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RFID Technology for vehicle identification

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Abstract- *In view of shortcomings exist in traditional toll mode of expressway and some defects of electronic toll collection system, such as short distance, high cost, and poor security, man power is required, a kind of radio frequency chip, is adopted to design electronic toll collection system and to use the similar system at the car parking of the mall. An efficient utilization of RFID technology to facilitate vehicle monitoring, vehicle authentication and automated toll collection on the highways and the car parking amount at the malls. The concept of RFID is explored more. The different applications of RFID are also being reviewed, exploring vehicle identification in details. In this paper mainly how RFID systems with its identification feature is useful for Vehicle Identification. With this feature we can improvise the current ETC (Electronic toll collection) systemand extent the same concept in car parking of the mall in the cities.*

Keywords- *ETC, Toll Collection, Car Parking, Vehicle Monitoring, Identification, RFID system, Automatic toll collection system, electronic payment, traffic.*

I. INTRODUCTION

Radio-frequency identification (RFID) is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information. Some tags are powered by electromagnetic induction from magnetic fields produced near the reader. Some types collect energy from the interrogating radio waves and act as a passive transponder. Other types have a local power source such as a battery and may operate at hundreds of meters from the reader. Unlike a barcode, the tag does not necessarily need to be within line of sight of the reader and may be embedded in the tracked object. RFID is one method for Automatic Identification. RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line; RFID-tagged pharmaceuticals can be tracked through warehouses; and implanting RFID microchips in livestock and pets allows positive identification of animals.[2]

II. LITERATURE REVIEW

A. Tracking moving vehicle:

There are many ways in which we can track a moving vehicle for example using RFID system, Zigbee Technology etc. Let us see each in detail as follows:

- **RFID system:**

RFID tracking System for Vehicles uses RFID (Radio Frequency ID) for developing tracking systems for vehicles. The three major problems in the city are: traffic signal timings, congestion on roads and theft of vehicles. The traffic signaling is made dynamic based on regressions over data archives, containing a detailed set of traffic quotient and time. This technique incorporates a simple, unique way to calculate traffic quotient based on the physical dimensions of the road and nature of traffic on the road. The theft of car is detected using track logs of vehicle. Analysis of congestion forms a key attribute for traffic signaling system and is used for suggesting faster routes to vehicle drivers and balancing the traffic across various routes. The RTSV requires installing RFID tags on all vehicles and RFID readers on various junctions of city for tracking. [6, 10]

- **RFID for Vehicle plate number**

RFID Vehicle Plate Number (e-Plate) for Tracking and Management System [7, 10] uses RFID vehicle plate number (e-plate) for tracking and management system. The system explains the designed RFID e-plate antenna based and vehicle plate number size to achieve optimum performance by utilization of plate number size then an RFID chip attached to the plate. The antenna of e-plate design uses a low cost FR4 material and antenna band works at 902-928 MHz frequency for UHF RFID application, with result 3.8 dbi antenna gains. The shape of antenna is rectangular and has a dimension of 300 mm x 100 mm, which is usually the typical size of the conventional vehicle registration plate number. All information

fed in the RFID e-plate tag is collected by the RFID readers and is analyzed for vehicle tracking, monitoring and transportation management system.[6,10]

- **Zigbee based Vehicle tracking:**

Zigbee-RFID Based Vehicle Tracking [8, 10] gives a solution to improve the traffic condition using zigbee based vehicle monitoring. It explains the design of RFID and zigbee based system architecture at the network level for tracking the vehicle information which is send to the centralized server. The aim of the design is to provide a simple and easy solution to track the location of the moving vehicle. Compared to the old systems, Zigbee based network architecture is able to provide information about the vehicle accurately. The vehicle will be having a unique RFID tag (Radio Frequency Identification). The RFID reader is placed in particular places. The RFID readers are integrated into the Vehicle tracking Information System. This RFID reader can check or collect the data and the information which is given to the control station through the Zigbee protocol. The Zigbee protocol is used for the messaging service between the control station and the vehicle.

