RESEARCHERID
THOMSON REUTERS

[ICRTCET-2018]

ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

AN INTELLIGENT TOLL-GATE SYSTEM FOR TOLL COLLECTION BASED ON DISTANCE AND POLLUTION CONTROL USING INTERNET OF THINGS

Shridevi. Soma[*1] & Pavitra[2]

[*1&2]Dept., CSE, PDACE, Kalaburgi, Karnataka, India

ABSTRACT

Nowadays, toll plazas at the highways are operated manually, where a vehicle comes near the toll booth and operator collects the cash and enter the vehicle data and provides a receipt. Since this may lead to longer waiting time of vehicles at the toll booth and heavy traffic at the highways where unnecessary pollution will be generated near toll highways. To overcome these two problems of avoiding congestion at the toll highways and reduce toxic oxides dissipated by vehicles an intelligent traffic system is developed. This paper includes a low cost and efficient technique of automatic toll collection using RFID and pollution monitoring through WSN. A vehicle owner maintains a prepaid account and that account is registered with the vehicle data for authentication. The cost at the toll gate is calculated by considering the distance travelled by the vehicle which is measured using GPS. This is the novelty of the proposed system compared to the existing toll collection system. If the balance is low the user account can be recharged in the toll booth itself. A smoke sensor fitted to the vehicle senses the smoke emitted from the vehicle and then through RF transmitter fixed to the vehicle transfer this signal to the RF receiver fixed at the toll booth. At the receiver end the threshold value to measure the smoke emitted is measured, if the threshold value is crossed then an alert is sent to the vehicle owner through GSM. The owner is also penalized if he/she tries to violate the emission rules by sending an appropriate message.

Keywords: *Radio frequency identification (RFID), Toll booth, GPS, Congestion, Emission test.*

I. INTRODUCTION

As per the survey carried out the e-toll collection was implemented using RF communicator [1]. It was implemented using MSP430 Launch pad, various other research was carried out in order to avoid traffic at toll highways where RFID is used for unique identification of vehicles and its transactions is recorded a detailed monthly bills will be sent to the customer at the end of the month [8]. Earlier a research has been carried out for pollution monitoring using M2M wireless sensor network using Zigbee protocol [2]. In order to have an efficient toll fare regarding to distance travelled a proposed system is been developed. The intelligent traffic system with automatic toll collection is a new approach used when a vehicle enters the toll plaza, the RFID [3] tag fixed to the vehicle is used to read each vehicle with the help of RFID reader. The reader receives this signal and send it to the microcontroller (SST). We assume that each vehicle has a unique identification number. When the RFID tags swipes with the reader the vehicle data is collected and validates with certain conditions to be true such as valid user, have balance in prepaid account and if the user is valid and have balance in the account the gate opens. The gate is fitted with the stepper motor when the RFID reader reads it send the signal to microcontroller it validates the vehicle details and insist the stepper motor to move in a anticlockwise direction and the gate opens and after few seconds when vehicle pass the stepper motor rotates in clockwise direction and the toll barriers closes. If there is a low balance in the prepaid account the gates remains closed and the owner can manually pay amount and collect the receipt. The vehicle owner is given a toll application when the toll system checks for the valid vehicle and the toll gate opens, the owner should press the start button then the GPS system saves the current location and keeps on tracking the vehicle with updating the latitude and longitude values and at the end of the journey the owner clicks the end button and same way the current location is been saved it compared with the previous values as the distance is measured and the fare is calculated and deducted from the predefined account earlier a research is been carried out to collect a fare depending on the load of vehicle[6]. Due to large number of vehicles [5] emitting toxic oxides earlier a research is been carried out using WSN [4] where vehicle emitting smoke is monitored and sent a data to smartphone. Large amount of carbon di oxide in atmosphere leads to air pollution [7] where it is dangerous for living organisms. In order avoid pollution and owner should not ignore the emission rule we have a proposed system where the vehicle is registered with a complaint for violating the emission rules. When the vehicle enter the

toll plaza the smoke sensor fixed in the vehicle sense the smoke emitted and the RF transmitter fitted to the vehicle send the vehicle data along with the smoke value and the RF receiver at the toll plaza receives the data and send the signal to microcontroller, the controller compares with the threshold value it alerts the owner regarding to carry out the emission test if ignored by the owner a complaint is sent to the police for violating the emission rules.

