H)	32*32*8mm

RFID based toll collection system is used as a technology for fast and efficient collection of toll at the toll plazas. This is possible as the vehicles passing through the toll plaza do not stop to pay toll and the payment automatically takes place from the account of the driver.

The electronic toll lanes are set up with the special antennas that continuously send out signals. These signals are used to automatically identify the vehicles that travel by them. To use the electronic toll facility, the driver needs to set up an account and get an electronic transponder fixed in the vehicle. These transponders commonly known as the tags are usually fitted on the windshields of the vehicles[6]. The tag has all the information regarding the patron's account. The antenna continuously sends out a radiofrequency (microwave) pulse, which returns only when it hits a transponder. These pulses are returned back from the transponder and are received by the antenna. These microwaves reflected from the tags contain information about the transponder's number, patron's account, balance, etc. Other information such as date, time, and vehicle count could be recorded depending upon the requirement of the data needed by the toll agencies. After encrypting the contents of this microwave, the unit then uses fiber-optic cables, cellular modems or wireless transmitters to 15 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. This system uses diverse technologies for its working.

Figure 4 shows the working of the electronic toll collection system with its components. These components may vary depending upon the technology used. As the vehicle enters the toll lane, sensors (1) detect the vehicle. The two-

antenna configuration (2) reads a transponder (3) mounted on the vehicle's windshield. As the vehicle passes through the exit light curtain (4), it is electronically classified by the treadle (5) based on the number of axles, and the ETC account is charged the proper amount. Feedback is provided to the driver on an electronic sign (6). If the vehicle does not have a transponder, the system classifies it as a violator and cameras (7) take photos of the vehicle and its license plate for processing.

Working arena

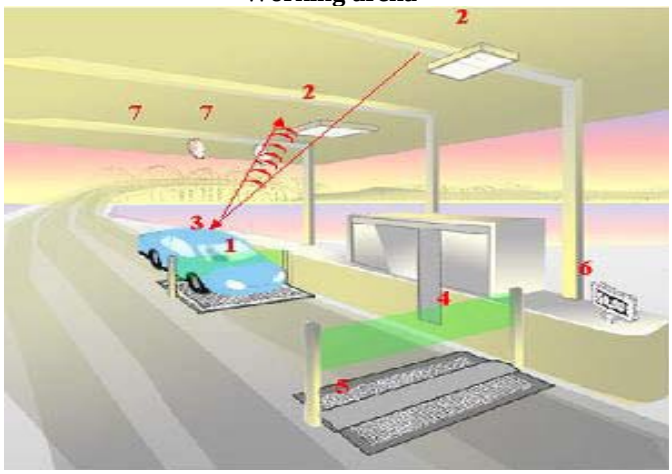

Figure 4: Implementation of RFID based toll collection system

The System architecture is shown below:

Architecture of RFID based toll collection system:

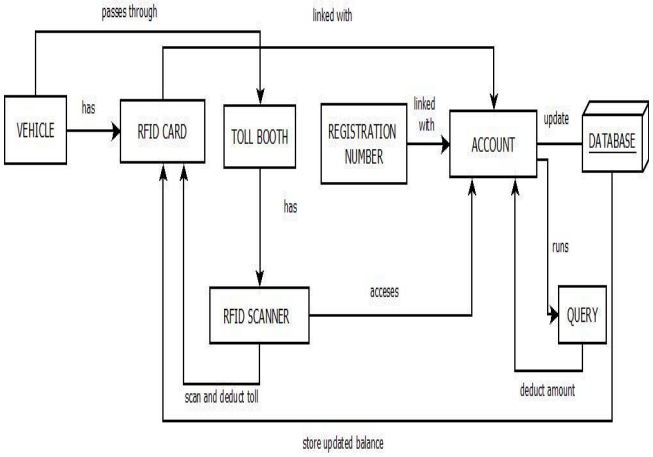

Figure 5: RFID based toll collection system

The main system components are as follows:

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

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

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 (or some combination of these determinants). Some toll agencies use as many as 15 or more vehicle classes to assess tolls, although for toll collection applications, four or five classes are more typical.

3. 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 ETC tollbooth without a valid ETC 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[7].

