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## Electronic Toll Collection System for Road Transportation

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### **Abstract:**

*The highway transportation has become more and more important in modern road network and the traditional manual toll collection system has become outdated due to its drawbacks. By employing automated toll collection system, driver of vehicles need not to stop at a window or toll machine and waste time waiting in a long queue to pay their toll. This reduces the consumption of fuel; reduce road congestion, increase road safety and traveller become pleased. An Automated Electronic Toll collection (ETC) system is basically designed for an uninterrupted toll collection, which has become an important part of intelligent transportation system. This paper presents the concept of Automated ETC using RFID technology. This work eliminates the need for motorists and toll authorities to manually perform ticket payments and toll fee collections, respectively. Data information are also easily exchanged between the motorists and toll authorities, thereby enabling a more efficient toll collection by reducing traffic and eliminating possible human errors.*

**Keywords:** Intelligent transportation system, Automated Electronic Toll collection (ETC), RFID technology.

### **1. Introduction**

Transportation is the backbone of any country's economy. Advancement in transportation systems has lead to a lifestyle characterized by extraordinary freedom of movement, immense trade in manufactured goods and services, high employment levels and social mobility. In fact, the economic wealth of a nation has been closely tied to efficient methods of transportation. Due to increasing number of vehicles on the road, problems such as congestion, incident, air pollution and many others have become a major factor of concern. Evidently, nearly all-economic activities at some point use different means of transportation to operate. For that reason, enhancing transportation will have an immediate impact on productivity and the economy. Reducing the costs of transporting natural resources to production sites and moving finished goods to markets is one of the key factors in economic competition. Electronic toll collection (ETC) is a technology enabling the electronic collection of toll payments. It has been studied by researchers and applied in various highways, bridges, and tunnels requiring such a process. This system is capable of determining if the vehicle is registered or not, and then informing the authorities of toll payment violations, debits, and participating accounts. The most obvious advantage of this technology is the opportunity to eliminate congestion in tollbooths, especially during festive seasons when traffic tends to be heavier than normal. It is also a method by which to curb complaints from motorists regarding the inconveniences involved in manually making payments at the tollbooths. Other than this obvious advantage, applying ETC could also benefit the toll operators.

The benefits for the motorists include:

- Fewer or shorter queues at toll plazas by increasing toll booth service turnaround rates.
- Faster and more efficient service (no exchanging toll fees by hand).
- The ability to make payments by keeping a balance on the card itself.
- Other general advantages for the motorists include fuel savings and reduced mobile emissions by reducing or eliminating deceleration, waiting time, and acceleration.
- Meanwhile, for the toll operators, the benefits include:
  - Lowered toll collection costs;
  - Better audit control by centralized user account and
  - Expanded capacity without building more infrastructures.

Thus, the ETC system is a win-win situation for both the motorists and toll operators, which is why it is now being extensively used throughout the world. ETC system commonly utilizes radio frequency identification (RFID) technology. RFID is a generic term used to identify technologies utilizing radio waves to automatically identify people or objects. RFID technology was first introduced in 1948 when Harry Stockman wrote a paper exploring RFID technology entitled, "Communication by Means of Reflected Power". RFID technology has evolved since then, and has been implemented in various applications, such as in

warehouse management, library system, attendance system, theft prevention, and so on. In general, RFID is used for tracking, tracing, and identifying objects.

## 2. Problem statement

“Design an Automatic toll plaza which is based on microcontroller, RFID technology to save the time at toll plaza and having cash free operation”

As the name suggests “Automatic Toll Plaza” the key theme of our project is the automation. So here we will just take the over look of what is mean by Automation. So in very simple language the Automation means to replace the human being from the process with the machines. Means what presently the human is doing on the process now onwards the machines are going to do.

## 3. Objectives

Here are some points regarding to purpose behind choosing this topic & what is the requirement of this type of the project in our day to day life.

- Avoid the fuel loss.
- Saving of time in collecting toll.
- Avoid financial loss.
- To monitor the traffic.

So, according to the survey of Karnataka Government carried out in Sept.2012,they have proposed to get the annual toll collection of 2500 crores/year .But in the present situation only 1900 corers of the toll value is collected. Means there is loss of 600 cores due to some human errors. So, we have to control this leakage.

