

Easy Go - Automated Toll Collection System using RFID backscattering and Cloud Based Server

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Abstract— While Going on Highways, we tend to spend much more time waiting at the toll booth queue and some more, to pay the toll tax manually. An Automated toll Collection system would eliminate these drawbacks and facilitate a speedy transport. Our Project focuses on an automated toll collection system using radio frequency identification (RFID) technology and is based on concepts of embedded systems. RFID technology is an “Automated Data Collection” technology. The technology uses Radio Frequency to transfer data between the reader and a movable item that has been installed with a RFID tag. Each RFID tag will have a unique electronic code called as “Tag’s Identification number”. RFID tags consist of RFID chip along with the antennas which are required to increase the range of the RFID chip. RFID chips don’t have their own source of power. Passive RFID chip harness energy from nearby radio transmitter device called as “RFID reader” which will read the unique ID of the RFID tag and store it in the computer. RFID technology is fast and does not require physical sight or contact between reader and the tagged item. In the proposed system, RFID tags will be mounted on the windshields of vehicles, these tags will be read by RFID readers which will be interfaced using Atmega64 microcontroller. Data information is exchanged between the motorists and toll authorities, thereby enabling a more efficient toll collection by reducing traffic and eliminating possible human errors. Also the proposed system will be postpaid wherein the toll tax is added to the user’s account and the respective bill will be generated on a monthly basis and sent to the user, analogous to the traditional credit card system.

I. INTRODUCTION

‘EASYGO’ is an Automated Toll Collection System (ATCS) which enables the electronic collection of toll payments. It has been studied by researchers and applied in various highways requiring such a process. In 1959, Nobel Economics Prize winner William Vickrey was the first to propose a system of electronic tolling for the Washington Metropolitan Area. He proposed that each car would be equipped with a transponder. The transponder’s personalized signal would be picked up

when the car passed through an intersection, and then relayed to a central computer which would calculate the charge according to the intersection and the time of day and add it to the car’s bill [1]. The advantage of this technology is the opportunity to eliminate congestion on the tollbooths, especially during peak hours and festive seasons when traffic tends to be heavier than normal. It is also a method by which to curb inconveniences involved in manually making payments at the tollbooths.

II. BACKGROUND OVERVIEW

A. Existing Toll Collection System

At Present, there are two ways of collecting toll tax being practiced. First is the traditional manual toll collection method and second is the smart card system. In manual toll collection system the car arrives at the toll booth and stops for paying the toll tax to a person who then issues a receipt. The toll terminal features an embedded controller that communicates to the control computer via a digital I/O parallel interface. Vehicles passing through the lane are detected by loops installed in each lane. Axles are counted by using two-strip Traffic 2000 piezo-electric treadles. The main plaza monitor screen shows vehicle information in real time. Receipts are printed using a thermal paper receipt printer housed in a stainless steel enclosure and linked to the control computer via RS-422. Toll amounts, plaza name, lane number, vehicle class description and other variable text printed on the receipts can be easily changed by a mouse-controlled configuration utility program on each of the plaza systems [2].

B. Drawbacks of Existing System

The above mentioned methods for collecting toll tax have some major drawbacks:

1. They are generally slow and thus high compliance cost, of such a system.
2. Traffic accumulates at the Toll Booth.
3. Increased Fuel Consumption.
4. Even if the smart card system is automatic, it still needs to stop and validate the card.
5. Toll Evaders.



C. Related Work



Canada's 407 ETR for ETC

Automated Toll Collection systems are not new to the 21st Century world, in fact it marked its existence way back in 1970's in the United States of America. Easy-Go system however has different approach compared to their existing models [3].

Their technologies consist of sophisticated Image Processing algorithms which track the vehicle number plates and process the information from it. Although it serves its purpose in Canada, in the worldwide approach, it may not be feasible. There are number of reasons for that.

1. These high-tech systems generally cost a fortune, since it requires use of high speed video cameras.
2. Extracting the informative images (Optical Character Recognition) from the video is a cumbersome process. It also increases the concept of redundant data.
3. Standardized number plates are needed for this system to work efficiently. Standard number plates are not used everywhere in every country. This reduces the efficiency of the system.

