International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 4, Issue 4, April 2015

Electronic Toll Collection and Theft Detection System on ARM-7 and RFID Technology

Amol A. Chapate, D.D. Nawgaje

Abstract: ***Electronic Toll Collection system which is a more convenient way of collecting the toll and traffic management leads to eliminate delay on toll roads. This paper describes a new method for collecting toll and theft vehicle detection by radio frequency identification technology (RFID). This system is fabricated based on ARM7-LPC2148 Microcontroller. RFID Reader fixed at tollgate frame read the vehicle information by accessing the tag mounted on the vehicle. Validating the information of vehicle belongs to the authorized person and toll deduction take place from his account, message will delivered to register mobile number and automatically opens the toll gate. It also helps to catch the theft vehicle very easily. The vehicle real time information which passed from the toll booth, store in database for future reference. The system help in lower fuel consumption, eliminate the manual cash handling and increase efficiency of toll collection by reduce traffic congestion at toll plaza.***

Keyword: ***Electronic toll collection, GSM, RFID.***

I. INTRODUCTION

With the increase in the number of vehicle on road, the task of traffic management becomes more complex. It is hard to keep and maintain the details of the each vehicle which is running on road. Also in case of hit-and-run or theft vehicle or road robbery cases, the police may not get the information very easily, as the vehicle details are not monitored continuously. A manual system is time consuming thus there is a long queue of vehicle to pass the toll plaza. To solve this complexity very easily electronic toll system can be used.

Electronic Toll is an element of intelligent traffic system which allows nonstop toll collection as well as continuous monitoring of traffic [1]. Computerized system provides traffic monitoring and data collection. It is a technology for smooth flow of traffic in efficient and faster way and intended to help the RTO, police Department, Public Transport.

Manuscript received

Amol A. Chapate*, PG Student, Electronics and Tele Communication* Engineering*, SGBAU University/ Shri Sant Gajanan Maharaj College of Engg. Shegaon, MH, India.*

D.D.Nawgaje*, Assisant Prof., Electronics and Tele Communication* Engineering*, SGBAU University/ Shri Sant Gajanan Maharaj College of Engg. Shegaon, MH, India.*

Electronic toll collection (ETC) is a technology that allows for electronic payment of tolls. The microcontroller gets the data received by RFID reader. Passive tag use incoming signal from reader thus have a shorter range. Tag mounted on the vehicle has unique identification number allotted to each vehicle. The classification of vehicle can be done by providing particular series number to that type of class. Gate mechanism is controlled by the microcontroller. It sends the message to registered customer number or police station number those will updates the tag number for any reason. LCD display is controlled by the microcontroller to show information to customer at toll plaza. The system allows non–stop service to the road users without bothering about toll rates or money change, same tag is read at toll plaza on all the Highways across the country and we save paper as well as fuel.

II. METHODOLOGY

When any person buys a vehicle, he registered vehicle at RTO office. RTO office will gives a number plate of vehicle and RFID enabled tag, this card has unique ID to be fixed on vehicle. Customer must have to deposit minimum amount to this account. After registration data will be available in database with details and transaction history.

Every time vehicle approach to toll plaza tag fixed on vehicle activate by signal of reader and send ID to the reader. System access the data corresponding to that ID and transaction begin, depend on the balance available, toll will deduct directly, if less balance available vehicle need to pay extra toll in another lane manually. Details update in database, also status of transaction will be send to user as a text message.

In the other side, any vehicle owner registers a complaint to RTO office regarding theft vehicle that entry add in database. Now every vehicle approaching at toll plaza with same ID register in stolen vehicle category can easily identified.

All toll plazas will be connected to each other to centralized server thus updating and monitoring is very easy.

ISSN: 2278 – 909X

III. SYSTEM HARDWARE DESIGN

The system is simple in construction; provide automatic toll collection and vehicle theft detection. Hardware Implementation consists of RFID tag, reader, ARM7 TDMI LPC2148 microcontroller, LCD display, GSM and motor driver circuit. Block diagram of electronic toll collection using RFID technology is as shown in Fig 1. RFID reader received data transmitted by the tag and it access by the controller. Microcontroller controls all the peripherals.