or person. RFID are categorized according to their frequency ranges as Low-Frequency RFID (30 KHz to 500 KHz), high-Frequency RFID (900KHz to 1500 KHz), UHF RFID (2.4GHz to 2.5GHz), where this frequency tell the RF range of the tag. RFID tag is comprised of a microchip and antenna that transmit the data wirelessly to a reader (Fig. 2).

II. HARDWARE COMPONENTS DESCRIPTION A. Programming board

The programming board is designed to program the SST89E516RD2 Microcontroller. It is a 8-bit 8051 compatible microcontroller with embedded superflash memory. SST operates at 0 to 40 MHz at 5V Maintaining the Integrity of the Specifications

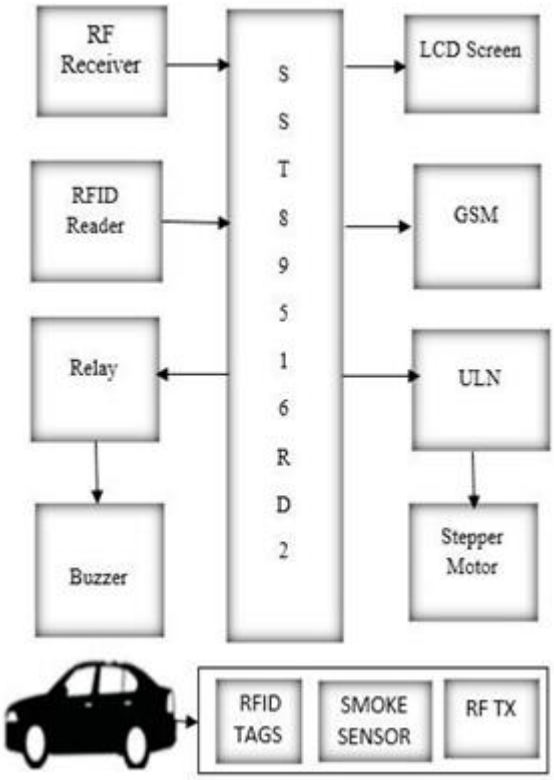

Fig.1. Block diagram of automated toll system B. RFID

RFID is a form of wireless communication it uses electromagnetic field to uniquely identify the objects, animal or person. RFID are categorized according to their frequency ranges as Low-Frequency RFID (30 KHz to 500 KHz), high-Frequency RFID (900KHz to 1500 KHz), UHF RFID (2.4GHz to 2.5GHz), where this frequency tell the RF range of the tag. RFID tag is comprised of a microchip and antenna that transmit the data wirelessly to a reader (Fig. 2).

ISSN 2348 – 8034
Impact Factor- 5.070

Fig.2. RFID reader

C. Stepper motor

A stepper motor (Fig.3) is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are carried out to it in the proper sequence.

Fig.3. Stepper Motor

D. Smoke Sensor

A smoke sensor is a device that senses smoke, an analog smoke/LPD/ CO sensor (MQ2) module utilizes an MQ-2 as the sensitive component. It requires 5V power to operate the detection zone of MQ2 sensor ranges from 300-10000ppmm

Fig.4. Smoke Sensor

When the vehicle emits the smoke the smoke senor (Fig.4) sense and pass the signal to the RF transmitter fitted to the vehicle and when the vehicle enters the toll gate the RF receiver fixed at the toll receives the signal form the RF transmitter and send the data to the microcontroller and their the code is written to check for the threshold value if the obtained smoke value crosses the threshold value the alert is sent to the owner of vehicle through GSM.

