IJPRSE
Progressive Research

International Journal of Progressive Research in Science and Engineering
Volume-1, Issue-2, May-2020
www.ijprse.com

IoT Based Toll Booth Management System

Sudha M S[1], Yashodhre K[2], Snehil Sarkar[2], Spoorthy G[2], Shubham Khosla[2]

[1]Assistant Professor, Department of Electronics & Communication Engineering, Sapthagiri College of Engineering, Bangalore, India.

[2]Student, Department of Electronics & Communication Engineering, Sapthagiri College of Engineering, Bangalore, India.

Abstract: -This paper is mainly focused on a RFID based toll booth management system that is monitored using IOT. The database maintains all the data of user accounts and also their balance. Each vehicle owners possess a unique RFID (Radio Frequency Identification) based card mounted on their vehicles which stores their RFID number. The toll booth management system will monitor the cards scanned when a vehicle arrives at the toll booth. The system then connects to the database to check if the card is valid and if valid what is the balance. If the user balance is sufficient, the toll amount is deducted and card scanner system sends signal to the motor that the user has been billed and the billing details are sent to user via SMS. On receiving this signal, the system operates a motor to open the toll gate for that vehicle. The system is controlled by a microcontroller to achieve this purpose. The Wi-Fi module uses a Wi-Fi connection to connect the toll system to IoT cloud platform through which interacts to perform the online verification process, for the stolen vehicles and sends the information to the nearby police station and vehicle owner together. The system allows storing data to all the vehicles passed at particular time intervals for further reference and surveillance, and it also serves for the revenue generation process. This system thus automates the entire toll collection and monitoring process by using RFID plus IoT based system.

Key Words— RFID, IoT Cloud Platform, Congestion, Stolen vehicles, NodeMCU.

I. INTRODUCTION

In the present days by the ever increasing number of vehicles day by day on road has led to the immense traffic and also made the duration of the journey slow. This slow moving traffic not only is the burden in the cities but also on the highway where people stand in queue just in order to pay toll fee to enter the highway. This automated toll booth management system is more effective and well organized as people are not stuck in the long queue thereby eliminating the waiting time. RFID based toll system has the capability of eradicating corruptions in highway tax management authorities and also minimizing the operating cost. Implementation of this system can be efficient way to keep a check on fuel wastage.

Electronic toll collection is used for transforming manual transaction work to the automatic toll collection using RFID technology. RFID cards provided to the users are scanned through RFID reader fixed at tollbooths in specific positions and online transactions are carried out regarding the specific RFID card number of user. Due to the online transaction this system provides transparency to the whole system. The tender dealer hiring the toll tax collection projects were often involved in corruption of hiding revenues collection of tolls. But, the easy availability of real time toll revenue collection data figures over IoT cloud platform has proven beneficial to the government to collect road tax properly.

For the data storage and tracking of blocked cards ADAFRUIT.IO IoT cloud platform is used which stores the information of the vehicle NO, Timings, Date, Gate no at which the user has scanned the card for later reference and surveillance and also the information about toll revenue generated monthly. The IoT is primarily a network of things before which physical things can interchange data with the help of sensors, electronics, software and connectivity. ADAFRUIT.IO is an open-source software, Internet of Things application and API to reserve and recover data from things using the MQTT protocol over the Internet or via a Local Area Network. Most of criminal activities are carried out on stolen vehicles.

The business of trespassing stolen vehicles across states, district and borders is prevailing since several years. Taking this into consideration, the combination of RFID system and IoT platform could be effective to detect these vehicles and prevent these trespassing activities.

International Journal of Progressive Research in Science and Engineering
Volume-1, Issue-2, May-2020
www.ijprse.com

II. LITERATURE SURVEY

Literature survey has been carried out on various present toll collecting systems. Comparison between different toll systems helps in selecting an optimal toll system.

In paper [8] the toll collecting system is a Manual system. Depending on the vehicle whether heavy weight or light weight toll, one-way journey or roundtrip journey toll is charged to the user. The use has to pay toll manually for which he is provide a billed slip. This system requires large manual work force and is time consuming, etc. This system lacks transparency and is employed in most of the toll plazas.

In paper [2] the process of toll collection system is achieved through barcode. Though implementation of these barcode is cheaper but it has less storage capacity for storing information.

