

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

Electronic Toll Collection System using RFID

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ABSTRACT: This paper mainly focused on how the electronic toll collection system reduces manual work load using RFID technology. Ultimately, this system reduces environment pollution due to the burning of fuel as well as reduces the waiting time of users in toll queue. System mainly uses the centralized database due to which this system has user friendly approach. Users can access the website and may perform their toll transaction from any location. Their transaction will reflect in the centralized database. Due to the use of online transaction, users don't need to carry cash with them. This leads in the reduction of human error occurring at the toll booths. Cashless transactions gives the transparency to this system. Practical implementation of this system is explained in details in this paper.

KEYWORDS: Radio Frequency Identification (RFID), RFID Reader, Toll plazas, Digital India.

I. INTRODUCTION

As the electronic toll collection system is transforming manual transaction work to the automatic toll collection using RFID technology, the main objectives behind the systems are reducing the longer waiting time in the toll queue, reducing illegal toll gate entry, improving the speed and the efficiency of traffic flow and saving the drivers' time. Due to these objectives, it reduces loss of fuel, use of paper and efforts in the management at toll plaza.

Due to some disadvantages of image processing technology and infrared technology, now a day's use of RFID technology for the toll collection system comes into the picture. Disadvantages of this two technologies have been explained in the literature survey.

RFID tags provided to the users are scanned through RFID reader fixed at toll booths in specific positions and online transactions are carried out regarding the specific RFID tag number of user. Due to the online transaction this system provides transparency to the whole system. From the users point of view, web application is provided.

II. LITERATURE SURVEY

In 1959, Nobel Economics prize winner William Vickrey was the first to propose a system of electronic tolling for the Washington Metropolitan Area.

INFRARED short-range communication systems in the wavelength band 780–950 nm are suitable for electronic toll-collection (ETC) applications due to their lower cost and simpler technology, compared with microwave systems. In this wavelength range, low-cost light-emitting diodes (LEDs) and p-type-intrinsic-n-type photodiodes are commonly used for the source of the transmitter and the detector of the receiver, respectively [1].

However, for windshields with high infrared attenuation, the problem of severe shrinkage of the communication region is very serious, in particular, for vehicles at high speed. IR technology fails due to its disadvantages.

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Image processing tools are used for extracting only the region of interest. Then different luminance and background are removed by changing colour image to gray scale and then in to binary matrix form. Character recognition algorithm is applied on the binary images. All components of image are compared with pre-defined standard template and characters are recognized based on best match. Each matched character is displayed and stored in a log file. This algorithm is tested with vehicle images of different backgrounds and illumination. The camera focus, viewing plane and the distance from the vehicle were varied. The results of experiments are fascinating with good accuracy rate [2]. The problems associated with registration plate recognition are, plate images have different quality, illumination, view angle, distance, complex background and fonts.

RFID is better to use to reduce cost of entire project. As the system is developed with the help of some high end applications which provides easy and fast processing. Research on ETC has been around since 1992, during which RFID tags began to be widely used in vehicles to automate toll processes [3].

Khalid Al-Khateeb, Jaiz A. Y. Johari proposed that RFID traffic control avoids problems that usually arise with standard traffic control systems, especially those related to image processing and beam interruption techniques [4].

III. METHODOLOGY

The proposed system at toll plaza should have two lanes namely mixed and dedicated lane.

Mixed lane: Mixed lane will allow vehicles with or without RFID tags. Online transaction facility will be provided to the RFID tagged containing vehicles in this mixed lane, but they will have to wait in the queue if there are vehicles without RFID tag.

Dedicated lane: Dedicated lane will allow only RFID tag containing vehicles. In this lane, Hybrid lane will be always on right side. Length of this lane will be 70-100m. When the vehicle will be enter into dedicated lane, gantry pole will verify the RFID tag of the vehicle. After that boom barrier will allow only the vehicles having RFID tag with valid amount. Vehicles having RFID tag with zero amount, with having some damage, black listed (Fraud cases) will not be allowed through the automatic boom barrier. Vehicles which are not allowed will have to go through the hybrid lane and have to perform manual toll transaction. The vehicles with successful entry will pass through another barrier and hexagonal ring. The gantry pole will take the first count of vehicles entering into the dedicated lanes. The second count will be taken at the hexagonal ring, the count taken at the hexagonal ring is of the vehicles which perform the successful ETC processing. Third count taken at the hybrid lane. The addition of second and third count should match with the count taken at gantry pole. Recommended speed along the lane for the vehicle is 20-25km/hr.