- **ETC system:**

The radio frequency chip, is used to design electronic toll collection system of expressway. System security is also explained by a new RFID authentication and authorization protocol model. [1,10] In Radio Frequency Identification (RFID) Based Toll Collection System have an efficient utilization of communication link between RF Modems over a wireless channel to facilitate vehicle monitoring, vehicle authentication and automated toll collection on the highways. The system is implemented to automatically register vehicles getting on or off a motorway or highway, cutting the amount of time for paying toll in large queues. The detailed monthly bills will be sent to the customer at the end of the month. The customers could register and get a transmitter module and thereafter would not need to stop at toll booth whenever they get on or off the motorway. [2,10]

III. PROBLEM STATEMENT

A. Problem-

The RFID feature of identification is very limited. It is only used for identification of items or animals etc. On the other hand the RFID technology used for the Electronic toll collection system currently requires man power and does not eliminate traffic in spite of it being electronic. Also the Vehicle identification feature of RFID is only limited to toll collection booth.

B. Objective-

To implement a RFID card that can be one solution to all the above problems. To implement a RFID card that an individual can use as Identity card, a Voter Id card through which it can locate the nearest voting booth. With the same RFID card use the Vehicle identification feature of RFID to improve the current ETC system, monitor the traffic and extent the concept for collection of payment at the car parking of a mall. The main aim is to design a card which could be used at ETC, car parking .

IV. PROPOSED SYSTEM

The block diagram below in Figure 1explains the proposed system. The first step is the registration step. The customer first have to register itself to get the unique identification number, if the customer has a vehicle then the details of the vehicle needs to be filled in during the registration. In case if the customer does not have a vehicle has registered then that UID (unique Id number) generated from the RFID database will be used for the voting application. As mentioned earlier the concept of ETC (electronic toll collection) is extended for the mall car parking application[20]

The block diagram consists of following:

1. Toll naka
2. Mall Car Parking
3. Voting Booth

The mall car parking application will have a defined time frame and accordingly the money will be debited from the customer's account. If the car parking time extends the defined time frame then while the vehicle is exits the car parking the extra amount is again debited and the customer is notified via email for the same.