In paper [20] the toll system is dependent on image processing. In this system number plate of the vehicle is captured with the help of camera and the amount is deducted by matching the number plate along with the database. But, this is expensive and also requires combination of complex dip algorithm.

Several other surveys were carried out which included analysis of Leach System, GPS and GPRS combined system, Infrared System for collecting toll, IoT based cloud platforms, and theft detection systems.

III. PROPOSED MODEL

The below block diagram provides a brief overview on the construction and working principle of the proposed IoT Based Toll Booth Management system which is to be designed.

Here, RFID reader is the input device along with RTC and matrix membrane keypad which serves for making the system real time and recharging respectively. The Arduino receives the signal from the input device and applies various conditions and based on that the results are obtained accordingly. The LCD Display, Servo Motor, GSM module and buzzer are used as output devices that is used to display the messages, to open the toll gate, and to send the message to user regarding transaction. The Wi-Fi module serves for both uploading the data as well as fetching the data from IoT cloud platform as in the case of stolen vehicle tracking.

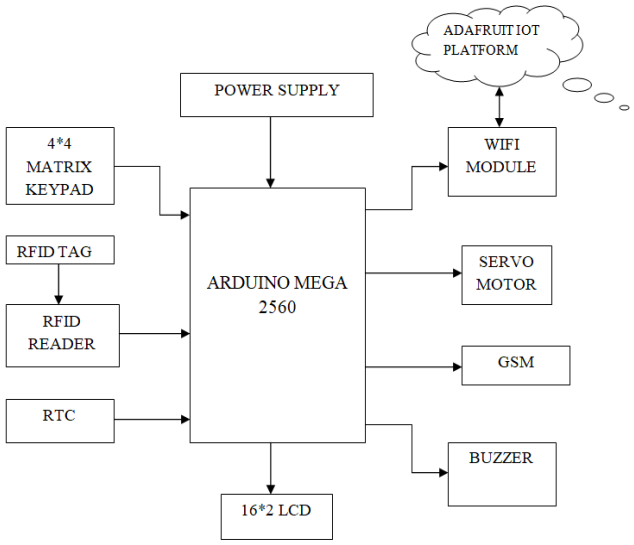

Fig.1. Proposed model of Toll collection.

A. Working Principle

As the vehicle arrives at the toll booth immediately user RFID card gets scanned. The unique ID of the RFID card fetches Vehicle No from database and the program will be checking whether the card is valid or invalid. If the card ID is found in database, it's valid. On the condition that it is valid card and the vehicle is not being stolen, then the program checks for the available balance in the account. If the balance is equal to or greater than the toll allowance, the amount is deducted from the user account.

The deducted amount and vehicle number is displayed on the LCD and then the message is sent to the registered user of the RFID card about the transaction. Then the toll gate is opened by rotating the servo motor anticlockwise thereby allowing the vehicle to cross the toll. If the user account does not have the enough balance, then the insufficient balance is displayed on LCD and recharge is done to deduct toll fees.

For the stolen vehicles the tracking switch is kept ON in Adafruit IoT cloud platform and during the processing of card the vehicle gets trapped followed with the alarming of buzzer in toll booth and a message is being sent to the respective authority.

The code extracts the unique ID of the RFID card using which vehicle No is fetched, the timings at which the vehicle has passed the toll and the vehicle no. All this information is then updated to the Adafruit cloud which can be accessible by the

administrator of the toll company for any security or further information analysis purpose.

The information that is updated in the cloud can be accessed by using the unique the user name and password. This provides the security to all the data that is updated on the cloud. The information stored can be accessed both globally as well as local access.

