Automated Toll Collection coupled with Anti-theft and Vehicle Document Verification System using RFID and Arduino Uno

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Abstract— India has a wide network of roads and transportation playing a key role in the economic development of the nation. Traditional manual collection of tax at the toll plazas doesn't provide an efficient and effective method for management of traffic on the highways leading to heavy congestions resulting in wastage of time and resources. Therefore in the paper a system is proposed which automatic toll collection, anti- theft system along with document verification of the vehicle. A system uses radio frequency identification (RFID), Arduino Uno microcontroller, GSM SIM 800, EM 18 reader and a computer host. Passive RFIDs are widely popular for its applications in the field of transportation and they are extensively used in motor vehicles for automated toll collection. They are easy to install and work for a lifetime based on getting its power supply from a reader module. In toll plaza collection it checks for blacklisted vehicles in the centralized database and verifies the documents, to ensure whether they are up to date or expired in terms of validity. This is a step towards digital India, where all the transaction are executed in an instant ensuring smoother flow of traffic and reducing the time spent in the ques of major toll plazas across the country. The system contributes to the existing methodology by ensuring the safety of the vehicle with anti-theft feature and keeping a check on the crime rate by maintaining a stolen vehicle directory. With document verification it manages all the documents and maintains a soft copy in the database along with an archive of modified records. It ensures that all the vehicles commuting on the roads have valid papers and rules & regulation are not violated and catching hold of people driving without proper documents at the toll booth. The proposed system increases efficiency in collecting taxes, reducing traffic congestion at the toll booths and resulting in lower fuel consumption.

Keywords—RFID, Arduino Uno Microcontroller, GSM SIM800, EM 18 Reader

I. INTRODUCTION

India has the second largest road network of the world comprising national highways, state highways, district, rural and village roads. India is a fast growing country with second largest in terms of population. In this vibrant country the growth of population has influenced the growth of number of vehicles giving rise to terrible road congestions. Transport is an important sector of the economy and inadequate transportation can hold back economic development of the country. Roads and highways are means of transporting people and goods and current revenue collection procedure at toll plaza requires a driver to halt the vehicle, pay the specific amount of tax in cash and then proceed with the journey.

With the increase in the usage of major toll plazas, they serve as a choc-o-block during peak hours and with increase in the number of vehicles, the toll plaza sees lakhs of commute from the toll post. Vehicles need to wait in queues that stretch over a kilometre to pay the toll especially in the morning and evening. Commuters call the ordeal a nightmare that they need to face every day. Some commuter say that the long wait not only eat into their time, but also fuel and money, thus increasing the pollution level. Along with these drawbacks tollbooths with manual tax collection need more labour as a workforce for its operation and results in wastage of resources and time. ETC system is an effective method to abolish this problem and provide an alternative to current tax collection system.

Electronic Toll collection is an automated system that collects the tax in a digital format. Automation system uses passive RFID (Radio-Frequency IDentification) technology to scan the tag with a RFID reader and deduct the amount from a prepaid account. Passive RFID tag is located on the windshield of a vehicle and when it comes under the radar of a reader it is automatically detected. The system maintains a

database of registered vehicles and keeps a track of stolen vehicles by blacklisting them in centralized database. It provides security and safety by identifying stolen vehicles at the tollbooth and reducing the crime rate involved in vehicle theft. It offers an additional feature of document verification by maintaining a centralized database of papers related the vehicle. In the process of toll collection, it checks whether the documents are up to date or not and maintains a soft copy of all the papers. This is a step towards digital India where a person need not carry physical proof of all the documents as they are time to time updated in the system and account of all the documents is maintained.

The system offers various advantages over the traditional approach as it eliminates congestion at toll plazas and controls the traffic flow in a more systematic and centralized manner along with collection of data maintaining the history of the transaction of every vehicle along with the conservation of fuel, time and reducing emissions by eliminating deceleration.

II. LITERATURE SURVEY

In the automatic toll collection system RFID reader with 125 KHz frequency is used for the detection of passive tags installed on the vehicle of the commuter. There are two modes of operation in this system, transaction mode and recharge mode. When the vehicle arrives on the toll booth, the tag gets detected by the reader.