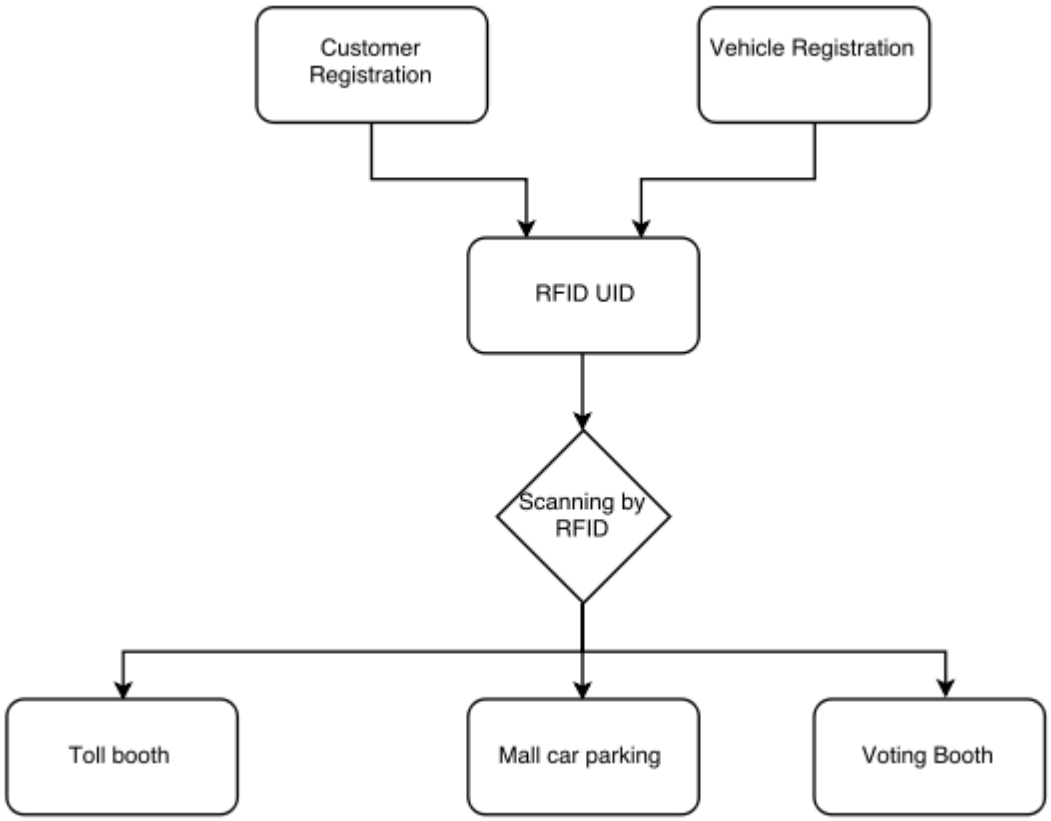

Figure 1 Block diagram of the proposed system

A. ETC – Electronic Toll collection

The first block in the diagram explains the ETC system. We already have an existing system for electronic toll collection at the toll plaza but the current system has various issues. In the existing system the vehicle is identification is by the physical parameters and by the number plate but we propose a system where the vehicle identification will be through the vehicle registration number which is provided by the manufacturer. This number is unique for each vehicle. Even if somebody tries to duplicate the vehicle with same physical parameters and same number plate the vehicle will be recognised only by its registration number which will be different for the duplicated vehicle. There are no chances to identify a wrong vehicle using the registration number. Also the second issue in the current system is that the owner is not intimated about the deduction of the amount on the spot but we propose a system where the scanning will be done by RFID reader and as soon as the amount will be deducted from the bank account of the owner he/she will be intimated by a SMS or an Email immediately. Ifthe owner does not have the money in his bank account that details will also be sent to him/her via SMS or Email immediately so he can pay the toll manually after knowing the reason for stopping the vehicle at the toll plaza.[20]

B. Automated Car parking

The block car parking in the system block diagram which explain the application for automated car parking in malls. The similar concept of ETC will be used here the only difference in ETC and automated car parking will be the deduction of the amount will be according to the time the vehicle is using the car parking area of the mall. We can define the car parking starting with the minimum of 1 hr and exceeding the amount upto 5 hrs. The breakage of the amount will be according to the time here. The deduction of the amount will be again informed via email and sms to the owner.

We have extended the vehicle identification feature of RFID to automated car parking whereas in the existing system it was only limited to the toll collection booth.

C. Voting ID

During elections many people go for voting but very few votes are received when counting of the vote is done. This can be due to people having the voter id and not knowing their polling booth. Many people go for voting but end up going to the wrong voting booth and do not vote. If we have a system which tells them the voting booth before the day of the election this will be eliminated and the individual will go to the correct booth and vote.

The RFID technology used to identify the individual will track the voting booth for them. The user will have a unique identification number UID number through which it will identify its voting booth. The card will have the details of the permanent address which will help the individual know its voting both, a mail with the details of the

polling booth will be received by the user. This will help people encourage voting and we will get more exact result of the voting. The chances of the people entering a wrong polling booth will be eliminated.

V. IMPLEMENTATION

Let us first see the work flow or the working methodology used to implement the proposed system. The figure below (Figure 2) explains the flowchart of the work flow. For any software application implemented we need an admin login credentials so that the code is not misused hence we have created a login page first.

A. Registration

Whenever any person buys a vehicle, one first needs to get his or her vehicle registered at the RTO office. RTO officials will not only assign a number plate to it but also will give a RFID enabled smart card or a tag. This card will have a unique ID feasible to use with that vehicle only. They will also create an account for the use of that particular smart card and maintain transaction history in database. User needs to deposit some minimum amount to this account. Every time a registered vehicle approaches the toll booth or mall car parking, first the Infrared sensors will detect the presence of the vehicle. It will in turn activate the RFID circuit to read the RFID enable smart card fixed on the windscreen of the vehicle. Transaction will begin, depending upon the balance available toll will be deducted directly or the vehicle will be directed towards another lane to pay tax manually. The software further updates the details in the Centralized database server. It also triggers mechanism to generate the bill and will be sent to user as a mail at his registered email address. [20, 22]

B. Customer Registration

The customer first needs to register. The personal details like Name, Email id , address and the contact number can be filled in in the registration form also the customer needs to fill in the bank details while registration which will used to deduct the amount as and when the vehicle passes the toll booth and mall car parking.