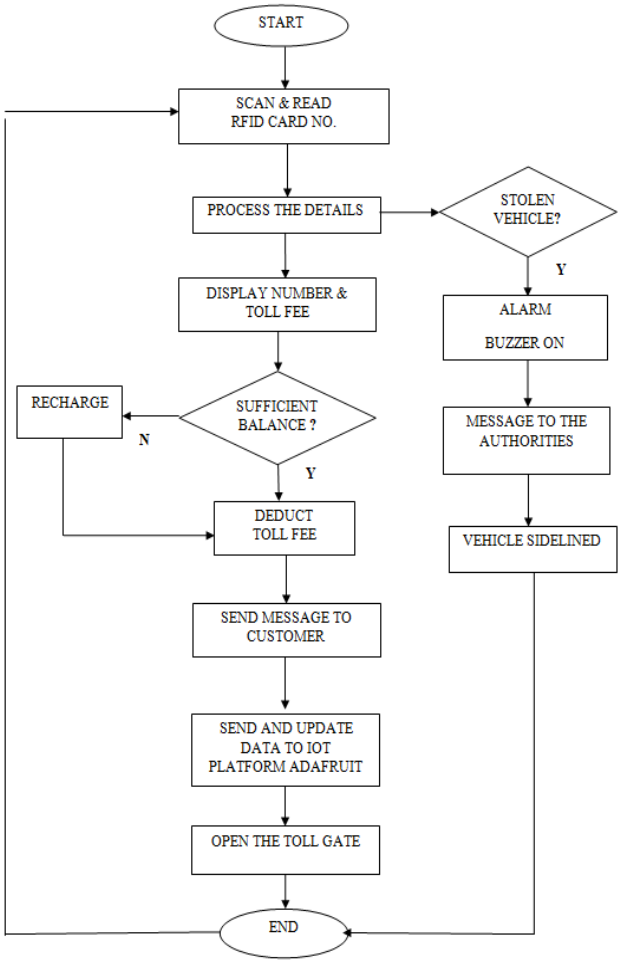

Fig.2. Flowchart of the work flow of toll system

IV. Objectives and Methodologies

The objectives and methodologies of the paper is outlined as below:

A. To propose an automatic toll collection using RFID technology.

Methodology:

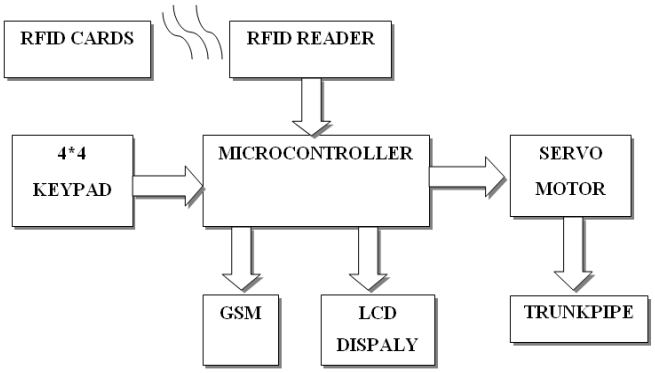

Fig.3. Block diagram for Automatic Toll Collection using RFID Technology

1. A fixed toll charges are deducted from the user account if balance is sufficient or else recharge is done to deduct the balance.

2. After the billing is over, microcontroller will direct the motor to unroll the trunk gate to allow passage of vehicle and send the customer transaction details via GSM thereby automating the entire system.

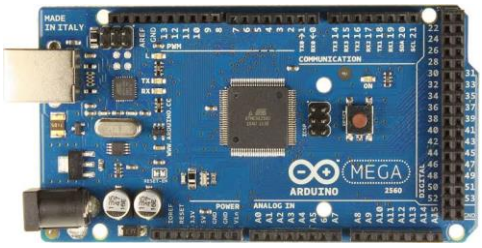

Fig.4. ATmega 2560

The Arduino Mega 2560 serves as the best for this application as the proposed system requires several UART communication pins.

The GSM and RFID reader is made to communicate with the arduino using UART. The RFID module reader is connected to UART 0 of arduino, the GSM is interfaced to the UART 1 of the arduino and Node MCU is connected to UART 2 of the arduino. All 54 digital pins on the Arduino 2560 Mega board can be used as an input or output, by making use of pin Mode (), digital Write (), and digital Read () functions.

International Journal of Progressive Research in Science and Engineering
Volume-1, Issue-2, May-2020
www.ijprse.com

B. To upload and maintain data in the cloud for further surveillance.

Methodology:

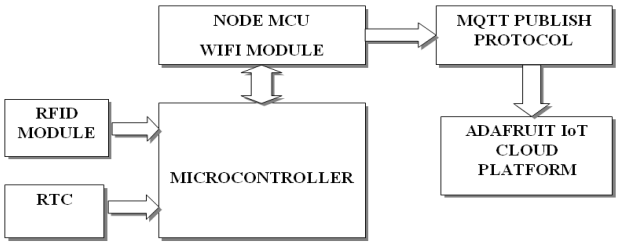

Fig.5. Block Diagram for uploading data to IoT cloud platform

1. The NodeMCU will use Wi-Fi connection to connect with the internet through which system having many electronic devices interacts with the IoT Cloud platform.