The reader will serially communicate the information with the microcontroller (ATMega8) and the specified amount gets deducted from the user's account. The message about the transaction and amount deduction is displayed on the LCD screen and motor driver lifts the barricade, to allow the vehicle to pass through. A message is delivered to the user via an SMS by using GSM modules that are interfaced with the microcontroller. If the account holder has an insufficient balance, he/she can recharge the card with a specific amount not exceeding the card limit of INR 250 and a message is sent informing the user about the new balance using GSM modem. [1]

In this, the author has simulated automatic toll collection using RFID system, balance reduction system in host computer and control of toll gate. The RFID system uses 13.56 MHz passive RFID reader. Deduction of balance is executed by using Microsoft Visual Studio 2010 (for developing computer programs) and Microsoft SQL Server as IDE (Integrated Development Environment) as software for maintaining a relational database to store and retrieve data when requested by other software applications, be it on the same computer or another across a network. PIC 18F4550 microcontroller is used for controlling the stepper motor and LCD displays the output of the balance deducted or a message on the screen.

When a vehicle arrives on the booth, the reader containing an RF module receives a radio frequency signal along with the data from a passive tag. An authorized person checks the ID number, vehicle number and balance amount in a database on PC that contains GUI (Graphical User Interface) along with database of all the users. The ID number is matched with the recorded database and specific amount as per the toll tax is deducted. Microcontroller displays the amount on the LCD and gates are opened. IR sensor, a motion detection device, is designed for 38 KHz frequency along with 555 timer integrated circuit. This sensor detects the motion of the vehicle and closes the gates automatically.

If the user is not registered in the database, he/she can register into it and deposit the amount in the account as a prepaid balance that is maintained in the repository. [2]

In this system, automatic toll collection, vehicle theft detection, signal breaking avoidance and tracking of over speeding vehicle is implemented. It promotes cashless transaction for the digital India and saving time and resources in the process. In Sept. 2012 Karnataka Government reported loss of about 600 crores worth of toll value due to human error.

When a vehicle is bought first, it is registered at the RTO office. Number plate is linked with the RFID tag at the registration and an account is created for smart card with a unique ID. Software stores all the information in the Centralized database server. The antennas at the toll booth are continuously sending radio frequency pulses that return only when it hits an electronic transponder (tag) fixed in the vehicle. Reflected pulses contain all the information about the driver number, account, balance etc. After deduction of toll tax, gates are opened and vehicle can pass through. In case the tag is removed, the cameras that are installed at the toll plaza will capture the front and back number plate's image and since number plate is also linked with the account, specific amount will be deducted from it. In case of stolen vehicle, RFID is blacklisted in the database and when it finds a match, it can be identified at the toll booth only. RFID readers can be installed on signals to keep a check on drivers who ignore the traffic signal and notify the traffic police about the offenders. [3]

III. PROPOSED SYSTEM

Our Proposed system is designed to overcome the shortcomings of the existing manual methodology of collecting taxes and generated revenues are directly transferred to the government's account which will reduce the fraud & corruption. This system performs an electronic tax collection, stolen vehicle identification and document verification. To achieve these functionalities passive RFID tag is used. A passive tag is an RFID tag that does not contain a battery; the power is supplied by the reader module. When radio waves from the reader are encountered by a passive RFID tag, the coiled antenna within the tag forms a magnetic field. The tag draws power from it,

energizing the circuits in the tag. The tag then sends the information encoded in the tag's memory. This tag has its own identification and this tag number is stored in the database to keep an archive of all the tags that have been issued by the RTO office. This tag can be placed on the windshield of the vehicle or anywhere on the vehicle where it can get scan by reader module.

When the reader detects the tag, it deducts a specified amount from the account and the gates are opened after the completion of the transaction. Stolen vehicle's RFID is blacklisted in the database. When the vehicle arrives on the toll booth, RFID matches with the blacklisted RFID from the databases and higher authorities are alerted about the stolen vehicle and gates remain closed throughout the process.

This system also checks for document verification. Documents such as PUC (pollution under control) and insurance must be up to date and failure results in violation of rules and regulations under the Motor Vehicles Act. If the documents are not up to date, commuters are alerted about it with an SMS. If documents are not updated in the stipulated time, commuters are charged with a fine and penalties according to the law.

