RFID Based Automatic Toll Transportation System

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ABSTRACT

In Manual toll collection methodology, a driver has to stop at a charging toll booth and pay the required fee directly to a collector. Thus we introduce RFID Based automatic Toll transportation system at highway speeds and simply pay tolls using their toll tags (RFID tags). This means toll booths, attendant staffing, and collection and management of cash are not required and hence we get the operational efficiencies and cost savings are significant. The RFID tag stores all the necessary detail of the owner electronically. The RFID tag is put on the vehicles allowing deduction of money at toll plazas automatically and sends a mobile message to the driver. Here the owner should maintain a prepaid account, thus the toll tax is deducted automatically from the driver's account at toll plaza. In such cases where the balance in the owner's account is low or if the vehicle is not equipped with an RF system, the toll gate remains close. In such situation the vehicle owner will have to pay the toll tax through mobile banking. The alert message is sent automatically to the traffic governing authority in case of rash driving, breaking of toll gate.

KEY WORDS: RFID tag, Intelligent Toll Transportation System, Radio Frequency Identification, Automatic Toll Collection System, Electronic Toll Collection.

1. INTRODUCTION

An automatic toll transportation system commonly utilizes radio frequency identification (RFID) technology. RFID is a term that is used to identify technologies utilizing radio waves to identify objects .In 1948, Harry Stockman first proposed Radio frequency technology by introducing a paper about RFID technology named, "Communication by Means of Reflected Power" (Stockman, 2006). Then, RFID technology (Roberts, 2006) has been developed and been implemented in various applications, such as in library system, theft prevention, warehouse management, attendance system, and so on. Initially RFID is used for tracking, tracing, and identifying objects.

From the Beginning of the roadways (Zhengang, 2009), the road maintenance and tax of road-ways are collected either directly or indirectly. At first, the indirect way of collection is done in the road-ways by budget allocation from national income that is common for all. This made a disadvantage that not all people use roads for transportation .Thus, for collecting the tax from vehicles, a toll gate is introduced and then the gate will be opened by authority that made tax collection directly from the drivers while passing the road/street., which leaded to traffic jam problem, etc (Wei Du, 2011).

To solve the traffic problem for the toll collection, a transmitter (that has the brought from prepaid tax payment at the toll office) is attached to the vehicle. On reaching the toll, the tax will be deducted electrically by pressing a button in transmitter which will be sensed by IR sensor at toll booth that deducts the amount payment electrically from the database of the transmitter leading to open the toll gate automatically (Sandhya, 2012). Since it has many disadvantages, new technologies such as RFID and ZigBee are proposed.

Later on, an advancement on RFID technology evolved with various combinations of networks like satellite navigations leading to a global common database on toll systems for intelligent transportation (Aniruddha Kumawat, 2014). RFID technology on toll collection system consists of the RFID tag (looking like a smart card) that contains details about vehicle owner and vehicle details .When the RFID tag is reached to the toll, it will be sensed by the RFID transmitter and receiver that deducts tax automatically in the vehicle drivers database and thus the toll opens electrically (Sathya, 2015).

Thus RFID technology saves time, man power and effort in toll collection system. Later on, electrically maintained database also made advancement by finding the number of vehicles passing though the toll gate and a message is sent to driver's phone regarding the deduction of tax amount. The driver can also pay tax though mobile banking (Al-Ghawi, 2016).

Figure.1. Automatic toll collection system using RFID technology

In the toll plazas, the multi-lane free flow system is introduced for various vehicles passing at a time in the toll and nonstop vehicle transaction at toll for tax payment using passive RFID tag (Noor, 2016). This may lead to many security issues at border of cities and countries. Hence, in this paper the alert for some emergency cases is proposed.

Related work: The automatic toll collection system is being developed for decades and many technologies had been implemented. Such technologies are Tax collection by the means of reflection power, Microcontroller based control system, Advancement in toll collection using RFID and ZigBee Technologies, Passive RFID based automatic toll transportation system, toll collection using satellite navigation.