2. ADAFRUIT.IO.IO is a cloud service - an IoT platform used by us to display Real time data and connect internet enabled devices.

3. MQTT (message queue telemetry transport) is a protocol for device communication that ADAFRUIT.IO IO supports.

4. Using a MQTT library we issue and subscribe to a feed to transmit and receive feed data.

5. The system permits us to store data of all the vehicles passed at particular time intervals for further reference and surveillance.

Fig.6. ESP8266 NodeMCU

NodeMCU is equipped with ESP8266 which is mostly integrated chip, designed for the needs of new connected world. It provides a complete and self-contained Wi-Fi networking solution, permitting it to either host the application or to offload all Wi-Fi networking functions from different application processor. It plays a vital role for connecting the toll collection system to IoT based toll booth management system.

C. To track and report authority about stolen vehicles

Methodology:

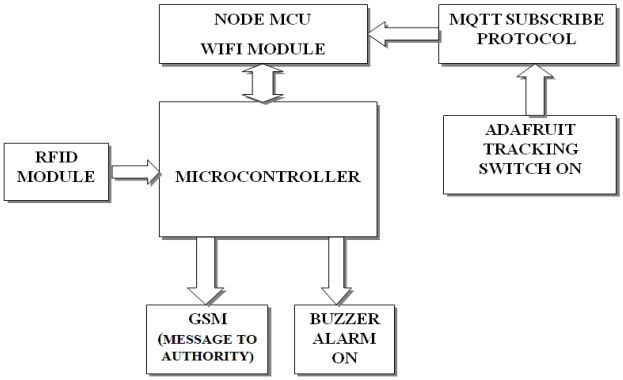

Fig.7. Block Diagram for reporting of stolen vehicles

1. In case, of a report about vehicle being stolen the vehicle No is put into the tracking mode of ADAFRUIT.IO IoT cloud Platform by using triggering switch.
2. Using a MQTT subscribe we can to receive data as per our needs.
3. As the vehicle no matches the microcontroller directs the buzzer alarm to sound and send the police station as well as owner message about the vehicle found status via GSM.
4. Every toll Plaza has a particular longitudinal and latitudinal position which is pre fed into the system designed by us.
5. The message send to the authorities also comprises the information about the location of that particular Toll Plaza in the form of link that can be opened in Google Map.
6. Thus, the stolen vehicle is sidelined by Toll security on being caught.

International Journal of Progressive Research in Science and Engineering
Volume-1, Issue-2, May-2020
www.ijprse.com

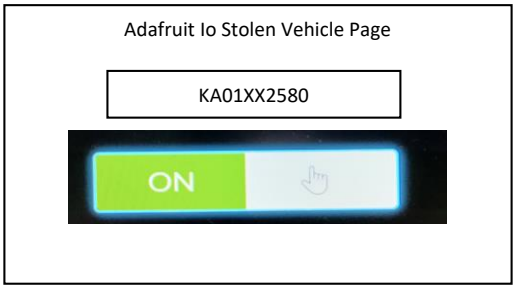

Fig.8. Tracking IoT platform

The vehicle NO is entered and the switch is switched ON for stolen vehicles in the Adafruit IO.

D. To achieve major growth in revenue generation.

Methodology:

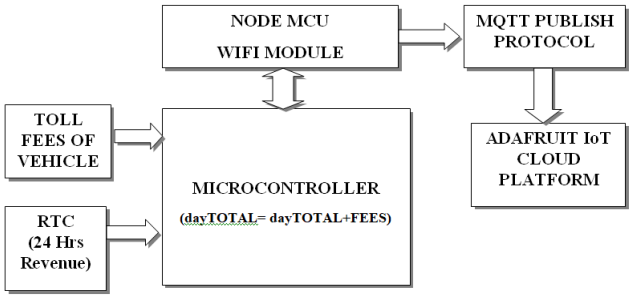

Fig.9. Block Diagram for reporting revenue generation

1. The IoT Based Toll management system designed by us is a Real time system which is 24 Hr. working.

2. Using the Real Time Clock (RTC) and microcontroller transactions of every 24Hr. is summoned and saved in the system.

3. By setting up a threshold time total revenue generation of a period is calculated.

4. At 00:00 Hr beginning of everyday using MQTT publish the data of previous day is pushed to ADAFRUIT.IO IoT cloud platform by the microcontroller.

