

# A novel non-payment vehicle searching method for multilane-free-flow electronic-toll-collection systems

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## Abstract

*Toll gate Automation and Vehicle Tracking is designed to automatically keep track of the vehicle's movement, record the time and the details like Owner's name, date of registration, vehicle model etc. This system is very useful for automatic vehicle tracking, time management and also for automation of Toll gate. This paper explains the implementation of Toll Gate Automation which is a step towards improving the Tracking & monitoring of vehicles, traveling in predetermined routes. In this system, a computerized system automatically identifies an approaching vehicle and records the vehicle number & Time. If the vehicle belongs to the authorized person/group, it automatically opens the Toll Gate and a predetermined amount is automatically deducted from its account.*

## Keywords-

Automation; Toll gate; Transmitter; Receiver

## 1. Introduction

With the increase in the number of vehicles onroad, the task of traffic management becomes more complex. It is hard to keep & maintain the details of the each vehicle, which is running on the road. Also in case of hit –and-run or carrying of illegal goods over inter-state cross boarder or road-robbery cases, the police may not trace the

culprits very easily, as the vehicle details are not monitored continuously. [2]. Suppose The Cargo Company wants to send a message to its On-road vehicle to stop delivering the goods to customer, policeman want to stop a vehicle which is smuggling some illegal goods or city transports want to track each buses details such as departure and arrival time on bus terminal, number of round trips it has undergone in a single day. All this is possible by the use of automated toll gates. This system is intended to help the RTO, Police Department, Public Transport and Cargo Companies to track the vehicles. This system comprises of Toll Gate office having a personal computer connected with the receiver and the software to run the “Automation of Toll Gate” system. To implement this system, every vehicle must be fitted with a remote transmitter, hidden behind the number plate of the vehicle. The transmitter continuously sends the number of vehicle on which it is mounted, in coded form.

When a vehicle enters the zone of toll office, the sensors fitted on either side of the road, sense and send the signal to the toll office control unit. This micro controller based control unit activates the number plate sensor, which in results receives the number of the entering vehicle [capturing the signal sent by vehicle's remote transmitter] and

sends it to computer. The computer scans its centralized database and displays the details of that vehicle with the current time and date. The details can be: registration number and model number with vehicle's body color, owner's name and address, date of registration, current status-clear or in black listed etc. If the vehicle records show that its current status is clear, then the gate will be opened automatically. Otherwise, the gate will not open and the vehicle owner can be called for further enquiry. This system can be used at the regional Transport Office to watch the unregistered vehicles or trace the other state vehicles. The public transport s can keep the details of each vehicle's check-in and check-out times with number of round trips it makes in a day. The police department can easily stop the wanted vehicle, by posting the vehicle's registration number on its data base. If the toll gate PC checks its data base and finds the current status as 'wanted', it does not open the gate and immediately alerts the concerned authority. This system is a step towards improving the tracking and monitoring vehicles of traveling in predetermined routes. Here, a computerized system automatically identifies an approaching vehicle and records the vehicle number and time. If the vehicle belongs to the authorized person/group, it automatically the toll gate and a predetermined amount is automatically deducted from its account. There are many benefits of Toll Gate Automation. The average service time with Epass is 2 seconds compared to 30 seconds for manual collection. This translates to reduced traffic congestion at toll plazas, lower fuel consumption, less air pollution, and therefore less economic losses.[3]. The paper is organized as follows. Section 2 explains the system architecture. Section 3 gives an overview of the system design. Section 4 explains the applications and

future development. Paper is concluded in section 5.

## 2. System architecture

### 2.1 Receiving end

This system is designed to automatically open the toll gate whenever there is registered vehicle within the Toll Gate Zone. The figure below shows the receiver end of the system.

The Rfid card transmitted by the moving vehicle is received by the Rfid receiver. The Rfid card consist of coded vehicle registration number is decoded using micro-controller IC. The micro controller. The signal must be elevated to sufficient level, such that it can be fed to the next stage without any load effect. Buffer section provides a stronger current path to the decoded signal and also to isolate the driver section and PC from the rest of the circuit. Toll Gate Motor Controller section acts as an electronic switch and drives the Gate Open/Shut Motor. When it senses the OK signal from the PC (after confirming that the vehicle has current status clear), driver section switches the motor and thus toll gate opens. The PC software recognizes the decoded vehicle registration number coming out of the buffer and starts scanning its database for the details. After fetching the details, it shows it in standard fashion on the screen for operator's knowledge. It also checks the 'Current Current Status' of the vehicle. If the vehicle is black listed by any authority, then it will be marked as 'blocked', otherwise it will be marked as 'Clear'. If the Current Status is 'blocked', then the system immediately alerts the concerned authority by sounding a siren and shuts the gate if it is open. If the current status is 'clear', then the system will order the Toll Gate Motor Controller section to open the door. All these interaction are carried out through

interface circuit, which sits next to the PC's port.