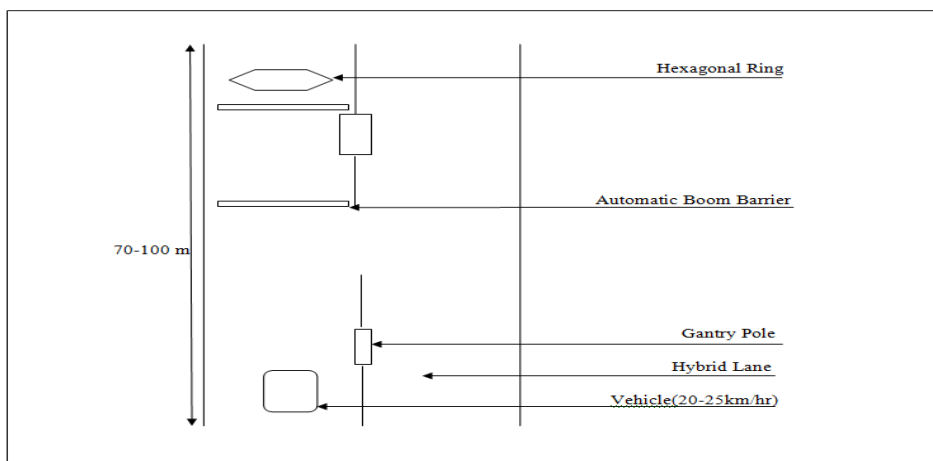


Fig.1. Working System of E-TOLL

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In the implementation, RFID reader will read the value of RFID tag (passive tags) using radio frequency waves. Information stored on microchip of RFID tag will be read remotely without any physical contact. It uses the energy in the RF spectrum. The controller will take the input from RFID reader and Arduino will fetch the RFID reader from controller. At regular intervals, input data captured from the RFID reader will be send to the web server. Web server will put the data in respected datasets for particular device. Web server will formulate and represent the data. Results can be seen at web portal maintained centrally.

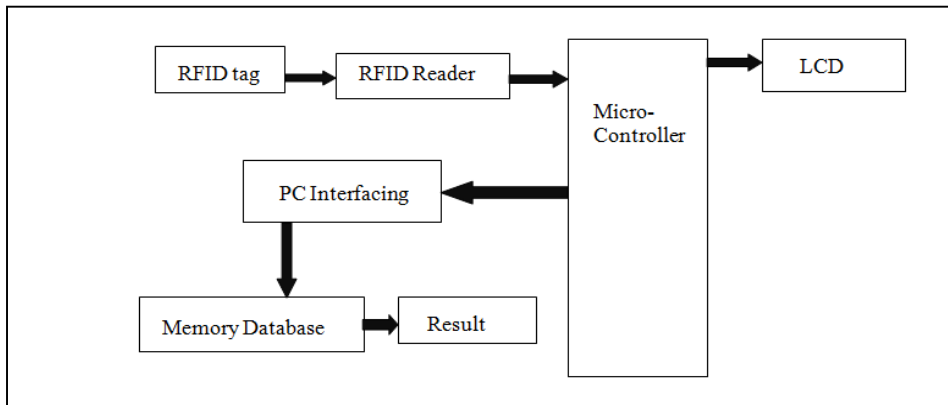


Fig.2.Architecture View of E-TOLL

IV. EXPERIMENTAL RESULTS

In the actual implementation HTML, CSS, bootstrap based web application is designed using PHP MySQL database. This webpages are uploaded on the cloud so as to make them available to the users from any location. First user interface of the webpage is shown in the Fig.3. User can also visit the about us session for details about the system.