## 4. Hardware Implementation

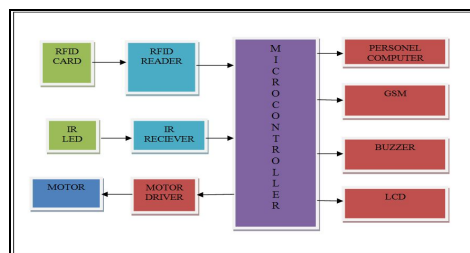


Figure 1: Block diagram of automatic toll collection system

The “RFID based Toll Collection System” basically consists of following main blocks

### 4.1. RFID card

RFID cards have diverse range of functions, while provides convenience, as the cards must simply be waived or tapped in front of a reader rather than swiped. These cards are used for applications as access control in security systems, time and attendance, network login security, biometric verification, cashless payment, and even event management.

### 4.2. RFID reader

An RFID reader is a device that is used to interrogate an RFID tag. The reader has an inbuilt antenna that emits radio waves; the tag responds by sends back its data.

### 4.3. Micro controller

Micro controller senses the signal given from switches and decides the mode of operation i.e. recharge mode or toll collection mode. It fetches data from memory location and sends it to output devices like display, motor driver and buzzer. At the same time it can accept data from Keypad for recharging options and from IR receiver to sense that vehicle has passed from toll collection booth.

### 4.4. Liquid crystal Display

It consists of Liquid Crystal display (LCD).The display is various messages like valid card, invalid card, access allowed, manual access etc. It’s a 16x2 alphanumeric display.

### 4.5. IR Receiver

IR receiver is used to sense that vehicle has passed the toll collection booth. The other alternative for infrared trans-receiver is optical sensor.

### 4.6. IR Transmitter

IR LED is used as IR transmitter. Transmitter will be placed at the one side of the booth while receiver is at the other side. When the vehicle passes through the booth, IR rays going to receiver are cut and signal is send to microcontroller.

#### 4.7. Motor Driver

Microcontroller output is 5 volts and DC motor requires 12 volts supply. Motor driver IC is used to convert 5v to 12v, which is required to drive the motor.

#### 4.8. DC Motor

DC Motor is used to open the Gate barrier. This will be done when user has successfully performed operation with sufficient balance.

#### 4.9. Buzzer

Buzzer will be turned on when invalid access is performed.

#### 4.10. GSM

GSM modem is used to send the message to the authorised user.

#### 4.11. Personel Computer

It is used to maintain the database of the users.

### 5. Structure and Design

Database plays a very important role. Database system is divided into mainly three parts:

- Database Admin
- Centralized database
- Integrated database.

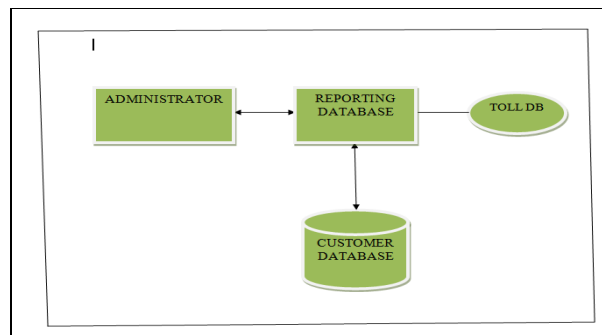


Figure 2: database Structure

The central database is the heart of the whole database system. Firstly admin database contains details of central database administrator and also the details of all toll booths under Construction Company. Centralized database consist record of all tollbooths under that specific construction company. This central database will be managed by a central administrator. The customer has to be registered for this account to use this system. This account information is stored along with the RTO database. When the registered customer will pass through the specified toll booths them automatically toll-charge will deducted from customer's account. And Central database will update with this information at a same time. Integrated database connected to the central database of the system. Integrated database consist RTO database. This database will update automatically. RTO database includes all registered vehicles with details like vehicle owner, vehicle number, licence number, account ID, account balance, current charges, etc. Get vehicle information from RTO at customer account registration time and when vehicles tag is detected the related database will match with customer database if the tag is valid and then automatically charges deducted from customers account all these records are maintained at corresponding toll-booth and central database of toll construction Company. These records can be seen by account ID, Customers name or number of the vehicle. All toll-booths records stored at central server and these records could be seen and printed by day, date, month, and year.

