An Artificial Intelligence Based Toll Collection System

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Abstract. Presently everyone is working for automation in every field so, to aid the tedious work AI-based toll collection uses a radio frequency identification system that works on current issues faced at toll collection system. The everyday user faces stumbling blocks while waiting in the queue at toll gates due to congestion of vehicles and using the traditional manual toll ticketing systems to collect toll from the users. For such a problem AI-based toll collection system is used where all data is electronically transmitted through a platform to the main office in real-time which helps in decreasing manpower so, for all vehicles, sufficient tags are made without requiring to stop at toll gate to save time. The RFID tag was made to replace barcodes in the supply chain as it electronically stores details of the owner's vehicle, the account and the design of the vehicles. As the cards can be reused, they are much more convenient than the ticketing system based on paper.

Keywords: Electronic toll collection, Radio frequency Identification [RFID], toll station, infrared sensor, intelligent toll collection system.

1 Introduction

One of the issues that we witnessed every day is the toll plazas. The confusions and poor management of the whole toll system are becoming very clear. Often when traffic is massive and there is an immediate need for passengers to reach their destination, the situation becomes a little complicated [1]. There would be just a few people to collect the toll, so running these large crowded vehicles together is difficult for them. This can create problems such as traffic jams, noise pollution, poor handling of tolls and other issues. To overcome these problems and to have an effective collection of tolls, it is important to have a better idea of automated toll collection. We can therefore suggest a smart toll collection system where the performance is guaranteed to be increased compared to the existing systems [2].

As the collection of tolls becomes automatic, it will be very efficient for both passengers and the toll authority. Besides the collection of tolls, our program aims to give the authority concerned a helping hand by integrating drug detection and fraud detection into the proposed system. If the vehicle owner is alcoholic, it will be stored in the database of the owner and forwarded for further action to the authority concerned. Same as robbery case. If the number of the vehicle is reported missing or any case of theft is lodged on a car, the gate will be closed and an alarm will be triggered and data will be sent as in the previous case [3].

Radio Frequency Identification [RFID] is an artificial intelligence-based identification system which uses the toll tags [passive RFID tags] for intelligent transport system that is implemented at highway speeds and simply pays tax. Therefore, there is no need for attendant resources and cash collection and administration. This approach eliminates traffic jams and human power. Web based systems are useful for managing multiple areas. Artificial intelligence can be used to see certain and uncertain or incomplete information which occurs in the real world. The study is about the union of RFID and artificial intelligence.

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The RFID tag is electrically connected to the tax deduction at toll plazas and sends a telephone message to the driver There, the owner of the motor vehicle/ automobile will have a prepaid or post-paid account, so the toll tax is automatically deducted from the driver's toll card. The toll gate stays near the vehicle owner when the toll has to be paid if the vehicle is not fitted with an RFID system then the owner has to pay via cash and if the vehicle owner happens to have the toll card working fine the he/she will be required to pay the toll tax via mobile banking in such a case. In the case of reckless driving, toll gate breaching, the warning notice is immediately sent to the traffic regulatory authority.

2 Artificial Intelligent [AI] based toll collection

Radio Frequency Identification (RFID) is a complete term for technologies that makes use of radio waves to robotically perceive and track product [living (humans, animals etc.)/ Dead (goods and services)] with the aid of way of the use of RFID tags which can be applied or incorporated on them [5].

The automatic/intelligent Toll e-ticketing system is the approach used for the vehicle when it arrives or depart through any toll plaza which is detected by using a Sensor as shown in figure 1 [6]. Using the Radio Frequency Identification [RFID] scanner machine, unique RFID tags are used to read each car. The RFID readers are reading the vehicle owners' signal and data. Such Radio Frequency [RF] signals are transmitted at the toll site by a radio frequency-based receiver that sends data to the parallel port of a device. Appropriate toll tax is deducted from the vehicle owners' prepaid account, based on this data. If a vehicle lacks a RFID module, the vehicle's identification is not found in the database, or a commuter has insufficient bucks to compensate for the toll [7].