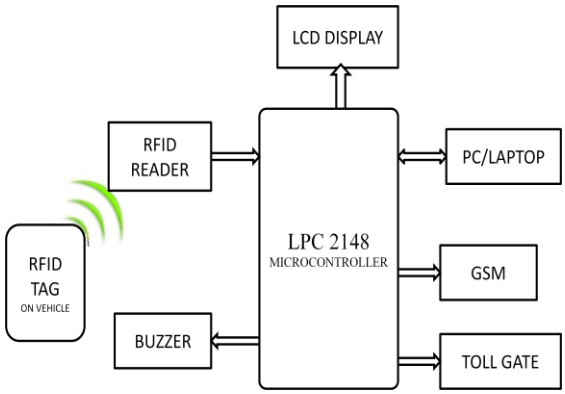

Fig 1: Block diagram of ETC

A. *Operation of System*

A RFID tag is mounted on each vehicle with unique ID. This ID is invisible on tag. RFID reader fixed at toll lane will continuously emit the RF signal, when vehicle reach at toll plaza in the range of RFID reader, signal emitted by reader incident on tag attach to vehicle and tag will activate and reflect the signal to reader through RF frequency, signal reflected from tag contain tag ID number, decode that signal and gives to ARM controller, it access the registered data corresponding to that tag number at toll booth. The controller will display the vehicle status of transaction on LCD. Microcontroller is interface with computer host through serial port to collect the vehicle data for monitoring. It shows all the vehicle details such as tag ID, vehicle number, date, time etc. on computer screen with GUI. Graphical User Interface is completed with the visual basic programming language. Microcontroller check the balance if sufficient balance is available then deduct toll balance from its account and update the balance, message will send to vehicle owner by using GSM modem. After deducting the toll, gate will open and green signal will on to pass that vehicle otherwise gate will not open and red signal remains on.

If the vehicle is stolen the vehicle owner register his complaint to police station, only authorized person update it on database with RFID tag number. When vehicle passed from toll plaza every vehicle tag number is compare with stolen vehicle tag number present in stolen vehicle directory database at toll plaza. If it is matched, depending upon the balance condition deduct the toll balance and gate open to allow it, because it is not possible to provide security at every toll plaza. Buzzer will be alarm and message will send to registered police station and vehicle owner also. A GSM module is interfaced with ARM controller which will send message to car owner regarding less balance or deduction balance.

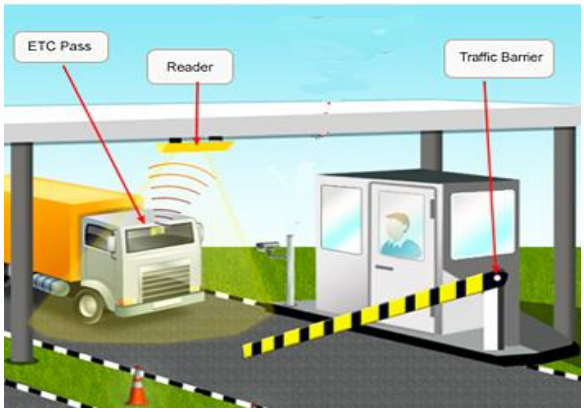

Fig 2: Implementation of ETC system

B. *USB to TTL Converter*

The USB to TTL device is provide connectivity between USB and serial UART interface. The power pin provides the 5V, 500mA direct from the USB port and the RX/TX pins are 3.3V level for interfacing with the most common 3.3V logic level chipsets. Fig. 3 shows the controller interfacing with PC.

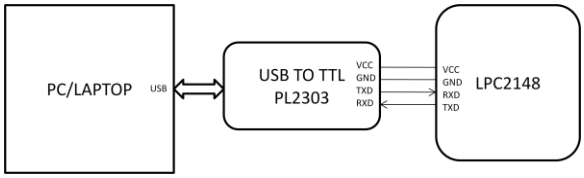

Fig 3: Controller interfacing with PC

C. *RFID Module Interfacing*

RFID utilizing radio wave for automatic identification, tracking and tracing of the vehicle, it is combination of tag and reader. Fig. 4 shows RFID interfacing with controller.

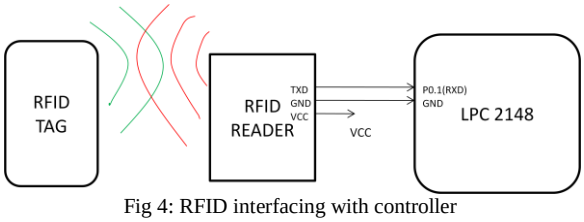

Fig 4: RFID interfacing with controller

Passive tags active by incoming RF signal. RFID tag consist chip and antenna [1]. A unique serial number store in a microchip which is attach to antenna, transmit the information to RFID reader

ISSN: 2278 – 909X

The RFID Reader is low-frequency (125 kHz). It incorporates energy transfer circuit to supply the transponder. Reader decodes the received data transmit to controller.