The flow chart for the proposed system is shown as follows:

Flowchart 1: Working of the RFID based toll collection system and theft detection system:

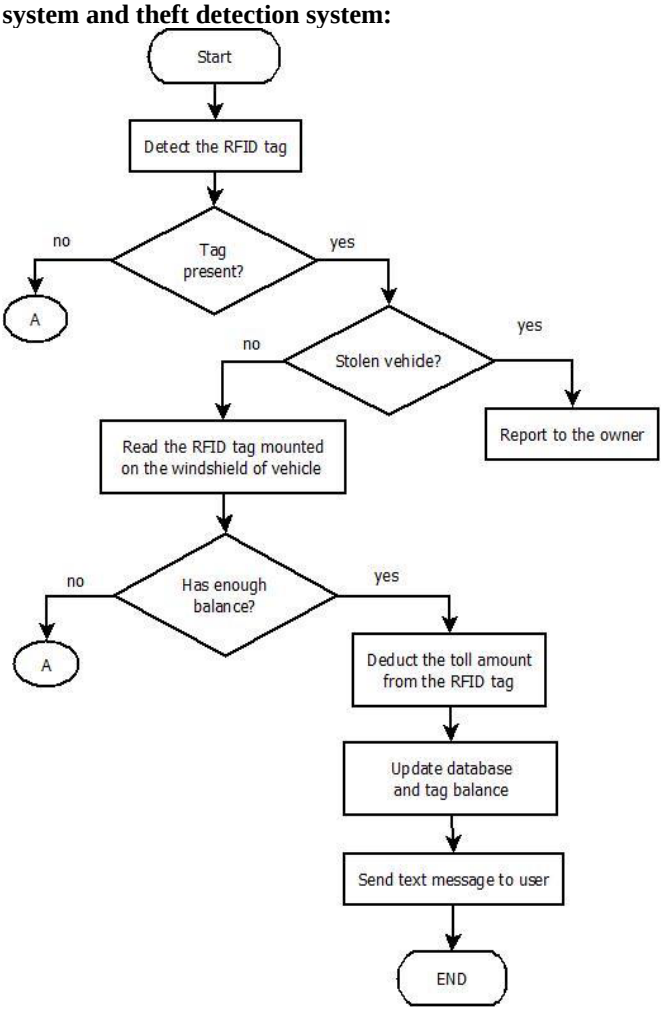

Figure 6: Working of system

Flowchart 2: Working of the RFID based toll collection system and theft detection system (continued..)

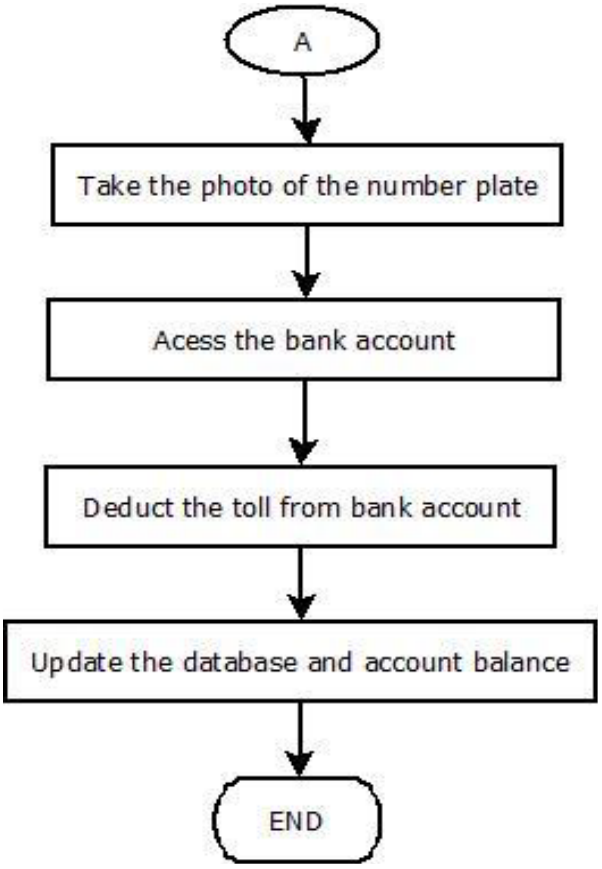

Figure 7: Working of system

CONCLUSION

The electronic toll collection system in expressway based on RFID, a design scheme was put forward. It has characteristics of low cost, high security, far communication distance and high efficiency, etc. It not only can improve technology level of charge, but also improve passage ability of expressway. Electronic toll collection system 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.

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