5. Therefore, at the end of the day total revenue generated can be easily calculated with less human error and eradicating corruption in the system.

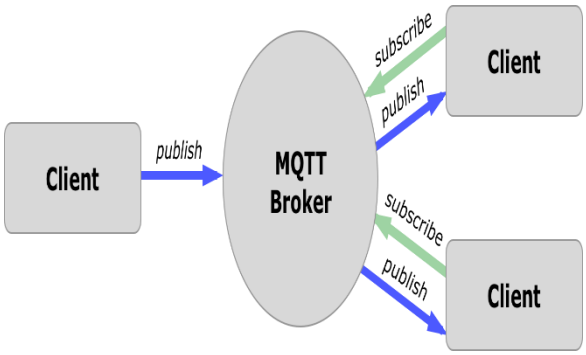

Fig.10. MQTT Systems Communication Protocol

The MQTT system is made up of clients which communicates with the server often known as a "broker". The client is either involved in publishing the data or subscribing the data. Many clients can join to the server. In case, if a publisher wants to distribute a new data, MQTT sends a connection request to server along with the data. The server is then responsible for sharing the data to clients that have subscribed for it.

V. RESULTS

The purpose of the proposed project is to facilitate automatic toll collection systems with the help of RFID technology and make it a centralized audit system for toll collection. The results of the projects are updating the data to cloud platform as shown in below figures and sending toll transaction details to users in the form of mobile message. The stolen vehicle gets trapped by alarming the buzzer as it enters the toll plaza by keeping the tracking switch ON in Adafruit IoT cloud platform as stated in objective 3 and the status is send to customer in the form of mobile message consisting the location link of vehicles whereabouts.

Fig.11. Real Time Uploaded Data

International Journal of Progressive Research in Science and Engineering
Volume-1, Issue-2, May-2020
www.ijprse.com

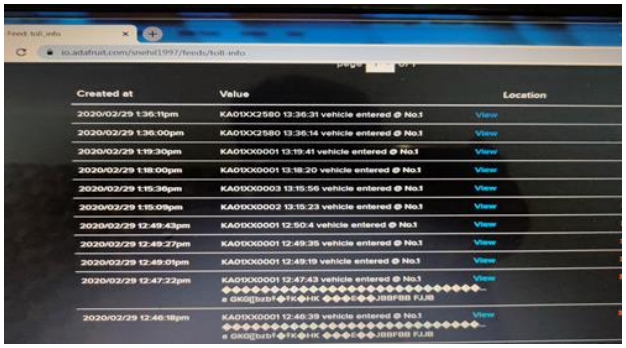

Fig.12. Surveillance Data available

VI. ADVANTAGES

1. Improves urban environment.
2. No need to wait in the long queue.
3. Reduces normal work load using RFID technology.
4. Environmental friendly as it saves fuels and billing papers.
5. Since the proposed system records the data, it can be used for surveillance purpose if needed.
6. Theft detection prevents passage of stolen vehicles.
7. Centralized audit system which favours revenue generation.

VII. CONCLUSION

The "IOT Based Toll Booth Management System" is a prototype of the toll system using RFID which supports the vehicle to pass across the toll with ease and hassle free. The system aims in making the toll booths free of long queue and also eliminates the clumsy manual work. The proposed solution also sends the user transaction details; this makes the transaction open which is free from all corruptions. The information such as the vehicle No, toll gate no and the timings at which the vehicle pass are recorded in the cloud which helps in analysis for the future unforeseen reason. The easy availability of real time total toll revenue collection data figures over IoT cloud platform will also help the government to collect road tax properly. The combination of RFID system and Adafruit IoT platform appeared effective to detect stolen vehicles, informing the respective authority about their whereabouts and prevent their trespassing across states, districts, borders. Thus the existing toll management system can be completely implemented with this technology so that the transaction will be digital without any burden to carry the cash and also the journey becomes ease at the toll. Since most of the fuel is wasted by keeping the engine idle in the toll gates, so indirectly it also helps in saving the fuel which is the most precious nonrenewable resource available.