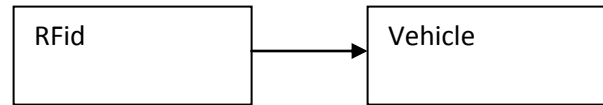
### 2.2. Transmitting End

Rfid chip is the heart of the rf transmitter, as it contains the vehicle's registration number. Every RF transmitter fitted besides the number plate, is implanted with one RF ID chip which stores the vehicle's registration number. This output is further encoded for security reason. After the encoding, the RC-5 encoded signal is fed to the multiplexer, which in result sends the encoded signal to the modulator for frequency modulation to prepare the signal for transmission. Every vehicle which moves on the road has this RF transmitter besides its number plate. This transmitter continuously transmits the radio frequency signal towards its moving .

### 2.3. Toll Gate Control Room Unit

The figure below show the block diagram of vehicle's transmitter. The remote control receiver fitted outside the control unit senses and accepts the signal transmitted by the remote control transmitter and sends these signals to the computer placed inside the control room for getting the full details of the vehicle, such as owner's name, registration number, type of vehicle, model etc. The remote control transmitter transmits different combination of pulses(code word) to the receiver using Pulse Code Modulation. Different set of transmitters use different combinations of this code word. This makes vehicle a secured transmitter, which can transmit only its registration number and not any other vehicle's. The pulse code word is generated by the remote control transmitter IC. In this IC, each transmitted code word is assumed to be made of 12 binary digits. Out of these 12 bits, 4 bits are address bits and 6 bits are command bits. The transmitted code word is received by the control room receiver and

after receiving the signal, receiver will check if the transmitted address in the code word matches the address of the receiver. If the address in the code word matches the address of the receiver, the receiver will accept the command word.



## 3. Overview of the system design

### 3.1. Hardware

Every vehicle bears the RF transmitter on the side of the number plate. The RF transmitter continuously sends the RF rays towards the receiver. Whenever vehicle enters the toll gate zone, RF receiver immediately sends the signal to the Toll Gate Control Unit. The Toll Gate Control Room Unit consists of two parts: Input Stage and Output Stage. The input stage provides the decoded RF signals to the computer, which contains the registration number of that vehicle. It is basically an RF receiver & decoder, 8-channel Amplifier and driver. The output stage gets the Toll Gate motor's control commands(Gate Open and Gate Close) from the computer and it alerts the authority about the presence of the vehicle by alarming the siren. The Toll Gate Motor Control section receives three commands from the computer; first to 'Open Gate' and second is to 'Close Gate'. There is a time delay between the two commands, as the vehicle to pass through the Toll gate. The last command signal is to alarm the authority and preventing the black listed vehicle to pass through the gate.

### 3.2. Software

The software has been developed to track the vehicle information with the help of the hardware provided. The hardware consists of sensor and emitter. Sensor is used to sense the RF rays. Emitter device emits unique frequency RF rays and is attached with vehicle. Whenever RF ray is in the

sensor range, it senses the rays and the signals are manipulated and information of the vehicle is updated.

#### 4. Applications and future developments

This system can be use to keep track of certain important details of the vehicle such as time of

arrival and departure of the vehicle, number of round trips each vehicle has made, the route taken between source and destination and can be used to trace the stolen vehicle.

##### 4.1. Future developments

- This can be extended to handle more number of vehicles, as the number of registered users may increase.
- The present set up in most countries is that, only one vehicle passes the toll gate at a given time and the vehicles enter the toll gate in a queue. Sophisticated setup can be built where in two or more vehicles can enter a toll gate at a time and still the system recognizes the valid users and differentiates the vehicles which are entering the toll gate parallelly. This increases the complexity of the entire system but at the same time increases the traffic handling capacity and saves time.
- The ID of the vehicle can be made more sophisticated to increase the security and reducing the risk of tampering.
- The registered user can use a pre-paid or post paid account by using a smart card. He/she can insert the card into the card reader placed on the dash board of the vehicle so that it can communicate with the IR interface at the toll gate. The system identifies the registered vehicle from the user information stored on the smart card and if he is a valid user, then the gate will automatically open and a pre-determined amount will be deducted from the account. Once the amount gets emptied, the user can always deposit the money and keep the account active.
- A facility can be introduced wherein the vehicle owner can pay the 'toll fee' through

his credit card by mentioning in the application form. Whenever the vehicle owner comes across a toll gate, the system detects the vehicle and charges the fee to his credit card and allows him to pass the gate without interrupting him. This would make the owner save his time and energy.

- The toll operators collect money only from the un-registered users and hence the amount of liquid cash collected in the toll gate is lesser. This reduces the risk of loosing more money in case of theft of the toll collecting office on the highway.
- GPS receivers can be used to get the current geographical position of the vehicles. Various sensors can be used to monitor critical parameters like engine oil level, temperature level etc.

#### 5. Conclusion

In this paper an overview of “Automation of Toll Gate and Vehicle Tracking” using microcontroller and IR communication has been presented. By adapting this technology, various applications like Traffic Management Process, Vehicle Movement Tracking and Stolen Vehicle Detection could be implemented. Using model based approach, this could be implemented and tested using MATLAB and Simulink.

#### 6. References

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