III. SOFTWARE IMPLEMENTATION

A. Keil Software

KEIL software is for coding embedded c and assembly language, U-Vision 2 is the new IDE for keil. Software combines task control, supply code editing and the software debugging is powerful. Keil require Flashmagic to dump the code into microcontroller an UART port is required as a USB device to connect to computer and microcontroller.

B. Android studio

Android studio is a software for developing the mobile application we implemented the Toll Application using this software where the coding is done using java and the UI coding is done using html. The application helps in having

ISSN 2348 – 8034
Impact Factor- 5.070

a smart usage of the toll gate where the distance is measured through GPS of the device and the calculated amount is deducted automatically from the predefined account.

IV. DESIGN DESCRIPTION

A. Operation of toll gate

The toll gate is fitted to the stepper motor where spindle of the stepper motor rotates in discrete step, it operates with the 5V power supply when the user swipes the card the reader sends the signal to the controller and the controller checks for valid user. If the card is valid then the controller sends a signal to the stepper motor to rotate in anticlockwise direction so the gate opens, some delay function is added so that the gate remains open until the vehicle moves after some time delay the controller pass the signal to rotate stepper motor in clockwise direction to close the gate.

B. Toll Application

The toll application is using android studio where this application is provided to all the vehicle owner during vehicle registration where the vehicle and predefined account details is been integrated with this application. The vehicle owner can use this application to travel across the toll highways. When the vehicle is validated at the toll and the gate opens at the toll the owner need to press start button in his journey and the GPS location saves the current distance and at the end of the journey the owner should press the end button and the location is saved and the distance is been evaluated so as to implement it as prototype the distance measurement is taken in terms of meters, for 1meter 2.Rs is been implemented so if the vehicle has travelled 10m then 20.Rs is been deducted from the predefined account.

C. Emissson Detection

To test the smoke emitted from vehicles we are using MQ2 sensor where it sense the smoke value and when the smoke is detected it glow the output LED and send the data to the microcontroller and their in code it checks for the condition whether smoke detected is true it display on the LCD screen at the toll and the controller fetch the vehicle data from the RF receiver as it gets data from the RF transmitter, controller sends the signal to the GSM and the GSM send the alert message to the server the server send the warning to the registered number of the customer. The server checks for two alerts if the third time the alert of the same vehicle is obtained it send the complaint to the police station for violating the emission rules. If required the police can track the vehicle using GPS.

The data flow diagram gives the clear representation of the flow of the system.

ISSN 2348 – 8034
Impact Factor- 5.070

Fig. 5. Dataflow diagram of toll system.

The data flow diagram of the flow of toll system as shown in fig.5 defines the toll gate operation. The RFID reader checks for the valid, invalid or low balance if invalid and low balance the buzzer at the toll is operated, the vehicle owner can manually pay amount the operator press the switch and the gate opens if the user is valid then the gate opens and remain for some time and then close the gate.

Fig.6. shows the data flow diagram of Distance Calculation When the vehicle is validated the driver should use the tollgate application to start the journey he can give his id and password and then press the start button the GPS fetches the current location and save it and at the end of the journey the driver press the end button and the end location is saved and distance is calculated then the fare amount according to the distance is deducted from the predefined account.

ISSN 2348 – 8034
Impact Factor- 5.070

Fig. 6. Dataflow diargram of distance calculation

V. EXPERIMENTAL RESULT AND DISCUSSION

A proposed system is developed as a prototype using toy car where the RFID tag is fixed to the toy car. The hardware setup is made as shown in fig. 7. The microcontroller contains the IC where the code for operating these hardware is dumped. The code is implemented in keil software, it is compiled and dumped into the IC using flashmagic tool. The RFID reader, LCD, stepper motor and buzzer are connected to the microcontroller. The toy car contains a RFID tag a smoke sensor and a RF transmitter. Once the setup is done the coding in the keil software is complied and run by making the microcontroller to operate in a 5V power supply.

An application is built for the purpose of distance calculation where the owner will have this application at the time of registration.