Making use of RFID technology as the heart of the project has its advantages over the existing systems. Most important of all, installing and reading a RFID tag is very easy process and uses much less time. Passive RFID tags are inexpensive and are relatively smaller in size.

III. NEW PROPOSED TOLL COLLECTION SYSTEM

A. Working of new proposed system

New proposed system consists of a Radio Frequency Identification (RFID) tag containing its unique ID. This tag emits RF signal under the proximity of Radio Frequency (RF) reader.

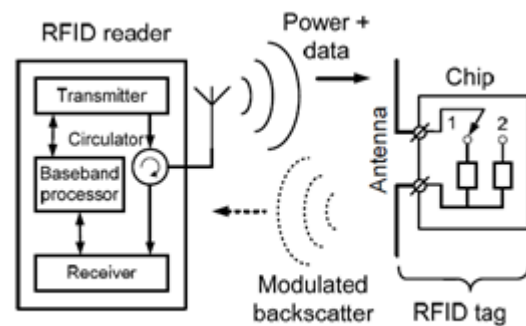


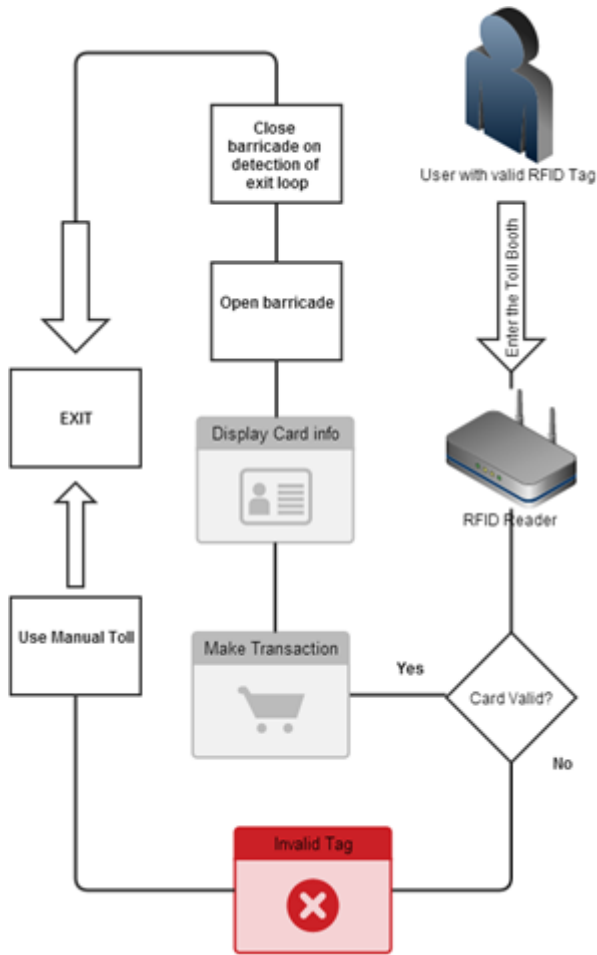
Figure 1. Passive RFID system overview.

Radio-frequency identification (RFID) is the wireless use of radio-frequency electromagnetic fields to automatically identify and track tags attached to objects. These tags usually contain electronically stored information. Tags can be broadly classified as Active and Passive Tags. Passive tags are non-powered and can be read at short ranges via magnetic fields. Active tags, on the other hand, generally use a local power source such as a battery, and may operate at hundreds of meters [4]. Unlike an infrared source or bar code, these tags do not necessarily need to be within line of sight of the reader, and may be embedded in the tracked object.

