AUTOMATIC TOLL GATE SYSTEM USING RFID & GSM TECHNOLOGY

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ABSTRACT

Automated toll gate system using Radio Frequency Identification emerges as a converging technology where time and efficiency are the matter of priority in toll collection systems of present day. In order to overcome the major issue of collision, in our project the reader is placed on the road, and the tag is placed beneath the vehicle. The object detection sensor which is placed on the side of the road detects the approach of the oncoming vehicle. Thus the reader reads the information in the tag and the transaction takes place through a centralized data base and the aftermath details of the transaction is intimated to the user’s mobile through GSM technology.

1. INTRODUCTION

Nowadays in this world all are very busy with their tight schedules. Men have no time to spare. The collection of tolls on toll plaza is a time consuming process due to traffic congestion and it causes inconvenience to the public. Thus we have thought of automatic toll collection system. Here the priority is for time and efficiency. The need for manual toll based system is completely reduced in this method and the tolling system works through RFID technology. Here the vehicle need not to be stop on the toll gate, the amount is collected from the user’s account from a tag in the vehicle using RFID technology and the transaction details will be send to the user’s mobile through GSM technology.

Need for automatic toll gate

Any structure, building or system needs maintenance and rehabilitation, which are of course costly. Highways and roads are also not an exception. From the very past, the construction, extension, maintenance and operating costs of highways, roads, bridges and tunnels were collected directly or indirectly. In the old indirect method the expenses are compensated either by tax payment for fuel or by budget allocation of the national income. The shortcoming of this method is that a number of tax payers, who do not use any of the roads and carriageways, have to pay extra money. However, in other system, called direct method, the tolls are taken directly from the drivers passing that road or street. The other three main reasons why tolling, or road pricing, is implemented are listed below.

- **Finance/Revenue generation:** To recoup the costs of building, operating and maintaining the facility. Road pricing is becoming a more appealing means of funding transportation. Moreover, toll financing allows projects to be built sooner instead of waiting for tax revenues to accumulate.

- **Demand management:** To moderate the growth in demand on the transportation and carpooling. For example, vehicles are charged to enter inner London, England, as a way of regulating the demand in the region.

- **Congestion management:** To place a price on limited roadway space in proportion to demand. In this application the toll increases with the level of congestion. In the absence of such pricing, drivers do not appreciate
the costs they impose on others as a result of the congestion they cause.

2. LITERATURE SURVEY

Conducting literature survey prior to begin a research project is vital in understanding a automatic toll collection system, as this will supply the researcher with much needed additional information on the methodologies and technologies available and used by other research counterparts around the world. This chapter provides a condensed summary of literature reviews on key topics related to automatic toll collection systems and the comparison between the present project and the related topics of the existing information will also be discussed.

Automatic toll collection system using RFID [1]

According to Aniruddha Kumawat and Kshithija Chandramore ATCSR is an Automated Toll Collection System using RFID used for collecting tax automatically. In this we do the identification with the help of radio frequency. A vehicle will hold an RFID tag. This tag is nothing but unique identification number assigned. This will be assigned by RTO or traffic governing authority. In accordance with this number we will store, all basic information as well as the amount he has paid in advance for the TOLL Collection. Reader will be strategically placed at toll collection center. Whenever the vehicle passes the toll booth, the tax amount will be deducted from his prepaid balance. New balance will be updated. Incase if one has insufficient balance, his updated balance will be negative one. To tackle this problem, we have camera on the way to capture the image of respective vehicle. As vehicles don't have to stop in a queue, this translates to reduce. Traffic congestion at toll plazas and helps in lower fuel consumption. This is very important advantage of this system.

Electronic toll collection system using passive RFID technology [2]

According to Khadijah Kamarulazizi and Widad Ismail, this paper focuses on an electronic toll collection (ETC) system using radio frequency identification (RFID) technology. Research on ETC has been around since 1992, during which RFID tags began to be widely used in vehicles to automate toll processes [1]. The proposed RFID system uses tags that are mounted on the windshields of vehicles, through which information embedded on the tags are read by RFID readers; The proposed system 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.