ISSN 2348 – 8034
Impact Factor- 5.070

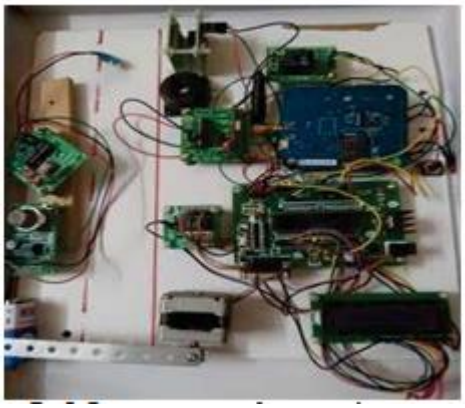

Fig.7. Prototype setup of automated system

The tollgate application is developed using android studio this application is given to the owner of the vehicle for having smart toll system it consist of the user name and password as shown in fig. 8 for the security purpose, authenticated user can access using their login credentials

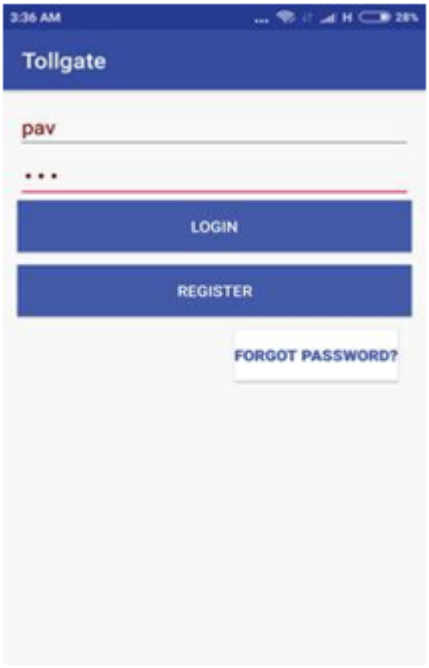

Fig.8. Tollgate Application

ISSN 2348 – 8034
Impact Factor- 5.070

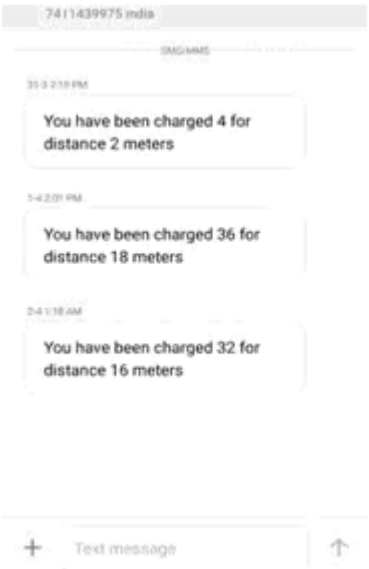

Fig.9. Sample SMS for distance travelled and fare charged

When the owner make use of this application the distance travelled and the amount deducted from the account is sent to the owner through the GSM (Fig. 9)

Fig.10 shows the alert message sent to the vehicle owner for violating the emission rule. Initially two alert message is sent to make the emission test soon the third message is sent by the police to notify that the owner is been penalized for violating emission rules.

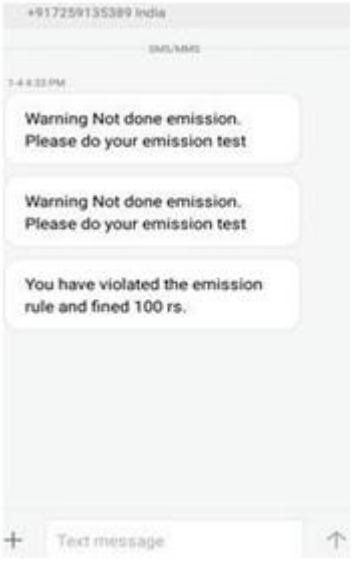

Fig.10. Sample emission test alert SMS.

The table I. describes the data collected to analyze the performance parameters where the parameters collected for making the performance analysis are time take by the vehicle to cross the toll booth with respect to traffic density.