Existing automated toll collection techniques cause power loss as the receiver is constantly switched on, even if no automobile arrived at a toll location. In our technique, only the infrared [IR] sensor is turned on to detect vehicle arrival. RFID scanner reads the information only when the identity of the vehicle is determined [8].

Figure 1. RFID-Based Ticketing for Public Transport System.

FIGURE 1. Working of Radio Frequency Identification [RFID] for toll collection
https://ipc2u.com/solution/solutions/transport/electronic-toll-collection/

As the accumulation of charges for the toll becomes automatic, it will be very efficient for both passengers and the toll authority. Besides the collection of tolls, our program aims to give the authority concerned a helping hand by integrating drug detection and fraud detection into the proposed system. If the automobile proprietor is considered as an alcoholic, it will be stored in the database of the owner and forwarded for further action to the authority concerned. Same as the robbery case. If the number of the vehicle is conveyed as lost or any case of theft is lodged on a car, the gate will be closed and an alarm will be triggered and data will be sent as in the previous case [7][8].

3 Existing system

Most of the toll ticketing ecosystems around the world is manually operated and the transaction makes time and effort. It also generates a time lag and delay and makes the vehicle waiting for to pay the toll amount which may create pollution. There are innumerable commuters using the toll entrance every day. the traditional method of accumulating toll fares at the toll station from the commuters is to halt the vehicle and pay designated charges to the toll booth after which the entrance is made clear for the commuters to make their way through the entire station. Some of the RFID based toll accumulation systems suffers from loss of electrical power since the RFID scanner is made to operate 24*7, irrespective of the scenario that whether an automobile arrives at the toll station or not. [G XU-2008][8]

3.1 Limitations of existing system

All systems have some or the other drawbacks, the limitation of our system are listed below: -

- The system will only deal in individual toll booth.
- Multiple Radio Frequency [RF] tags are unable to be processed together.
- The entire proposed configuration will significantly surmount the stationary cost.

Limitations of the existed system are due to some problems which are depicted In the figure 2 and the problem leads to some more problems shown in figure 2.1

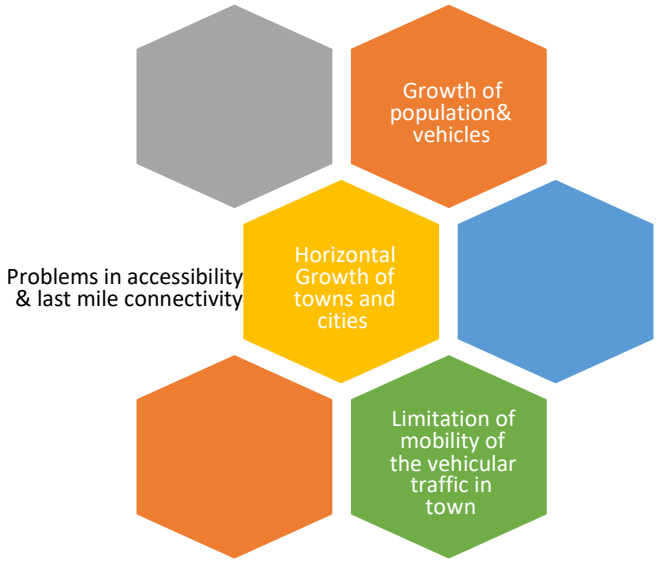

Figure 2. Depicting problems related to vehicles in current scenario [11]

Figure 2.1. Problems leading to complication of the system [11]