With reference to Journal of Theoretical and Applied Information Technology the study regarding the previously existing techniques such as using Optical Camera Recognition, Microwave Technology, RFID technology (active), GPS proved to be inefficient in some ways and these are discussed below. When taken into consideration the optical camera recognition since the whole object will be captured it is a time consuming process and also the error rectification in the laser cameras is very difficult. Seeing through the Micro technology it requires different transponders and also it tends to produce various problems regarding reflection.

The ETC system in Malaysia has been introduced in the year 1994. It has evolved since then, and many changes have been done. The most recent ETC system consists of the Touch NGO and Smart TAG, referred to as the single ETC system in the country. This system uses IR technology, making it very vulnerable to failure. Other than that, users also have to bear the high cost of owning the two-piece tag required for this system. Thus, Malaysian highway authorities have been looking for alternatives, such as the multi-lane free-flow (MLFF) ETC system. However, this proposed system requires major changes in the infrastructure of the existing toll roads. In contrast, the ETC system proposed in this paper will require only minimal changes. Moreover, the existing toll booths could be re-used with only slight modifications.

Automatic Toll Gate System Using Advanced RFID and GSM Technology [3]

According to S.Nandhini, P.Premkumar, most Electronic Toll Collection (ETC) systems around the world are implemented by DSRC (Dedicated Short Range Communication) technology. The concept proposed is of automatic toll tax payment system and the amount transaction information sends to the cell phone of the motorists through the GSM modem technology. It is an innovative technology for expressway network automatic toll collection solution. In this paper, the frame composing and working flow of the system is described and data information is also easily exchanged between the motorists and toll authorities, thereby enabling a more efficient toll collection by reducing traffic and eliminating possible human errors.

3. DESIGN OVERVIEW

![Fig 3. Block Diagram](image-url)
A block diagram depicts the total blue print of the proposed project. The total essence and functioning of the project is represented in a single block diagram, it depicts the pictorial representation of working of a project. Block diagram is something which gives the overview of a project.

The block diagram consists of the following components:
- Microcontroller
- Sensor
- RFID Reader
- GSM
- LCD Display
- Motor

**Microcontroller**

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industrystandard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

**GSM**

GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile), is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second-generation (2G) digital cellular networks used by mobile phones. GSM supports voice calls and data transfer speeds of up to 9.6 kbps, together with the transmission of SMS (Short Message Service). GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

Since many GSM network operators have roaming agreements with foreign operators, users can often continue to use their mobile phones when they travel to other countries. SIM cards (Subscriber Identity Module) holding home network access configurations may be switched to those will metered local access, significantly reducing roaming costs while experiencing no reductions in service.

GSM, together with other technologies, is part of the evolution of wireless mobile telecommunications that includes High-Speed Circuit-Switched Data (HSCSD), General Packet Radio System (GPRS), Enhanced Data GSM Environment (EDGE), and Universal Mobile Telecommunications Service (UMTS).

Using TDMA, a narrow band that is 30 kHz wide and 6.7 milliseconds long is split time-wise into three time slots. Narrow band means channels in the traditional sense. Each conversation gets the radio for one-third of the time. This is possible because voice data that has been converted to digital information is compressed so that it takes up significantly less transmission space. Therefore, TDMA has three times the capacity of an analog system using the same number of channels. TDMA is the access method used by GSM.

GSM systems provide a number of useful features:
- Uses encryption to make phone calls more secure
- Data networking
- Group III facsimile services
- Short Message Service (SMS) for text messages and paging
- Call forwarding
- Caller ID
- Call waiting
- Multi-party conferencing

**SIM 300**

This is a plug and play GSM Modem with a simple to interface serial interface. Use it to send SMS, make and receive calls, and do other GSM operations by controlling it through simple AT commands from micro controllers and computers. It uses the highly popular SIM300 module for all its operations. It comes with a standard RS232 interface which can be used to easily interface the modem to micro controllers and computers. The modem consists of all the required external circuitry required to start experimenting with the SIM 300 module like the power regulation, external antenna, SIM holder etc.