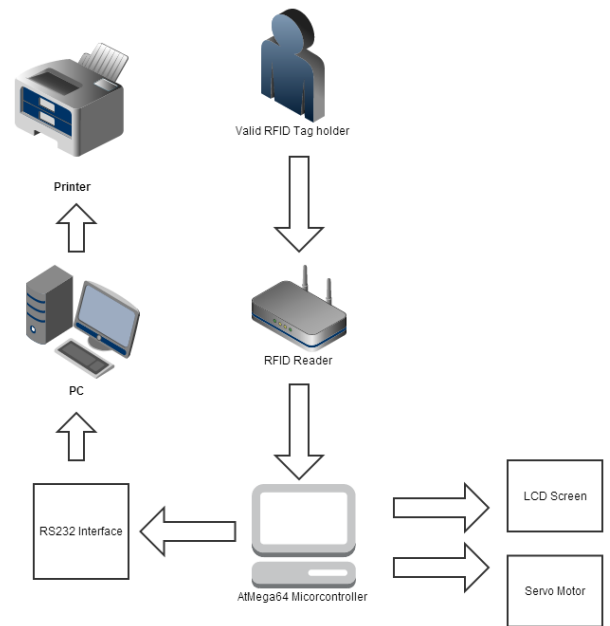
When the vehicle reaches the toll booth the RFID reader will detect these RF signals and reads the unique ID. This information is then passed to microcontroller for further processing. Microcontroller will in turn, display the information of the vehicle and the card on LCD screen. With the help of PC interface unit the data collected is passed to main server through serial port. Software developed will show all the details about the vehicle on the screen. Details like date & time of the transaction as well as the Unique ID will be

stored in the database. Based on these details a bill will be prepared on monthly basis and will be sent to the user for payment.

- 6. Problems with pursuing toll evaders.
- 7. Lower the toll collection costs.
- 8. Low Human interference.



D. Block Diagram



B. Cloud Based Server

Collected data from the Toll Booths viz. vehicle identification, toll tax amount, place, time etc. all can be stored on a cloud based server .It would be possible to seamlessly transmit the secured data to the cloud based server located far from the toll plazas. Making use of cloud based server it is now possible to add multiple toll booths in cascade and at various places [5].

C. Advantages of New Proposed System

The following are the major advantages of this system.

- 1. Automatic collection of toll tax.
- 2. Faster and more efficient service.
- 3. Free flow of traffic.
- 4. Time saving.
- 5. Record maintenance.

The basic working of Easy-Go system starts with the entry loop. Entry loop can be usually a metal detector, to detect the entry of the vehicle. After the detection of the vehicle, RFID reader would scan the unique RFID tag of the vehicle, eliminating the need to stop the car for this process. Once the unique ID is captured, it is sent to the microcontroller to further process the information and takes the necessary actions.

Assuming a successful transaction, the microcontroller would now display a message on the LCD Screen indicating the success of payment and the validity of the tag. It would also display additional information about the tag like the User Name and License plate number. Simultaneously, the microcontroller would send this information to the server for

updating the database and for maintenance of records on the server, by making use of dedicated software, it would be possible to sort the data according to Amount, Date of transaction, Place of transaction, Unique ID, License number etc. Also, barricade would open to let the vehicle move out from the toll booth. Exit loop would be installed here to indicate completion of one loop of entire process.

If for some reason, the tag is not valid or is not properly read, it would display the appropriate message indicating that the tag is not valid and the person should take the detour to make its way to manual toll tax payment.

Monthly bill would be generated automatically and would be sent to the user for payment. Additional information like the place, time, and amount of transaction etc. would be printed accordingly. By making use of various payment methods like online payment system on the website, the user can pay his toll tax. The amount paid would be segregated between various toll tax maintenance companies as per the usage.

E. Expected Result

Making use of Easy-Go system, promising results would be guaranteed. Faster commutation is the first and the most important advantage. Having no need to stop at each toll booths, commuters would save lots of their precious time which was initially wasted. Digitizing the systems has its own advantages as well – maintaining records of all the vehicles and their respective information would now be of much ease and simple to find from the records. This would speed up the overall process of the system. Since throughput of Easy-Go system increases drastically, the running cost reduces at the

same pace. Along with the preliminary advantages and results, vehicle theft would also decrease since each car is monitored at every toll booth, thus increasing the security of the vehicle.

Comparison of Easy-Go systems with existing technologies

Technology	Toll Type	System Used	Payment Method	Cost
US	Two Lanes	Two antenna	Postpaid	High
Canada	Closed Access	OCR & Laser beam	Postpaid	High
Poland	Closed Access	GSM & GPS	Postpaid	High
Easy-Go	Toll Booth	Passive RFID	Postpaid	Moderate

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