4 RFID based proposed system

The method conveys an effective ecosystem which offers rapid and reliable environment in which the toll charges will be accumulated autonomously. The infrared scanner proposed is to validate the incoming and outgoing of an automobile. The RFID scanner placed at the toll station will receive the data from the respective tags of the vehicle for processing. The automobile data is stored on the microcontroller. Based on that data, the toll charges are processed without any

human intervention to the toll plazas and the entire transaction notification is delivered to the proprietor of the automobile via the GSM modem. The status of the automobile is displayed on the LCD in system [9].
RFID reader is not always turned on; only the IR sensor is turned on to detect the incoming of the vehicle. Only when an automobile is identified and determined, the RFID reader reads the information about the number of vehicles that have passed through the toll gate and that is stored in a database. In addition, the number of times a particular automobile has crossed the toll station can also be easily determined by the use of this database. [WH LEE-2004][14][9]. with the help of this proposed procedure of toll collection we will conserve time, resources and man power. the proposed system also includes the user details to be added

4.1 Working of artificial intelligent based RFID systems

We are saying the working is artificially intelligent as it reduces man power and the work is totally automated and the labour is not required as it used to be in the existing systems. Radio Frequency Identification (RFID) is a generic term for technologies that use radio waves to automatically identify and track product, animal, or person by means of using RFID tags that are applied or incorporated on them. An RFID system consists of for the purpose of Vehicle Identification, the tags are embedded into the vehicle. Each vehicle will have two tags:

I. One is at front.
II. Other is at rear.

The front tag will inform the reader about its arrival to the vehicle stop whereas the rear one informs its departure. Each vehicle will also have a reader that is connected to the main server for charging of ticket fare from the passengers through a keypad attached with the reader on which the passengers give the information of their departure & destination locations. The reader sends the electromagnetic waves to the tag [10].
The tags draw the power from this wave and return back the vehicle information, which are stored in its memory to reader. The readers again demodulate this wave and convert it as a digital data. For the purpose of Ticketing, the operational feature of the cards is almost the same but here the tags are attached to special cards carried by the passengers and the reader collects the detail from them.
An E-Mail or short message service [SMS] can be sent to the user when his/her account has low balance so as to remind him/her to recharge before they use the highway. The Radio Frequency Identification Technique[RFID] can be used more effectively along the road so that the traffic on the road can be analysed and determined at any point of time and then the commuter can be guided towards a different route for an effective traffic handing In future we can enhance this project in addition with the face recognition mechanism where the rash drivers or stolen vehicle's face can be recognized by matching their face with the Radio Frequency Identification Technique [RFID] card holder's database and their details can be sent to the traffic authority[11][12].
There are two essential parts of Radio Frequency Identification [RFID] system which are as follows:

I. RFID Reader
   Detection of radio frequencies can be used in this procedure. We're installing an RFID scanner in the toll booth. Essentially, 5v is used by the RFID scanner. It will connect the microcontroller to the RFID processor. A selection of RFID readers will be available. The scope of the RFID reader is a region where the radio frequency can be reached as voltage is transmitted to the RFID reader. When the RFID tag hits the area,

the machine compares the data in the tag and calculates the total for that particular vehicle [14].

II. RFID Tag

Attached to the vehicle is the RFID Tag containing vehicle data. It is compared to the toll booth data. It determines how much is to be paid. RFID tag is a device that can be recharged. Each time a certain amount is deducted from the vehicle going through the toll booth. When it becomes a null balance, the client will receive a message. When a null balance mark goes through the toll booth, it becomes a negative balance [14].

5 Electronic Toll Collection [ETC] customer's financial benefits

There are several benefits associated with electronically based toll collection also we can term it as Smart toll collection for customers:

- Improves the transaction time and reduction in any journey delay.
- Provide improved convenience for the customers and for sure comfort.
- Enables extended payment options such as cash, credit card, debit card, cheque etc.
- Commercial customers no longer require cash or ticket from employer while ticketing. It can also be extended to allow vehicle tracking through global positioning system [GPS].
- Receive monthly statement and there will be no need for individual receipts anymore.
- Improved safety which is for conventional toll collection
- It may result in accidents typically rear-end collisions by drivers disturbed by their requirement to freed change, alter lane etc [19][20].
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Electronic Toll Collection (ETC) systems had a motive for raising the flow of the traffic by reduction in toll transaction time. The advantages of ETC can be widely classified into three categories: [Rajesh H. Chaudhary, 2003] [18] [11] [14].