Fig.3.User Web Interface

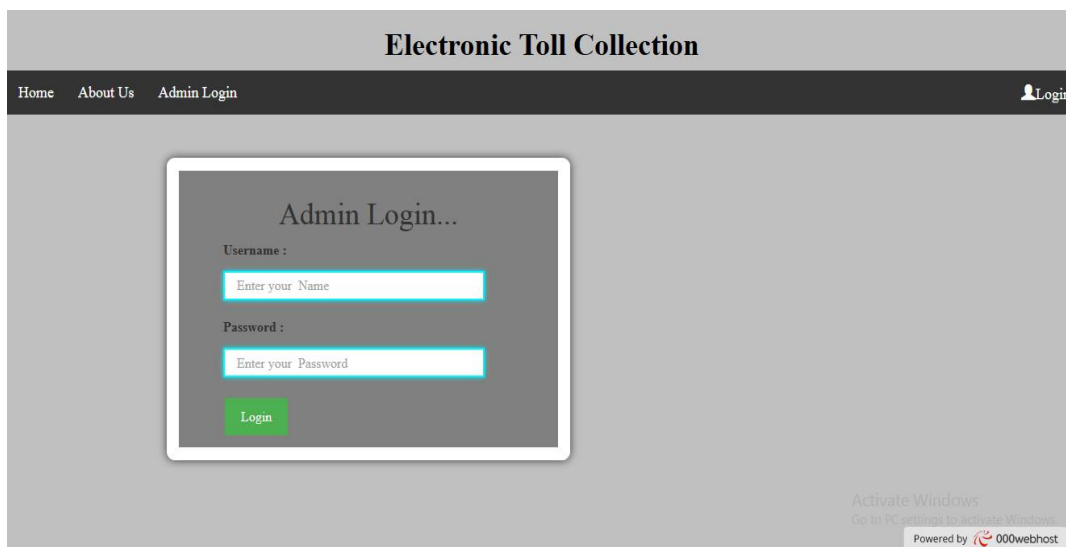
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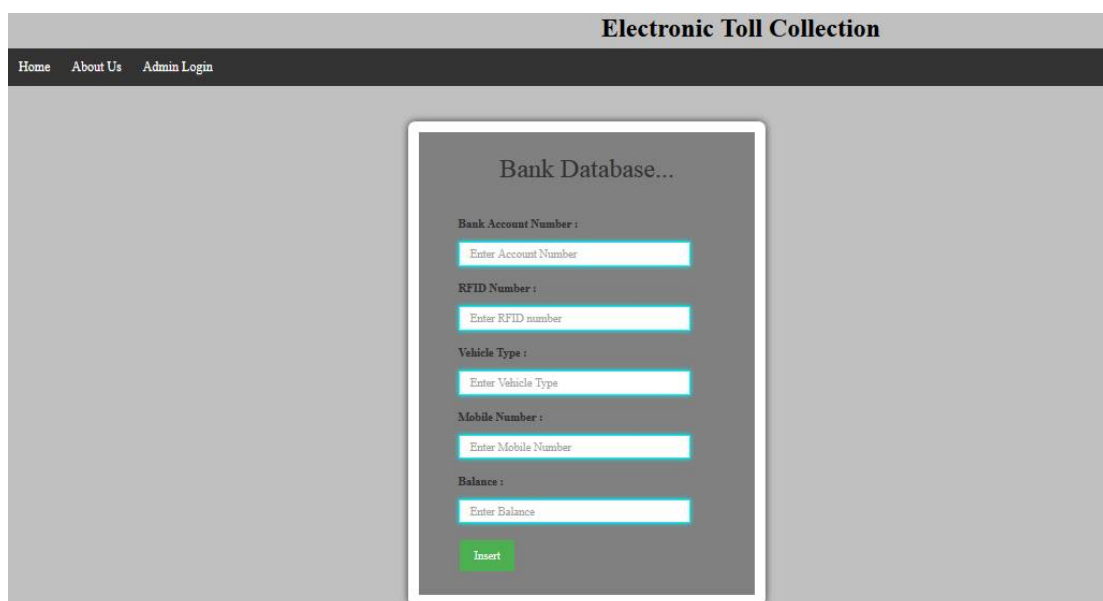
The separate web page for the admin login is provided in the Fig.4. Admin login is secured with the password provided to the admin. So that only admin can handle its account in very secure manner.