ISSN 2348 – 8034
Impact Factor- 5.070

TABLE I. Data of waiting time and traffic density

Waiting time of vehicles	Traffic Density		
	Low	Medium	High
Existing	20	33	45
Proposed	5	9	13

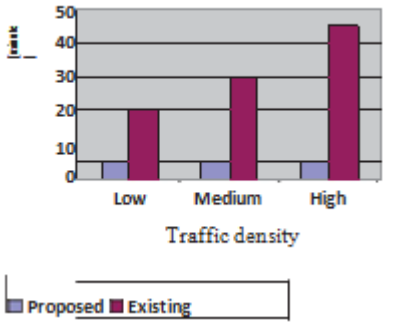

Fig.11. Chart of existing and proposed system

Fig.11. shows the comparative analysis of Time and Traffic Density for existing and proposed system, time indicates the waiting time (min) of vehicles at the queue near the toll gate the density of the traffic implies the number of vehicles at the toll gate, it is been categorized in three categories as Low, Medium and High it can be noticed that for the existing system as the density of the traffic increases the time taken to pass the toll is also large, whereas for the proposed system the time taken to process the vehicle is very low when compared to existing system, so the proposed work is very efficient with respect to time.

VI. CONCLUSION AND FUTURE WORK

In this paper, the automated toll system and pollution monitoring system is implemented using SST microcontroller. In this approach the owner is able to pay for the highway utilized by him. As this automated system used distance based toll collection had helped in saving time, money avoiding congestion and reduce pollution in the environment. Further it can also be implemented to calculate the amount based on the volume, load of the different vehicles. It can be implemented for various factors of vehicle.

VII. ACKNOWLDGEMENT

I would like to thank my Head of Department, PG Coordinator and management, PDACE for providing me all facilities and support and special thanks to my guide for their encouragement and support.

REFERENCES

1. *Sana Said Al-Ghawi, Muna Abdullah Al Rahbi, Dr.S.AsifHussain, Dr.S.Asif Hussain – "AUTOMATIC TOLL E-TICKETING SYSTEM FOR TRANSPORTATION SYSTEMS " International Conference on Big Data and Smart City – 2016.*
2. *Putut Andre LuqmanBesari, MamanAbdurohman, AndrianRakhmatsyah - APPLICATION OF M2M TO DETECT THE AIR POLLUTION in.3rd International Conference on Information and Communication Technology (ICoICT)- IEEE 2015*

ISSN 2348 – 8034
Impact Factor- 5.070

3. *PinakiGhosh, Dr. Mahesh T R- A Privacy Preserving Mutual Authentication Protocol for RFID based Automated Toll Collection System in proc IEEE – 2016.*
4. *Suganya E, Vijayashaarathi S- Smart Vehicle Monitoring System for Air Pollution Detection using Wsn in proc IEEE conf. 2016 International Conference on Communication and Signal Processing, April 6-8, 2016, India*
5. *V.S.Harilakshmi, P.ArockiaJansi Rani- Intelligent Vehicle Counter– A Road to Sustainable Development and Pollution Prevention (P2) in proc. IEEE 2016.*
6. *AkshayBhavke,SadhanaPai- Advance Automatic Toll Collection & Vehicle Detection During Collision using RFID in proc IEEE conf. 2017 International Conference on Nascent Technologies in the Engineering Field -2017.*
7. *Zhi-gang, Han dan Cai-hui, Cui., 2009. The Application of Zigbee Based Wireless Sensor Network and GIS in the Air Pollution Monitoring, in: International Conference on Enviromental Science and Information Application Technology – 2009.*
8. *R. Kalantri, A. Parekar, A. Mohite, R. Kankapurkar, "RFID based toll collection system," International Journal of Computer Science and Information Technologies, 2014.*
9. *R.B. Takbhate,S.D. Chavan-"Automated Toll Booth System," International Journal of Research Studies in Computer Science and Engineering, July2014.*