D. *ARM7-LPC2148 Controller*

It is a 16/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package. It has 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory, 128-bit wide interface/accelerator enables high-speed 60 MHz operation. 12 MHz crystal gives maximum 60MHz CPU clock, available from programmable on-chip PLL with settling time of 100µs. On-chip integrated oscillator operates with an external crystal from 1 MHz to 25 MHz. CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O pads.

E. *Stepper Motor*

Stepper motor for barricade is control by the arm microcontroller. ULN2003A driver IC is used to drive stepper motor. When gate will open green signal will on and red signal will on for gate closed.

F. *LCD Display*

To drive LCD display by arm controller require buffer IC because it operate on 5v supply and controller use 3.3v supply. Initially 16x2 LCD displays the welcome message at toll plaza and during transaction it shows the transaction status.

G. *GSM Module*

The GSM module [1] sends status as SMS to the customer's registered cell phone regarding deduction of balance, remaining or no balance. During theft vehicle send SMS to registered police also. It is directly interfaced to the microcontroller with 12v external power supply.

IV. SOFTWARE USED

- Keil uVision4.
- Visual Studio 12.
- Flash magic.

The Keil software is a compiler and debugger use to compile C code, assemble assembly source files, link and locate object modules and libraries, create HEX files, and debug your target program. Keil is Project management, source code editing, and program debugging in one single, powerful environment. Visual basic is used to create graphical user interface which display the vehicle and owner information and date and time of passing vehicle. Flash magic is to download the hex file in the LPC2148 controller.

V. PROGRAMMING FLOW CHART

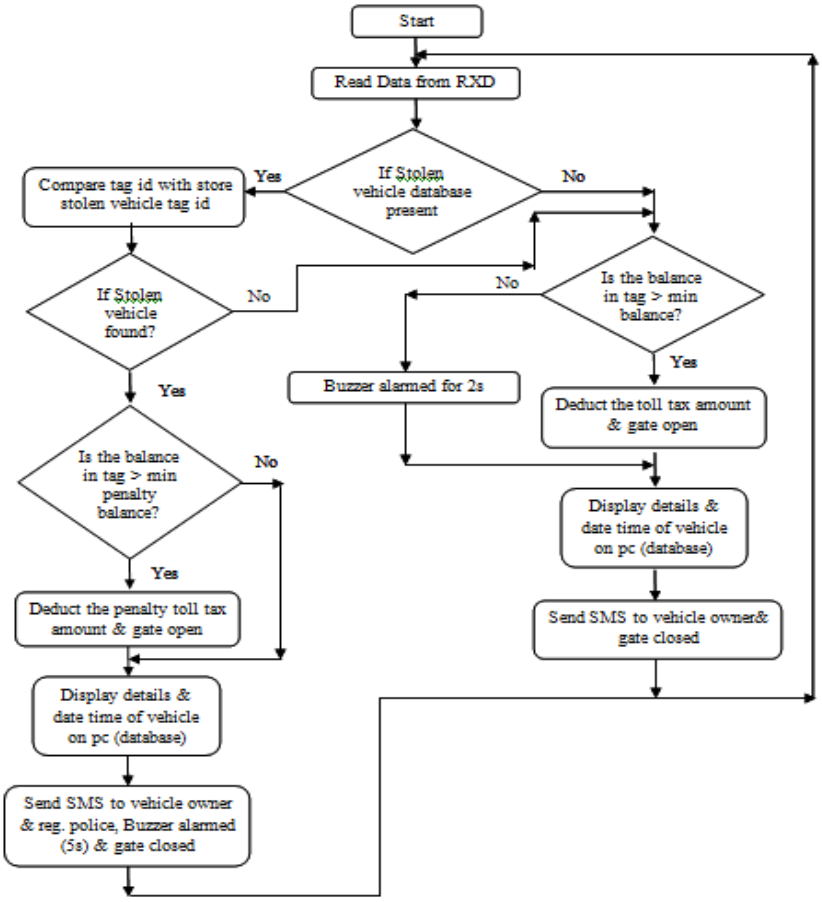

Fig 5: Flow chart of Electronic Toll Collection

ISSN: 2278 – 909X

VI. RESULT OF THE SYSTEM

System at initiation shows 'welcome' message on LCD display, the experimental result as shown in Fig. 6. During transaction it shows transaction status "Thank you, 25 Rs tax is paid or Sorry, Insufficient Balance".