- Toll Agency Benefits - The toll agency advantages consist of reduction in the resources that are under operation, decrease in manual labour, a significantly reduced maintenance, and an enhanced charge accumulation.
- User Benefits–The user advantages comprise of significant saving of time alongside the eliminated trouble of demanding change as well as an elimination of unnecessary accelerations as the automobiles don't wish to be halted for the toll transactions. In addition to this, the fuel and the overall commute time gets saved to a significant extent.
- Social Benefit - The social advantages include a diminished mobile emission that affects the neighbouring regions in which the Electronic Toll Collection [ETC] is situated. This research considers the user and the social benefits as they are considered to be the biggest success for Electronic Toll Collection [ETC] implementation [12][13].

The other benefits of the Electronic Toll Collection [ETC] is shown in figure 4 and on the wider perspective include:

- Congestion reduction–There has been a significant rise in the number of transactions that are done each day at the toll stations due to the usage of Electronic Toll Collection [ETC] systems which ultimately resulted in an increased throughput in the entire system. This has significant impact on the congestion at the toll stations. As the number of the Electronic Toll Collection [ETC] user rises up, the congestion in the manual goes up and gets diminished in the automatic lanes. The overall proportion of vehicles

halted and waiting in the line gets significantly reduced and henceforth the average waiting time gets minimised.

- Accelerated Capacity -- It is detected that the capacity of the electronic lane increases in multiples of three. The toll plaza would be able to shelter the increasing traffic without requiring building further more lanes [14].
- Fuel saving–Fuel consumption due to unnecessary vehicle movements has been completely eliminated. This results in effective fuel saving for the users using the Electronic Toll Collection [ETC]. In addition to this, the eliminated accelerations and decelerations results in cost cutting for the overall maintenance of the vehicle.
- Operating cost saving– The toll collection charges have been significantly reduced over the period of time and there has been a reduction in the requirement of manual labour as human intervention in processing is not required anymore [15][16].
- Time saving –Electronic Toll Collection [ETC] users don't have to halt their vehicles for paying toll charges which ultimately results in time saving. Besides, it has also led to an increase in the overall reliability in the travel time.
- Emission control–The elimination of the undesirable accelerations has resulted in reduced mobile emissions which consequently led to an increase in the highway financing with the construction of toll stations. In many non-attainment areas as declared by Environment Protection Agency [EPA], Electronic Toll Commission [ETC] seems to be an important factor in reduced mobile emissions [17].
- Enhanced cash handing -- There is no cash transaction for the Electronic Toll Collection [ETC] lane which resulted in removing the hassle of manual cash collection at the toll stations. Thus, it provides an aid in enhancing audit control by centralizing user accounts.
- Payment flexibility–The user doesn't have to worry about collecting and paying toll charges manually anymore. Since the patrons set up account for Electronic Toll Collection [ETC] usage it gives customers the freedom of paying the charges at the toll stations via cash, check, or even credit cards.
- Enhanced data collection -- Information such as vehicle count over the time of the day, date, time etc can be obtained due to the deployment of this technology. The pricing strategies for the toll stations can easily be determined by the toll operators with this data. This ultimately aids the planner to come up with better designing decisions for the toll stations [18].
- Incident reduction --It is observed that there is reduction in the number of incidents caused near the toll plazas [Rajesh H. Chaudhary, 2003] [11]. Considering these advantages, it is clear that there exists a lot of scope of research in studying the effects and impacts of these benefits over the Electronic Toll Collection [ETC] lanes. This research will address all the quantifiable components of the benefits on the integrated basis.