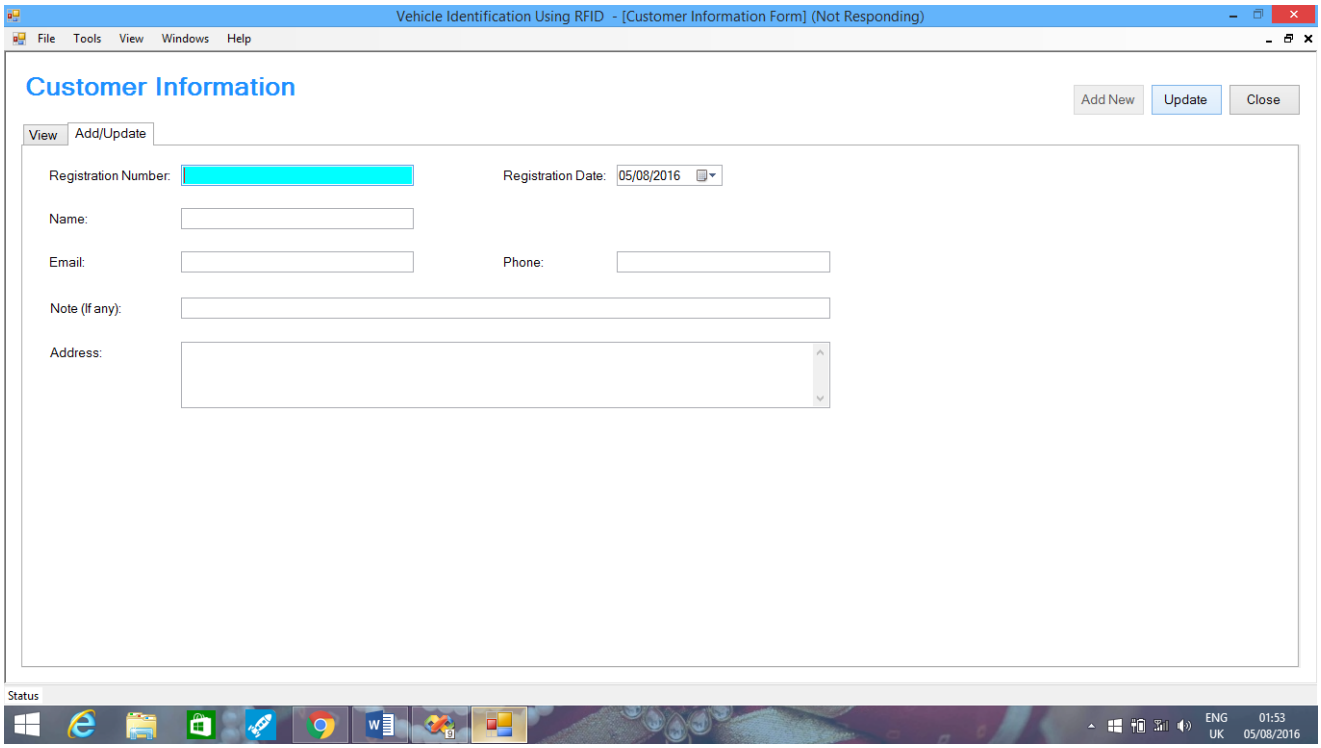

Figure 2 Customer Registration form

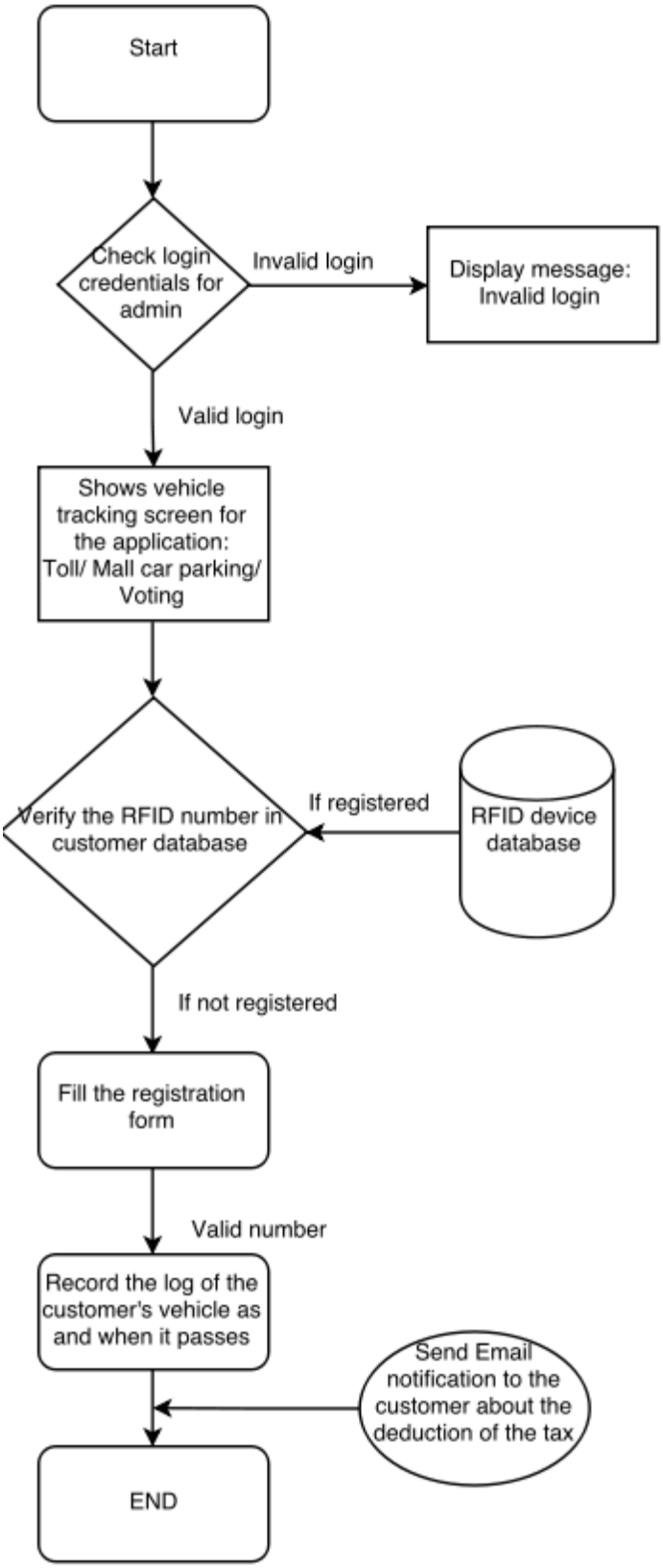

Figure 3 Work Flow

All the details of the customer registered in the form seen in the Figure 2 above will be stored in the SQL database.

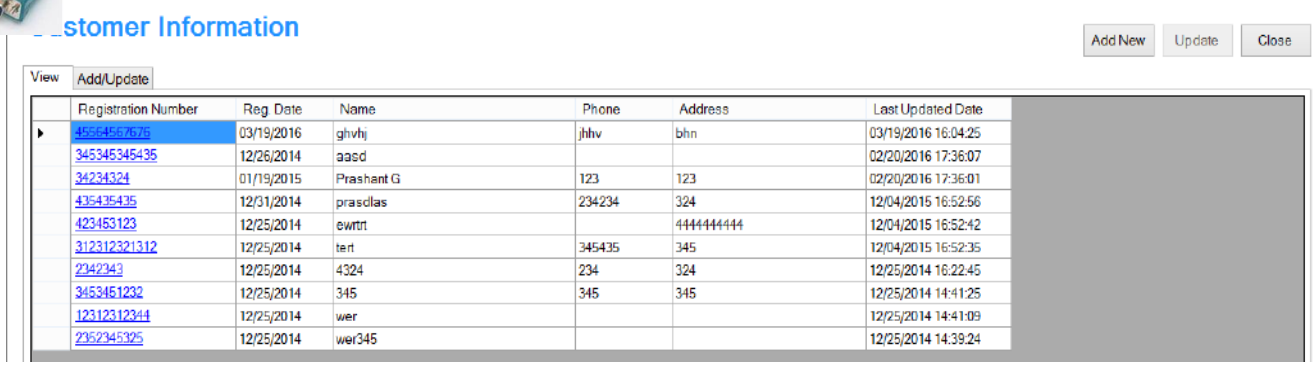

Figure 4 Customer Registration Form details

VI. **HARDWARE IMPLEMENTATION**

We will use the RFID reader module and a RFID tag which will be connected to thecomputer(host) via serial port communication RS 232 serial communication will be use to commute between the RFID module and the host[20]. The figure shows the hardware assembly.