Fig 6: Message on display

When vehicle passed from toll plaza information is displayed on user interface at toll plaza. It shows tag ID, date, time, vehicle number, owner name, mobile number, transaction ID if transaction done, status of E-Toll, deducted balance and available balance. First information of vehicle with sufficient balance, second for insufficient balance and third for theft vehicle, shown in experimental result Fig. 7.

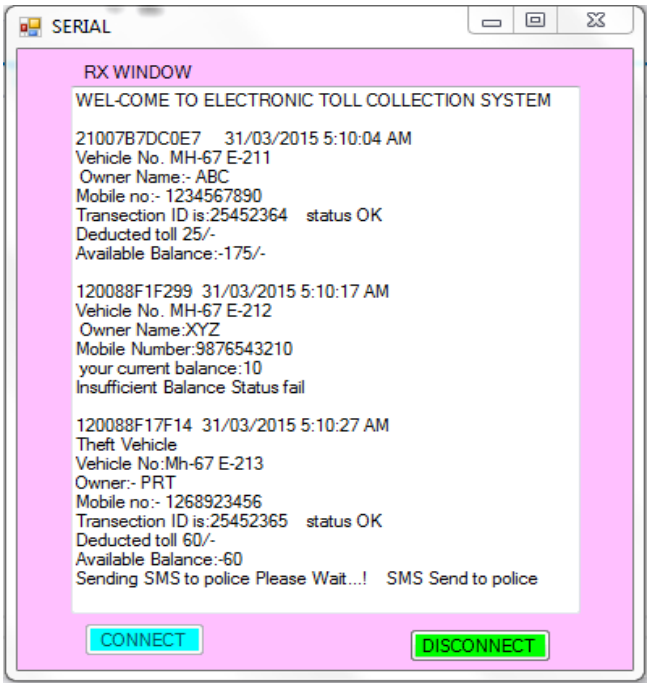

Fig 7: Details of vehicle on PC at toll plaza

The respective message will send to registered owner mobile number for information. Fig. 8 shows text message for vehicle with sufficient balance.

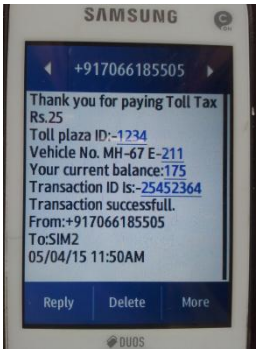

Fig 8: Message on mobile

VII. SCOPE & APPLICATIONS

The scope and application of system is as follows:

1) Restricted area like forest, defence.
2) Trace the vehicle if the system is centralized.
3) Parking system.

VIII. CONCLUSION

Electronic toll collection using RFID technology can reduce loss at toll plaza by reducing man power required for collection. It is nonstop collection, increase the efficiency and reduce the time at toll plaza. RFID is a highly stable and reliable technology. The RFID automatically detect the identities of the vehicles and deduct the toll amount as prerecorded in database. The system could automatically inform the owners of the vehicles. RFID technology can provide new capabilities as well as an efficient method to collect, manage, disseminate, store, and analyze information. It also eliminates manual data entry, system improves the better management.

REFERENCE

[1] Amol A. Chapate, D.D. Nawgaje, " Electronic Toll Collection System Based on ARM", (IJSETR), Volume 4, Issue 1, January 2015,46-49.

[2] Yin Mon Aye, Zaw Myo Tun, Hla Myo, "Design and Construction of Toll Gate Control System Based On Microcontroller", IJECS, ISSN: 2277-1956/V3-N3-262-268.

[3] "Electronic Toll Collection", Report by Apex Committee for ETC Implementation, Government of India, September 2011.

[4] Priyanka Chhoriya, Govinda Paliwal, P. Badhan "Image Processing Based Automatic Toll Booth in Indian Condition", IJETAE, Vol 3, Issue 4, 2013.

[5] Electronic Toll Collection, America's Transportation Network. www.nhai.org/doc/17feb12/etc_apexcomm_report_final_7oct.pdf

[6] Electronic Toll Collection System. http://ntl.bts.gov/lib/jpodocs/edldocs1/13480/ch5.pdf

[7] Intelligent Transportation System. http://www.metroinfrasys.com

[8] Electronic Toll and Traffic Management Indian Highways. http://irc.org.in/ENU/knowledge/Editorial/July%202011.pdf

ISSN: 2278 – 909X