The screenshot shows the 'Electronic Toll Collection' website. At the top, there is a navigation bar with 'Home', 'About Us', and 'Admin Login' links, and a 'Login' button on the right. The main content area features a central box titled 'Admin Login...'. Inside this box, there are two input fields: 'Username : Enter your Name' and 'Password : Enter your Password'. Below these fields is a green 'Login' button. In the bottom right corner of the page, there is a watermark for 'Activate Windows' and 'Powered by 000webhost'.

Fig.4.Admin Login

Once after the admin login, admin have authority to add the new user to the system and can also recharge the user's account to perform the transactions. User account details are provided in the Fig.5.



The screenshot shows the 'Electronic Toll Collection' website. At the top, there is a navigation bar with 'Home', 'About Us', and 'Admin Login' links. The main content area features a central box titled 'Bank Database...'. Inside this box, there are five input fields: 'Bank Account Number : Enter Account Number', 'RFID Number : Enter RFID number', 'Vehicle Type : Enter Vehicle Type', 'Mobile Number : Enter Mobile Number', and 'Balance : Enter Balance'. Below these fields is a green 'Insert' button.

Fig.5.Add User Account

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The user can access his account from any location and can carry out the transaction using the web page. User interface for this purpose is shown in the Fig.6. Firstly, User can choose the toll plaza which he is going to visit as toll charges vary according to the toll plaza.

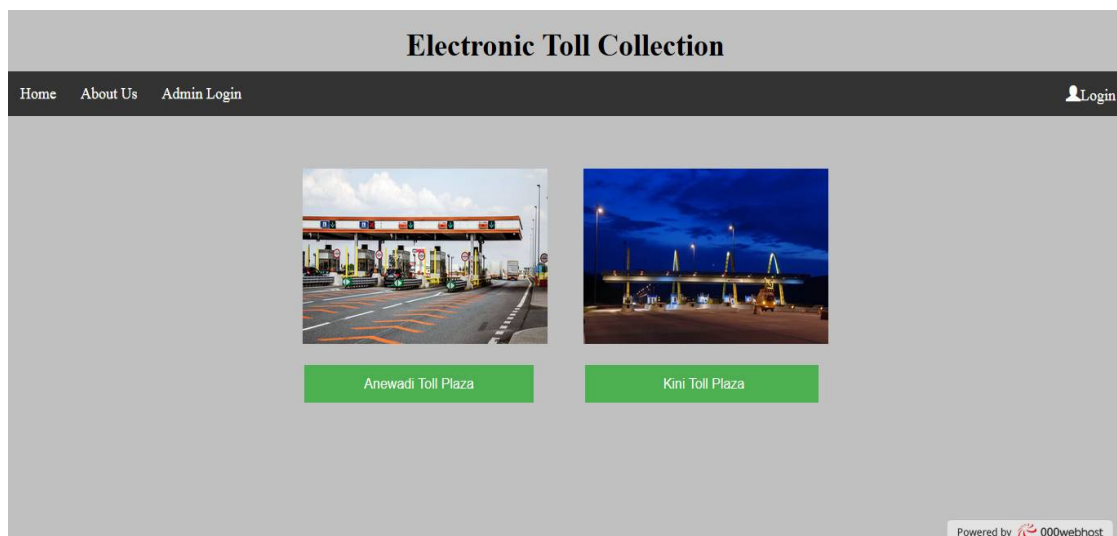


Fig.6.Toll plaza selection

Once After selecting the toll plaza, one can enter his/her RFID number to perform the transaction. User interface for this purpose is shown in the Fig.7.