A. *Automatic toll collection*

In India most of the toll collection is done manually. Majority of the population might not be able to avail the automatic services and keeping this fact in mind, there are separate toll booths for automatic toll collection and manual one. EM-18 RFID reader module radiates 125 KHz through its coils and when a vehicle with 125 KHz passive RFID tag is brought into the field, it gets energized from this field, a vehicle module receives a message. Then the vehicle module replies with the data that includes details about the registration number, identification data and other information that is mounted on the tag. Here the details are matched with the one present in the database of the system.
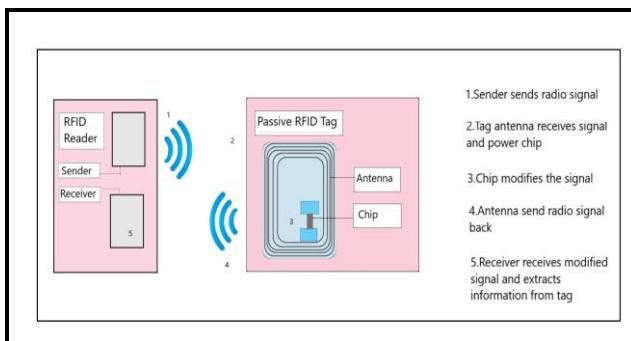

Figure 1. Shows how RFID reader reads a passive RFID Tag

The base that is processing the information receives this data and it sends an authentication message to the vehicle module.

Arduino Uno microcontroller board which is based on the ATmega328 having 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. Arduino Uno is interfaced with computer host to collect all the data through serial communication process.
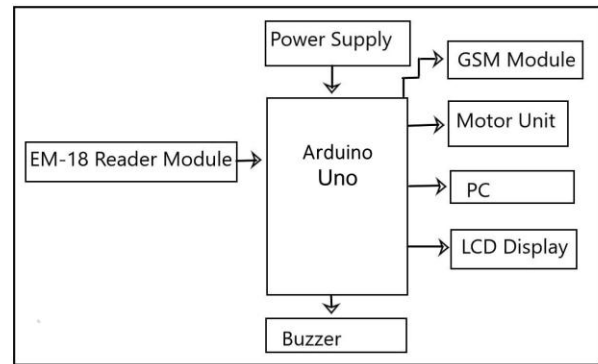

Figure 2. Working Principle of Toll Plaza Module with Arduino Uno Microcontroller

All the details of the vehicle get displaced on the screen such as vehicle number, ID etc. The balance is checked and according to the tax implied by the government, specific amount is deducted from the prepaid account of the user and the balance is updated along with a message that is sent to the vehicle owner by using GSM Sim800 modem. If the commuter doesn't have enough balance, they can recharge the account with a maximum amount of INR 2000 and minimum amount of INR 200 and then pay the taxable amount. Once the transaction is completed, vehicle will all to pass through. The transactions history is reflected from local to the centralized database system and archive of all the transaction is maintained. If the details of the vehicle are absent in the centralized database, they can be manually added in the system and next time when the vehicle arrives on the tollbooth, it will undergo similar steps to complete the transaction of automatic toll collection.

B. *Stolen vehicle identification*

If a vehicle is stolen, the owner reports it to the police and that registration number and RFID tag is black listed in the centralized database which is reflected in the local database. When the vehicle crosses the toll booth, the credentials are matched with the stolen vehicle in the database at the toll booth and buzzer will be alarmed to alert the authorities. An SMS about the whereabouts of the vehicle are sent to the nearby police station with GSM SIM800 module. SIM800 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. SIM800 supports Quad-band 850/900/1800/1900MHz, it can transmit voice, SMS and data information with low power consumption. With its tiny size, it can fit into slim and compact demands of our design. It also features Bluetooth and Embedded AT and allows total cost savings. A message

is also delivered to the owner of the vehicle on the number linked with the registration number. The gates remain closed throughout the process to prevent the thief from escaping the premises. This system provides security to the vehicle and helps in tracking a stolen vehicle in an efficient method.

Figure 3. GSM SIM800 Module

C. *Document verification*

This is an additional feature to the system to keep a check on documents of the vehicle in possession of an owner. The documents such as PUC, insurance need round the clock updating and if the owner doesn't comply with the rules, it's a violation of law. All the documents are stored in the database along with their date of issue and expiry date. When the expiry date is crossed, a linked number with the vehicle is notified about updating the documents and given a period of 15 days to comply with the request. An SMS is sent to the user periodically to remind him/her about updating the documents, until the task is performed. In case of failure, next time when the vehicle arrives on the booth, along with the road tax, an extra amount would be deducted from the user's account for not having proper documents of the vehicle.