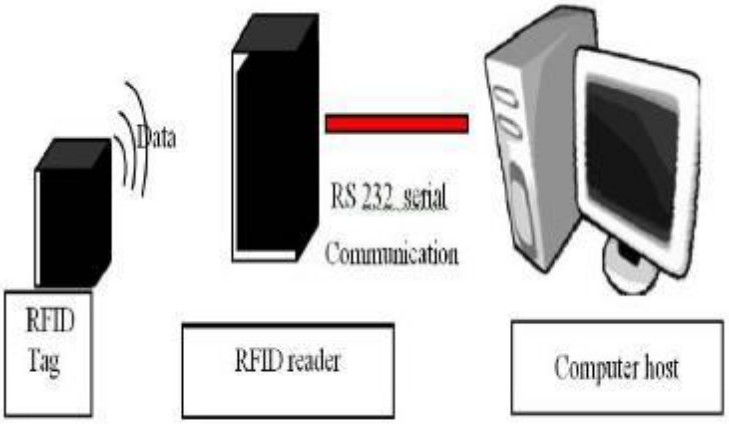

Figure 5 Hardware assembly

RFID stands for (Radio Frequency Identification). In this system EM-18 RFID reader uses as a receiver for RFID cards or tags. It reads out the data of cards when card is near about this and transfer data to its TX UART pin at 9600 baud rate. This have TTL output level so it can be directly connected to the micro controller RX UART pin. You can also use this module in Weigand data format at given pins. [24

RFID reader is an electronic device that can read the RFID tags and can send the read data through serial port. So from a serial client application this data can be consumed and used for further logic or analysis purpose. Even though there are several serial communication software available along with the option of coding through literally every programming languages, while browsing the internet you would not get too many resources in RFID that actually works. That is because there are more to programming with RFID and using it than simple serial communications. For serial communication we require RS232 9 Pin port. We would connect it to our laptop/computer. So we need a RS232 to USB converter cable as shown in figure below.[23]

Figure 6 USB cable for serial communication

We will connect this USB to our RFID modular and our laptop and we will also keep our card on it so that it can read the card. As soon as the RFID card is read by the tag it lights the LED light in red colour which tells us that the card is been read and the data is stored in the RFID database

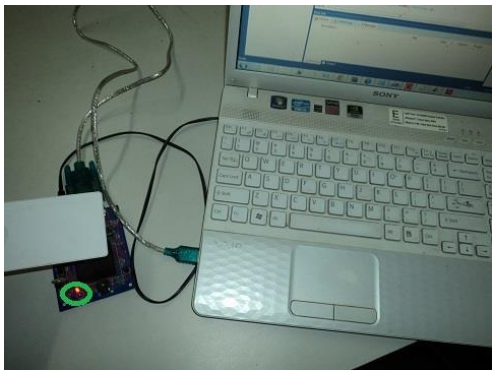

Figure 7 RFID set up and working

A. Working of RFID at toll plaza and mall car parking

The electronic toll lanes or the car-parking area can be set up with the special antennas that continuously send out signals. These signals are used to automatically identify the vehicles that travel by them. To use this facility, the driver needs to set up an account and get an electronic transponder fixed in the vehicle. These transponders commonly known as the tags are usually fitted on the windshields of the vehicles. The tag has all the information regarding the patron's account. The antenna continuously sends out a radiofrequency (microwave) pulse, which returns only when it hits a transponder. These pulses are returned back from the transponder and are received by the antenna. These microwaves reflected from the tags contain information about the transponder's number, patron's account, balance, etc. Other information such as date, time, and vehicle count could be recorded depending upon the requirement of the data needed by the toll agencies. After encrypting the contents of this microwave, the unit then uses fiber-optic cables, cellular modems or wireless transmitters to send it off to a central location, where computers use the unique identification number to identify the account from which the cost of the toll should be deducted [23].

This system uses diverse technologies for its working. Figure below shows the working of the electronic toll collection system and automated payment model at the car-parking with its components. These components may vary depending upon the technology used. As the vehicle enters antenna configuration (2) reads a transponder (3) mounted on the vehicle's windshield. As the vehicle passes through the exit light curtain (4), it is electronically classified by the treadle (5) based on the number of axles, and the account is charged the proper amount. Feedback is provided to the driver on an electronic sign (6). If the vehicle does not have a transponder, the system classifies it as a violator and cameras (7) take photos of the vehicle and its license plate for processing.[21]

The main system components are as follows:

1) RFID tagged vehicle
2) Toll booth or car-parking equipped with RFID scanners
3) Vehicle registration plate
4) Centralized database
5) Cameras
6) Laser transponders

These components of the RFID based payment collection system at toll plaza and car-parking technology work as Automatic Vehicle Identification -- The automatic vehicle identification (AVI) component of this system refers to the technologies that determine the identification or ownership of the vehicle so that the toll will be charged to the corresponding customer. [21]