VIII. ACKNOWLEDGEMENT

Our project team would like to convey the gratitude towards our guide, Assistant Professor SUDHA M.S for helping us in doing the research work regarding the project, guiding us in technical portions and every other aspects of the project.

REFERENCES

[1]. Sridevi, Vasantha Pai, Rakesh Y," IoT Based Unmanned Toll Booth Monitoring System" International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, (IJIREEICE), Volume 5, ISSUE 5, 2017.

[2]. R.Brindha, A.Jayanthi, A.Kalaivani, "IoT based Electronic Toll Collection System for Vehicles using Barcode System", International Journal of Electronics, Electrical and Computational System (IJEECS), Volume 7, Issue 3 March 2018.

[3]. Ganesh K. Andurkar, Vidya R. Ramteke, ''Smart Highway Electronic Toll Collection System", International Journal of Innovative Research in Computer and Communication Engineering, Volume 3, Issue 5, May 2016.

[4]. P. S. Hanwate, Ashlesh Mandke, Narin Meher," Smart Toll Collection System based on IoT", IJSTE - International Journal of Science Technology & Engineering, Volume 3, Issue 12, June 2017.

[5]. Rana Pratap, Sanjeev,Niraj Kumar Tiwary, "IoT Based Smart toll Booth System over Vahan 4.0 Cloud Database", International Journal of Science & Engineering(IJSE),Volume 4,Issue 8,2018.

[6]. Geethanjali N, Chiranth R, Chaitra J M, "IOT Based Intelligent Toll Gate System using Raspberry PI", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 6, Issue 2,2018.

[7]. Satyasrikanth P, Mahaveer Penna, Dileep Reddy Bolla, ''AUTOMATIC TOLL COLLECTION SYSTEM USING RFID", International Journal of Computer Science and Mobile Computing, Volume 5, Issue 8, August- 2016.

[8]. Allen Francis Antony, Anju P, Gautham Raj P," Design of an Integrated Speed Tracking and Toll Management System for Express Highways", Proceedings of the IEEE 2017 International Conference on Computing Methodologies and Communication(ICCMC).

[9]. Amit Hatekar, Nikita Kokal, Tarun Jeswani, Pratik Lalwani," RFID Based Automatic Toll Collection System

using GSM", International Research Journal of Engineering and Technology (IRJET), Volume 03, Issue 04, Apr-2016.

[10]. Amol V Dhumane, Rajesh S. Prasad, Jayashree R. Prasad, ''Infrared Automated toll plazas", International Journal of Rough Sets and Data Analysis(IJRDT) Volume 4, Issue 3, July-Sept 2017.

[11]. Arvind. K, Balaji. U, Gokul. R, Nishanth. P, Arivalahan. R, ''Theft Detection using Internet of Things in Automated Toll Plaza", International Journal of Advance Research and Development (IJARD), Volume 3, Issue 3,2017.

[12]. Mr.Abhijeet Suryatali, Mr.V.B.Dharmadhikari, ''Computer Vision Based Vehicle Detection for Toll Collection System Using Embedded Linux", Proceedings of the IEEE 2016 International Conference on Circuit, Power and Computing Technologies.

[13]. Sudheer Kumar Nagothu, ''Automated Toll Collection System Using GPS and GPRS", International Conference on Communication and Signal Processing, April 6-8, 2016, Germany.

[14]. K. Balamurugan, R. Pavithra, ''Automatic Check-Post and Fast Track Toll System", International Journal of Science Technology & Engineering (IJSTE), Volume 3, Issue 12, 2017.

[15]. Dinesh V,Arokianathan P,Veluchamy M,Sivakumar S, "Automated Toll Booth and theft detection System" 2017 IEEE International Conference On Technological Innovation in ICT for Agriculture and Rural Development (TIAR 2017,Las Vegas,USA.