According to the law in India, driving a vehicle without motor insurance shall result in suspension of the driving license of the driver. In addition, vehicle's registration number shall be suspended as well and a penalty for driving without insurance would be charging a fine of INR 2000, and/or be imprisoned for 3 months. The owner is given another 15 days to get the documents renewed. A vehicle without RC book (Registration Certificate) would be charged with a fine of INR 2000 according to the Indian Motor Vehicle Act. For not carrying the documents such as Pollution Under Control, fine of INR 100 and driving without carrying a valid Driving License results in a penalty of INR 5000 and/or imprisonment for up to 3 months. In case of not carrying the required documents as specified in Motor Vehicle Act while driving, a penalty of INR 500 is fined. All of these original documents are necessary for the driver to have.

The database is designed in such a format that failure of possession of any of the documents results in deduction of the specified amount from the account of the commuter. Again after the constant reminders about updating the documents of the vehicle, the commuter fails to comply with the rules and regulations, the vehicle will get blacklisted in the system and police is notified about the vehicle to necessary actions to prevent the person from violating the law.
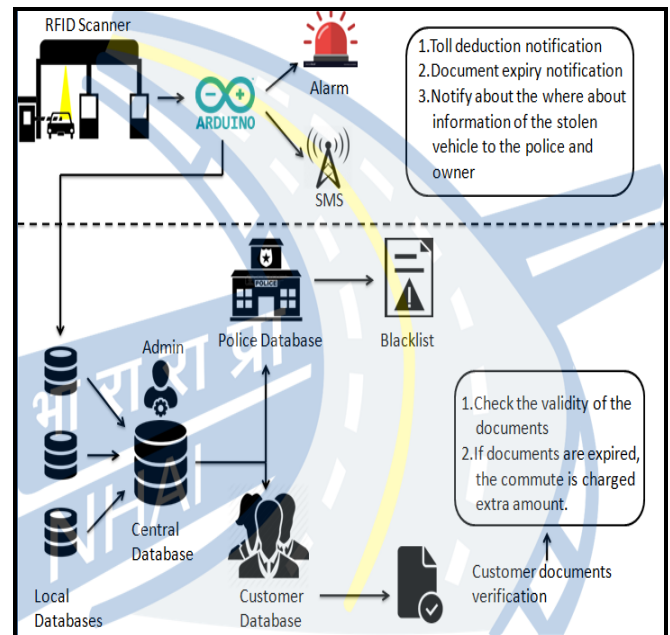

Figure 4. Proposed System Block Diagram of Automated Toll Collection

IV.   ADVANTAGES OF THE SYSTEM

- One of the primary concerns in today world is conservation of resources. With automatic toll collection the wastage of fuel is reduced up to a great extent.
- Traffic jams can be avoided and it facilitates smooth full of vehicles and the travel time is reduced with faster and efficient service along with air pollution reduction.
- RFID can installed anywhere inside the vehicle and still get detected. The passive tag used in the system don't require any additionally source of power and works for a lifetime until it is physically destroyed.
- Usage of SMS services as opposed to the traditional receipts that are handed

V. CONCLUSION

RFID system offers various advantages over the traditional approach of collecting toll. It tackles one of the primary concerns associated with tax collection i.e. corruption. The funds are collected in a digital format and directly transferred to the government, cutting down the middle man and laundering of money. This is highly reliable tax collection system working in all conditions. Along with automatic toll collection it also helps in tracking of stolen vehicle and maintaining a database of all the documents of the vehicle. With the additional feature of document verification, this system provides a platform to keep a check on the papers related to the vehicle and maintain a database of their renewed and expiry dates. This helps in tracking the vehicles easily that violate the law and don't abide by the rules and regulation.

This system inspires automation and ease in maintenance of millions of records of data. It improves management and cuts down the operational costs. It also helps in creating revenues and directly transferring the funds to the government without any human interference.

VI. FUTURE SCOPE

Instead of a prepaid account, we can have a post-paid mechanism where the user doesn't have to stop at the toll booth to deduce the balance from the account, instead an amount is added into the account and a bill is generated at the end of the month. With online application using internet facilities, person can directly pay the bill. In case of violation of rules, they can be charged a fine accordingly for not paying the taxable amount. This prevents the vehicle from stopping at the toll booth and helps in reduction of congestion at the toll plaza. This will ensure a faster flow of traffic and conserve a lot of time and fuel wasted while waiting in a que at the toll plazas.

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