Tax collection by the means of reflection power: Point-to-point communication with the carrier power generated at the receiving end and transmitter replaced by a modulated reflector. It represents a transmission system which possesses new and different characteristics. Radio, light, or sound waves (essentially microwaves, etc.) may be used for the transmission under approximate conditions of specular reflection.
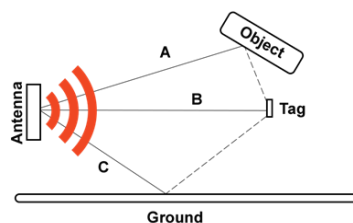

Figure.2. Reflection power

A few different methods for the modulation of reflectors are advanced in various laboratory and field test results .The reflected-power communication method may yield one or more of the following characteristics: high directivity, automatic pin-pointing in spite of atmospheric bending, increased security, elimination of interference fading, simple voice-transmitter design without tubes and circuits and power supplies, and simplified means for identification and navigation of objects and persons..

Microcontroller Based Control System: In this system, the user only has to get the transmitter from the main toll office .The transmitter will be charged by the operator of the booth office and the data will be stored in the micro controller. Visual Basic 6.0 is used to feed the various details of the users and the database will be maintained in Microsoft Access. The user will then mount this transmitter on its car. On pressing a button, the data transfer will take place. It will be get sensed by the IR. Receiver mounted at the toll plaza, the fare will get deducted automatically according to the toll charged and the remaining amount will be displayed. Stepper motor is used to open and close the gate. The gate will get opened for the legitimate user and for others it will remain close (Sandhya, 2012).

Figure.3. Microsoft Access Database

Advancement in toll collection using RFID and Zigbee Technologies: An efficient utilization of communication link between Radio Frequency Modems over a wireless channel to facilitate vehicle authentication, vehicle monitoring and automated toll collection on the highways is proposed. The system is implemented to electrically a more convenient way of collecting the toll tax and traffic management. This method can be done in a developed way and it's called Electronic Toll Gate Stations using RFID and ZigBee Technologies. The implementation is divided into the design of three modules, Vehicle Module (Active Tag) and Central Database Module, the Tollgate station. The three modules will communicate via GSM modem connected to each module. The feature of RFID tags it provides Security through PASSWORD is made.
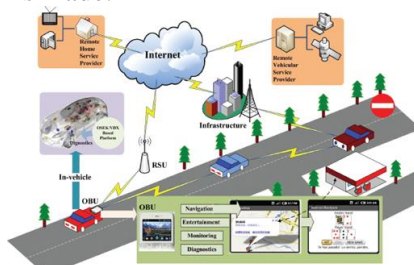

Figure.4. ZigBee wireless communication mechanism

The active RFID reader contains a transmitter that sends a signal to the receiver. The tollgate unit contains the Active RFID reader to the necessary vehicle identification information When a vehicle comes in the vicinity of the toll gate the tag attached to the vehicle is communicates with the reader attached to Toll gate station and the information of tag is sent through Central data base station using ZigBee wireless communication protocol (Lonkar, 2014). Thus the Toll collection system works electrically with better time consumption, traffic congestion etc.

Passive RFID based automatic toll transportation system: The passive RFID tag contains the details which will be read by the RFID receiver that acts as a transmitter for signaling to tags that are approaching. This system eliminates the vehicles to stop at the toll for manual payment, thereby enabling an efficient toll collection by reducing traffic congestion and eliminating possible human errors. In this method, passive RFID card is sensed by the RFID receiver in the toll booth and the money will be deducted automatically. Automatic process of toll collection saves time, effort, and man power.

Figure.5. Passive RFID toll collection system

Toll collection using satellite navigation: Automatic toll collection are implemented by dedicated short-range communication technology .In ETC development (GPS) global positioning system technique took place. However a new generation of electronic toll collection is developed to replace short-range communication based electronic toll collection system. Global positioning system technology has become new trend for road charging system, which implements automatic toll collection system based on positioning and Global System for Mobile communication.