[16]. Rafiya Hossain, Moonmoon Ahmed, Md. Mozadded Alfasani, Hasan U. Zaman, ''An Advanced Security System Integrated with RFID Based Automated Toll Collection System", 2018 IEEE Intelligent Vehicles Symposium (IV) Changshu, Suzhou, China, June 26-30, 2018.

[17]. Etqad Khan, Dipesh Garg, Rajeev Tiwari and Shuchi Upadhyay, ''Automated Toll Tax Collection System using Cloud Database", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 3, Issue 2,2018.

[18]. Amol V Dhumane, Rajesh S. Prasad, Jayashree R. Prasad," An Optimal Routing Algorithm for Internet of Things Enabling Technologies", International Journal of Rough Sets and Data Analysis, Volume 4, Issue 3, July-September 2017.

[19]. Swati Sagar, Jayshri Jori, Aishwarya Kale, Kalyani Khodade." Vehicle Counting and Automated Toll Collection System using Image processing", International Journal of Computer Science and Network, Volume 5, Issue 2, April 2016.

[20]. Sanchay Dewan, Shreyansh Bajaj, Shantanu Prakash, ''Using Ant's Colony Algorithm for Improved Segmentation for Number Plate Recognition",IEEE Congress on Evolutionary Computation (CEC),2018,pp 751-756,1-6 June,2018.

[21]. U Farooq, M Hasan, M Amar, A Hanif and M Asad,"RFTD Based Security and Access Control System," in Proc.l ACSIT International Journal of Engineering and Technology, Volume 6, No. 4, August 2016.

[22]. N. Liberis, C. Roncoli, M. Papageorgiou, "Predicotor-Based Adaptive Cruise Control Design", IEEE Transactions on Intelligent Transportation Systems,Volume 4, pp 751-756,1-6 June ,2017.

[23]. N. Bui, J. Gubbi "The Internet of Energy: a Web-Enabled smart Grid System", IEEE Transaction on Network Management, pp.39-45, Volume 26, No. 4,2018.

[24]. S. Ren, K. He, R. Girshick, J. Sun, "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks", IEEE Transaction on Pattern Analysis and Machine Intelligence, pp 1137-1149, Volume 3, No. 2, 2017.

[25]. Hui Lan, Ming Zhang, and Wee Ser, ''Automatic Tax Plaza" ,IEEE Transactions on Signal Processing, pp 1189-1193,Volume 8, No. 3, 2016.

[26]. Górriz, J.M, Javier Ramírez, Cruces-Alvarez, S., Carlos G. Puntonet, Elmar W. Lang, and Deniz Erdogmus, "Multiple Toll Using Passive Technology",IEEE Transactions on Signal Processing,pp 1321-1325, Volume 16, No.9,2018.

[27]. Bram Cornelis, Simon Doclo, Tim Van dan Bogaert, Marc Moonen, FellowandJan Wouters, "RFID Based Toll Deduction System", IEEE Transactions on Signal Processing,pp 971-975, Volume 18,No.5,2016.

[28]. J. Huang, X. Li, Y. Sun and Q. Xu, "A highly-reliable combined positioning method for vehicle in urban complex environments," Proceedings of 2017 IEEE International Conference on Vehicular Electronics and Safety, Dongguan, pp. 153-158, 2017.

[29]. A. Jedda and H. T. Mouftah, "Decentralized RFID Coverage Algorithms with Applications for the Reader Collisions Avoidance Problem," in IEEE Transactions on Emerging Topics in Computing, pp. 502-515, Volume 4, No. 4, Oct.-Dec. 2016.

[30]. K. Ding; P. Jiang; P. Sun; C. Wang, "RFID-Enabled Physical Object Tracking in Process Flow Based on an Enhanced Graphical Deduction Modeling Method", IEEE Transactions on Systems, Man, and Cybernetics Systems, pp.1-13, Volume PP, No.99, 2017.

[31]. Ye.Z and Zhao.Y, "Low cost GSM/GPRS BASED Wireless security system", IEEE Transactions on Consumer Electronics, pp.546-567, Volume 56, No.4, 2015.

[32]. M. Zorzi, S. Halabi and D. McPherson "From Today's INTRAnet of Things to a Future Internet of Things: A Wireless- and Mobility-related View," IEEE Transaction on Wireless Communication, pp. 44–51 Volume 17, No. 6, Dec. 2016.