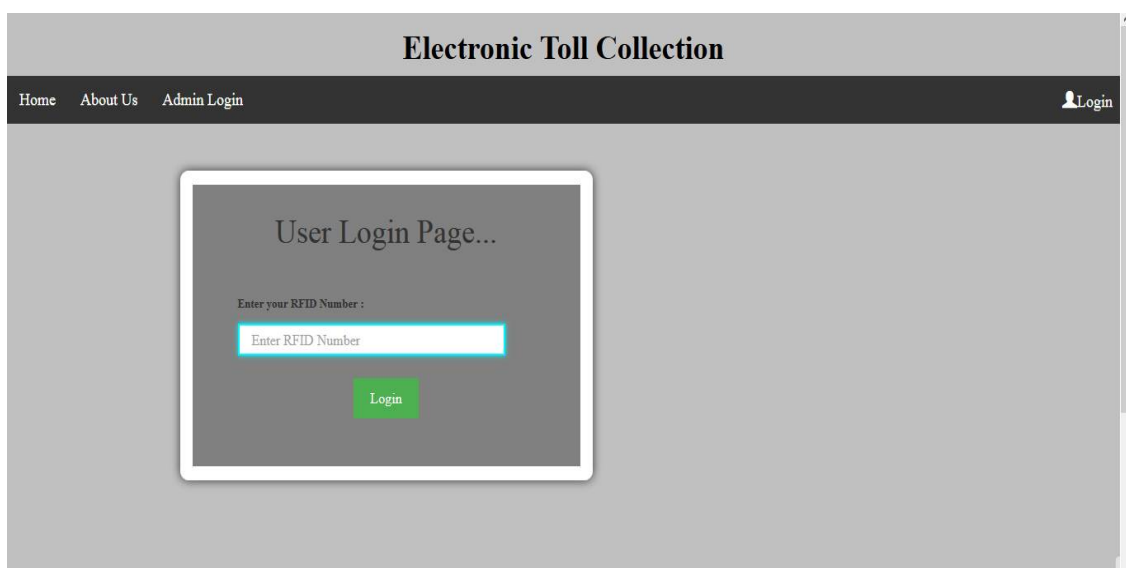


Fig.7.User login for transaction

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Hardware implementation of the whole system containing RFID tag, RFID reader, Arduino, LCD are shown in Fig.8. All this hardware are interfaced with the web application for the successful implementation of system.

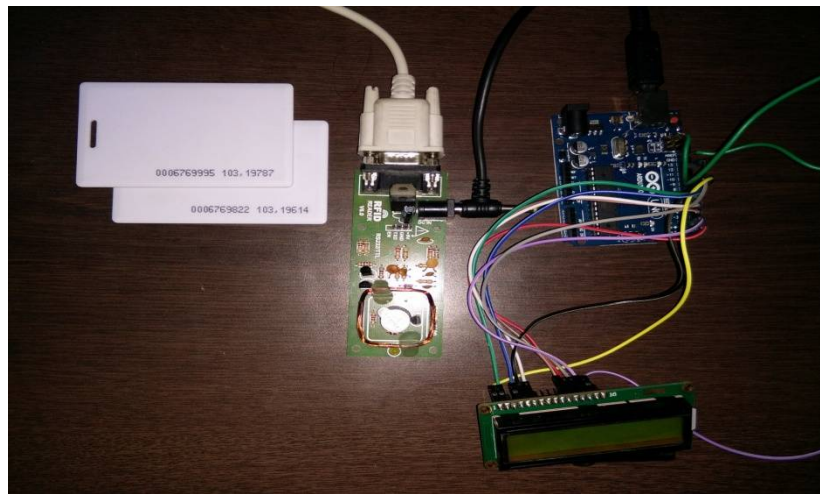


Fig.8.Hardware implementation

V. SCOPE OF RESEARCH

RFID tags fixed on the vehicles can also be used for avoiding the breaking of signals. RFID reader fixed at signal crossing will scan the RFID tag on the vehicle who are ignoring the traffic signals. And such RFID tags number will be informed to the traffic police for taking the further actions against the user.

In the same way, vehicles travelling at high speed than the specific speed limit will be tracked using this system.

Vehicle theft detection is also possible using this system. Owner of stolen vehicle may complain about his stolen vehicle on the website with his unique RFID tag number. RFID reader fixed at the toll plaza will detect the stolen vehicle's RFID tag number and will match with the vehicles tag number in the database.

VI. CONCLUSION

Different types of ETC systems applied in some countries has been discussed in literature review of paper. Passive RFID technology has been used in the implementation of electronic toll collection system. Use of RFID technology results in increasing the efficiency of whole system. There is no need of building the big infrastructure for the system. The main objective behind the whole system is reducing the waiting time, reducing the fuel consumption, ultimately the air pollution. Future applications using RFID technology has been discussed in this paper.

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