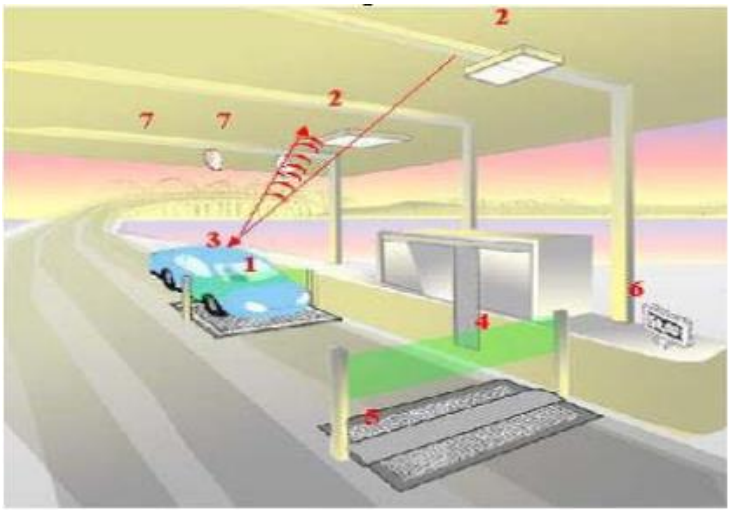

Figure 8 Work flow at the toll plaza and the car parking

VII. SOFTWARE IMPLEMENTATION

We have implemented the code using C# and MS Access dot net and back end SQL server for database storing the RFID data of the vehicle and the customer. We have also designed few screen as per need and created tables in SQL server as per need also did connectivity between application and SQL server. We have also added RFID detection code in application integrated Google map for navigation and traffic monitoring and also worked on other screens and its development.[22]

A. Programming RFID

For programming a RFID we need to first install the libraries. Once the library is installed, we are ready to begin building an RFID application. We have used Visual Studio Dotnet and C# to build the application shown in figure below.[22]

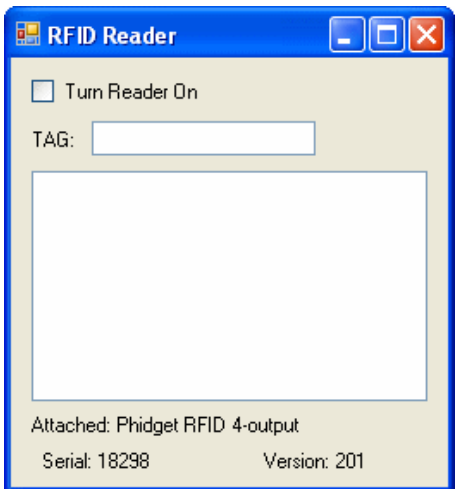

Figure 9 RFID application

This application simply reads tags and displays their unique IDs in the form. If you read a tag, it will be shown in the Tag text field while it is being read, and then added to the listbox once the read is complete. In this way, the listbox will maintain a history of what has been read. Figure below shows the dialog after the reader has been turned on (by checking the box in the form) and after a few tags have been read.

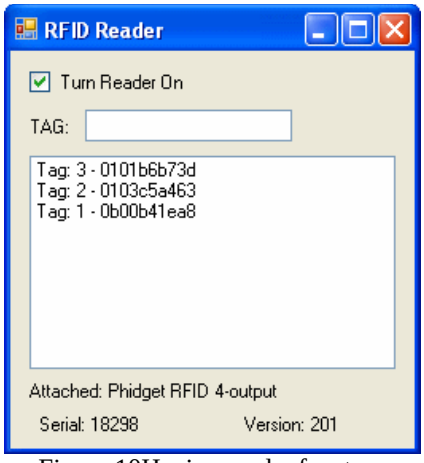

Figure 10Having read a few tags

To build this application, we start by creating a new C# Windows Application in Visual Studio . Within the form class, which we have called RFIDReader, we also set up three additional fields: *RFID rfid1;string lastRFIDTag;Int32 TagCtr;* [22]