5.1. Database Design

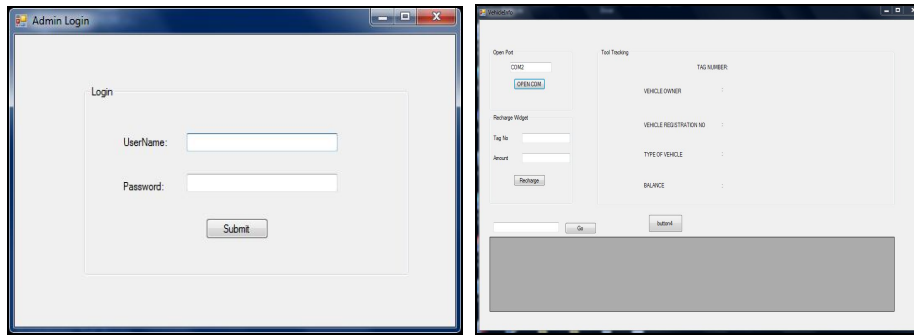


Figure 3: initial administrator login Figure 4: design of initial database of user

6. Working Principle

The automatic electronic toll collection works like this. Consumers use an electronic “tag” (transponder) about the size of an audio tape cassette which is attached to a vehicle ,as an equipped vehicle approaches a toll line, an antenna(RFID reader) in the lane reads the consumer’s vehicle and account information embedded in the tag. Using high frequency radio waves, the technology sends the information to a microcontroller that checks the data against a database of valid tags and active accounts, deducts the appropriate toll from the customer’s account, and approves passage or raises a tollgate to allow the vehicle to pass through the toll plaza with confirmation message to the user. In case of invalid tag or insufficient balance or no card it would send the signal to switch on the buzzer so that the staff person will approach and take necessity action and a switch is provided to manually lift the barrier. The system will be based on Radio Frequency Identification Technology. Every vehicle owner should purchase an RFID tag and that will be stuck on the vehicle. Now whenever the vehicle passes the lane of the toll booth across the country, the system will identify the vehicles and charge the appropriate toll which will be debited from the prescribed prepaid account.

Algorithm of functionality Input: Vehicle approach vehicle Detection (RFID tag) If vehicle is detected, search out related parameters in database. If it exist in then update the amount and give the signal to lift the barrier If it does not exist then alert by buzzer In both the cases send a message to the user. If the balance is not equal to or greater than the toll tax amount then also give Signal to buzzer. Here embedded c programming is used.

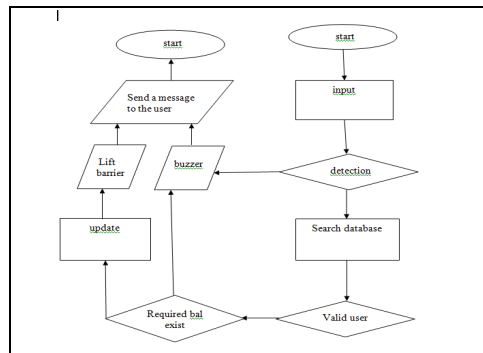


Figure 5

6.2.1. Advantages

RFID technology can dramatically decrease vehicle queuing at automobile toll plazas, speed throughput, and significantly improve the quality of life for commuters and communities

Electronic toll collection transactions can occur under normal highway driving conditions. Open road tolling eliminates plaza barriers and creates a new toll road design that mitigates & communities.

Open road tolling gives toll authorities the flexibility to set variable pricing for toll services. Pricing types include premiums or discounts based on the time of day and congestion level.

Scope and applications

Only the imagination can limit the applications of the above proposed system.

- Automated Vehicle Identification
- Automated Vehicle Classification
- Transaction Processing (Toll Calculation)
- Can be used to trace the vehicle if this system is centralized.

7. Conclusion

RFID offers highly reliable data collection in harsh environments. RFID technology can provide new capabilities as well as an efficient method to collect, manage, disseminate, store, and analyse information. It not only eliminates manual data entry but also

inspires new automation solutions. It fundamentally changes how processes are managed and how businesses operate. RFID's attributes provide greater automated tracking capability than existing technologies, and thus create the opportunity to reduce employees, improve inventory management and generate better market intelligence, leading to lower operational costs and increased revenue generation.

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