Thus, the Electronic toll collection system is being in development in various categories such as vehicle tracking, Parking management, etc.

2. PROPOSED METHOD

In the toll plazas, the multi-lane free flow system is introduced for various vehicles passing at a time in the toll and nonstop vehicle transaction at toll for tax payment using passive RFID tag. This In order to reduce the traffic congestion and to save time, RFID based automatic toll transportation system is introduced. Here RFID tag is used which stores all the details of vehicle electrically. Thus the toll tax can be paid electrically, without stopping the vehicle at toll gate. This paper introduces an alert system for threats like rash driving and passing the toll gate by breaking it, which can be detected by a vibration sensor that will be attached to the toll gate .The buzzer at the highway alert the toll plaza. Then details of the vehicle stored in the RFID tag and the image of that incident is captured and will be sent to the traffic government authority.

Architecture model: In this paper, we are implementing RFID based Automatic toll transportation system using various hardware and software components. The following is the architectural diagram for the electronic toll collection system that makes a proposed system of alerting the traffic governing authority through a message alert to the corresponding office.
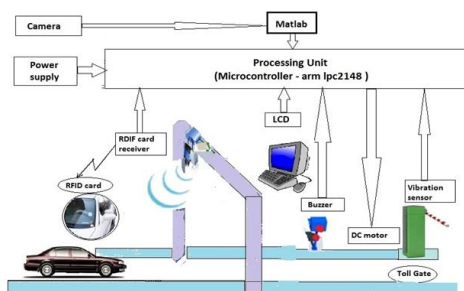

Figure.6. Architecture diagram of Automatic toll transportation system

The driver's RFID smart card is sensed by the RFID receiver automatically when the vehicle passes the toll gate. The money will be transferred electrically by processing unit that can be monitored by LCD that makes DC motor to open the gate at instant. The buzzer alerts the toll plaza in case of rash driving or passing the toll gate by breaking it which is detected using vibration sensor. The matlab will take a image using camera if violation is made and sends an alert message to traffic governing authority.

Hardware Implementation: The following are the hardware components that are used in this project implementation.

RFID Tag: The following are the Radio Frequency Identification (RFID) tag is like a smart card that is used for the toll tax deduction electrically by the vehicle driver. This RFID tag contains the details of the driver and the vehicle details which is sensed by the RFID transmitter and receiver from a particular distance. The RFID tag is a transceiver that makes no dc voltage supply to a chip, there will be a rectifier which rectifies input RF signal and generates DC voltage that powers the other blocks. RFID tag consists of a demodulator that detects command sent by the RF reader and it also extracts clock from received RF signal for the synchronization of RFID and RFID reader, a control logic that is, digital part that controls all the blocks in a tag which makes decision about, when to receive, when to transmit and when to stay idle, an internal clock that supplies internally generated clock to digital part, and a modulator that transmits the tag id.

RFID Reader: A RFID reader is simply a transmitter that makes the RFID tag which is approaching the toll to be deducted for electrical tax transaction. A low cost reader which is used as an educational tool that consists of a detector, analog comparator based on the data slicer and a low power transmitter based on off-the shell IC. The reader has power consumption of 60 mW, and an average current is 15 mA at 4V battery voltage.

Figure.7. Passive RFID tag and RFID reader

The reader has power consumption of 60 mW, and an average current is 15 mA at 4V battery voltage.

Microcontroller: This is a processing unit (the main block of the system), which is responsible for each and every process being executed in the toll collection system. Microcontroller controls and also monitors each component connected to the system .It also controls the peripheral devices. The working of microcontroller resides in the software code embedded in it.
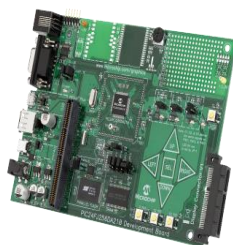
Figure.8. Microcontroller

Power Supply: It supplies various voltages as per requirement to each unit. It consists of transformer, rectifier, regulator and capacitors for filter. The rectifier is used as a bridge rectifier that converts 230V to desired 5V/12V DC.