RFID creates an RFID object called **rfid1**. This object will be assigned to the RFID reader so that we can pull information from it. The **lastRFIDTag**string field simply stores the unique ID from the last tag read. Finally, **TagCtr**is used to store a simple count of the number of tags read. As you could see in Figure 34, this counter is used to display the count on the listbox. After setting up these variables, the **lastRFIDTag**is set to blanks and the **TagCtr**should be set to 0 when you first initialize your form variables.[22]

private void Form1_Load(object sender, EventArgs e){ rfid1 = new RFID(); rfid1.Attach += new AttachEventHandler(rfid_Attach); rfid1.Detach += new DetachEventHandler(rfid_Detach); rfid1.RFIDTag += new TagEventHandler(rfid_Tag); rfid1.RFIDTagLost += new TagEventHandler(rfid_TagLost); rfid1.open();}

In this code, the first thing that happens is that an RFID object is created called rfid1. This will be used to attach to the RFID hardware. Before opening the hardware for use, event handlers are created for attaching to the RFID reader (rfid_Attach), detaching from the reader (rfid_Detach), having a tag put near the reader (rfid_Tag), and having a tag move out of the reader's range (rfid_TagLost). After adding these handlers to the rfid1 object, the openmethod is called to begin using the RFID object.[22]

To use the RFID reader, in addition to being connected to our machine, it also has to be turned on. The cboxAntenna checkbox is to let us control turning the reader on and off. By checking the box, we will execute the event to turn on the reader. The code to accomplish follows:[22]

private void antennaCheckBox_CheckedChanged(object sender, EventArgs e){ rfid1.Antenna = cboxAntenna.Checked;}

Now we know that turning on the reader is simply a matter of setting the **Antenna** property of our RFID object to true. The value returned from *cboxAntenna*.Checked will either be true or false, so this will set the rfid1 Antenna property to true or false (on or off). Once it is on, you are ready to begin reading tags.[22] With the reader attached and turned on, the next important thing is to read a tag. This is done in the *rfid_Tag*event handler that was added to the rfid1 object in the *Form_Load*event. The code for this event hander follows: [22]

voidrfid_Tag(object sender, TagEventArgs e){ txtTag.Text = e.Tag; lastRFIDTag = txtTag.Text; rfid1.LED = true; // light on}

The tag's unique ID will be passed into the event handler in the **TagEventArgs**. As you can see, the tag ID comes out of **e.Tag**and is simply displayed in the **txtTag**text box by assigning it to the text property. Because this application is only displaying the tag ID, not much is happening here.[22] The second line of code within this event sets the **lastRFIDTag**field to the ID of the tag just read. This field will be used to update the listbox on the form with the Tag ID thatwas just read. This update, however, won't happen until the tag is moved off the reader. If you did the update here within the *rfid_Tag*event, the update could happen over and over as long as the tag remained near the reader. We only want to list the read tag once for each time it moves over and away from the reader.[22]

The last line of code sets the LED property of the RFID reader to true. The RFID reader has an LED light on it. By setting this property to true, the light will be turned on whenever the reader is reading a tag. A tag may be read over and over as long as it is over the Reader. Once it is moved out of range of the reader, the *rfid_TagLost*event will happen. The code for *the rfid_TagLost*event handler follows:

voidrfid_TagLost(object sender, TagEventArgs e){ txtTag.Text = ""; rfid1.LED = false; // light off lbPrevRFIDTags.Items.Insert(0, string.Format("Tag: {0} - {1}", ++TagCtr, lastRFIDTag));}

In this routine, things are simply being cleaned up. The first line clears the textbox because no tag is currently being read. The second line turns off the LED light. The final line of code writes a line in the *listbox* showing the RFID tag information that was just read. In our applications, the *rfid_TagLost* event would be the location where you could do your tag processing. The *rfid_TagLost* event will only happen once when the tag leaves the reader area. That makes this a better location for processing application logic than the *rfid_Tag* event. For example, for our system where members have an RFID membership card, this would be the area in the code where we would do a look up of your database system to find the unique Tag ID and then the associated member information.[22]

VIII. CONCLUSION

By doing automation of toll plaza and automated car parking we can have the best solution over money loss at toll plaza and car parking by reducing the man power required for collection of money and also can reduce the traffic indirectly resulting in reduction of time at toll plaza. In our project we have introduced the techniques such as Radio Frequency Identification. This technique will include the RFID tag & reader which in coordination with each other can be used to detect the vehicle identity. The IR Trans receiver is used for detecting the presence of vehicle at different locations which will act as the gate pass to the toll plaza and car parking. By effectively utilizing these three techniques at different stages of our project we are able to represent the automation in toll plaza and car parking which will reduce the complete processing time by few seconds which is very important as well as helps to reduce money leakage in a very cost effective manner.

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