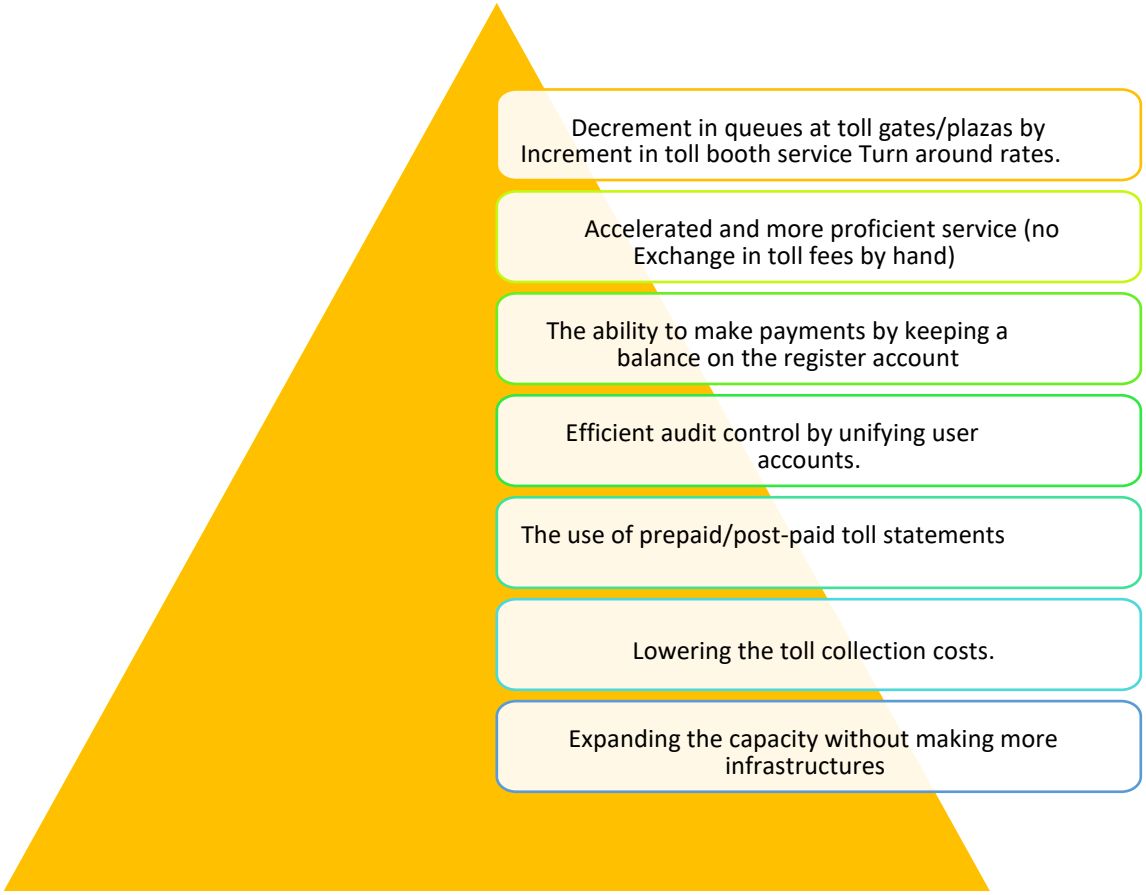

Figure 4. The benefits for the motorists include [Priyanka Chhoriya, 2013][11]

6 Conclusion

It is expected that the system will be fully automated, reliable, transparent and convenient. The entire system can also be used with small or no modification in vehicles on highways, their toll payments and in the railway ticketing system. As the cards can be reused, they are much more convenient than the ticketing system based on paper. The card can also be used as a universal travel pass card to enable transportation on any route. It is possible to avoid any unexpected events as every person carrying RFID tickets is monitored as they fly. There are also tremendous opportunities to reduce traffic congestion, confusion in the vehicle stop we typically experienced in Metropolitan area. The potential advantages associated with the deployment of Electronic Toll Collection [ETC] technologies are summarized on the following note that not all of these will be achieved in every circumstance.

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