LCD monitor: LCD monitor is used to display the processing unit activities to the toll collection system authority.

DC motor: This is a stepping motor used for opening and closing of the barrier on the toll gate. It is done when customer successfully performs the billing operation through the RFID tag with sufficient balance.

Figure.9. DC Motor

Buzzer: Buzzer will ring when there is insufficient balance in customer account or the driver makes rash driving by breaking though the toll gate.

Figure.10. Buzzer

Camera: In automatic toll E-ticketing process, a camera is fixed at the toll plaza to capture the image of the vehicle which passes the toll gate by breaking it without paying the toll amount. The image captured by the camera is sent to the matlab for processing that gathers the information of the vehicle stored in the RFID card and send to the traffic government authority.

Figure.11. Camera

Vibration Sensor: Vibration sensor is a sensing unit that is fixed to the toll gate. This sensor vibrates and makes the buzzer to alert the traffic control in case of rash driving or passing the toll gate by breaking it.

Figure.12. Vibration Sensor

Software Implementation: The following are the software components that are used in this project implementation:

Matlab: MATLAB is a programming language which is developed by MathWorks. It started out as a matrix programming language where linear algebra programming was made simple. It has the ability to run on both interactive sessions and as a batch job. In our project the micro controller is controlled and accessed by matlab. It creates the alert message and sends to the traffic authority.

3. EXPERIMENTAL RESULT

In this paper, the Alert mechanism is proposed for the violation case such as rash driving in toll by breaking the gate.

Figure.13. Experimental implementation of electrical toll collection system

The alert is made to the traffic governing authority. The RFID technology used has a database through a common global network that contains details of driver's account and vehicles. Hence the driver will get a message on tax collection when the vehicle passes the gate.
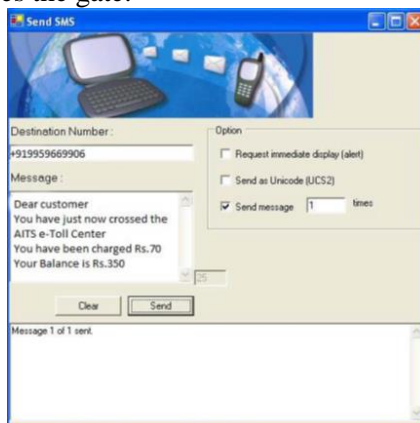
Figure.14. Graphical representation through LCD monitor by toll collection system authority

Performance evaluation and cost analysis: In the earlier time, the vehicles passing the toll plazas need to stop at the toll gate and the driver have to pay the toll tax to the staff and receive a receipt. All the process at toll plazas is fully manual. This leads to traffic at the highways, wastage of time and human power. Thus various steps are taken to make the toll process automatic. The toll collection is made automatic with the help of a RFID tag. RFID tag is a tag which stores the details of the vehicle electronically. The driver should hold this tag while crossing the toll gate at highways. The details in the RFID tag are sensed by the RFID receiver at the toll gate. The toll amount is automatically deducted

from the owner's account with the details in the tag. Then the toll gate is opened automatically without any delay. This system reduces time and also controls the traffic as the vehicle need not to stop at the toll gate. Thus instead of labor salary, all the toll system will be made electrically manual making the cost and performance far more better compared to earlier. The fuel is also saved in vehicles by nonstop movement at toll, saving energy.

4. CONCLUSION

In this paper, the concept of Automatic toll E-ticketing using RFID is explained. We have used an innovative approach where a vibration sensor is introduced at the toll gate which alerts the traffic authorities in case of rash driving and passing toll gate by breaking it.

Future advancement: In future we can enhance this project in addition with the face recognition mechanism where the rash drivers or stolen vehicle's driver face can be recognized by matching their face with the RFID card holder's database and their details can sent to the traffic authority.

5. ACKNOWLEDGMENT

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