**Features**
- Uses the extremely popular SIM300 GSM module
- Provides the industry standard serial RS232 interface for easy connection to computers and other devices
- Provides serial TTL interface for easy and direct interface to microcontrollers
- Power, RING and Network LEDs for easy debugging
- Onboard 3V Lithium Battery holder with appropriate circuitry for providing backup for the modules’ internal RTC
- Can be used for GSM based Voice communications, Data/Fax, SMS, GPRS and TCP/IP stack
- Can be controlled through standard AT commands
- Comes with an onboard wire antenna for better reception.
- Board provides an option for adding an external antenna through an SMA connector
- The SIM300 allows an adjustable serial baud rate from 1200 to 115200 bps (9600 default)
- Modem a low power consumption of 0.25 A during normal operations and around 1 A during transmission

**RFID**

RFID stands for **Radio-Frequency IDentification.** The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card; it provides a unique identifier for that object. And, just as a bar code or magnetic strip must be scanned to get the information, the RFID device must be scanned to retrieve the identifying information. An RFID reader’s function is to interrogate RFID tags. The means of interrogation is wireless and because the distance is relatively short; line of sight between the reader and tags is not necessary. A reader contains an RF module, which acts as both a transmitter and receiver of radio frequency signals. The transmitter consists of an oscillator to create the carrier frequency; a modulator to impinge data commands upon this carrier signal and an amplifier to boost the signal enough to awaken the tag. The receiver has a demodulator to extract the returned data and also contains an amplifier to strengthen the signal for processing. An RFID reader, also known as an interrogator, is a device that provides the connection between the tag data and the enterprise system software that needs the information. The reader communicates with tags that are within its field of operation, performing any number of tasks including simple continuous inventorying, filtering (searching for tags that meet certain criteria), writing (or encoding) to select tags, etc.

**Fig 5. RFID**

The reader uses an attached antenna to capture data from tags. It then passes the data to a computer for processing. Just like RFID tags, there are many different sizes and types of RFID readers. Readers can be affixed in a stationary position in a store or factory, or integrated into a mobile device such as a portable, handheld scanner. Readers can also be embedded in electronic equipment or devices, and in vehicles.

**EM18 RFID Reader**

This module directly connects to any microcontroller UART or through a RS232 converter to PC. It gives UART/Wiegand26 output. This RFID Reader Module works with any 125 KHz RFID tags.

**Fig 6. RFID Reader**

**Specifications:**

- 5VDC through USB (External 5V supply will boost range of the module)
- Current: <50mA
- Operating Frequency: 125Khz
- Read Distance: 10cm
- Size of RFID reader module: 32mm(length) * 32mm(width) * 8mm(height)

**LCD**

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor...
position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

**DC Motor**

An electric motor is a machine which converts electrical energy into mechanical energy. DC motor works on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force. DC shunt motors can be used where almost constant speed is required and very high starting torque is not required as lathe, machine tools, centrifugal pump and etc. Series motors are used when very high starting torque is required such as electric traction, trolley car, crane, etc. Cumulative compound motors are suitable for applications where the load fluctuates such as rolling mills, printing press, reciprocating type compressors, crusher units, etc. Differential compound motors are rarely used because of their poor torque characteristics.

**L293D IC**

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

Vcc is the voltage that it needs for its own internal operation 5V; L293D will not use this voltage for driving the motor. For driving the motors it has a separate provision to provide motor supply Vss (V supply). L293D will use this to drive the motor. It means if you want to operate a motor at 9V then you need to provide a supply of 9V across Vss Motor supply.

Vcc pin 16 is the voltage for its own internal operation. The maximum voltage ranges from 5V and up to 36V.

The maximum voltage for Vss motor supply is 36V. It can supply a max current of 600mA per channel. Since it can drive motors up to 36V hence you can drive pretty big motors with this L293D.

**Pin Description:**

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Function</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enable pin for Motor 1; active high</td>
<td>Enable 1,2</td>
</tr>
<tr>
<td>2</td>
<td>Input 1 for Motor 1</td>
<td>Input 1</td>
</tr>
<tr>
<td>3</td>
<td>Output 1 for Motor 1</td>
<td>Output 1</td>
</tr>
<tr>
<td>4</td>
<td>Ground (0V)</td>
<td>Ground</td>
</tr>
<tr>
<td>5</td>
<td>Ground (0V)</td>
<td>Ground</td>
</tr>
<tr>
<td>6</td>
<td>Output 2 for Motor 1</td>
<td>Output 2</td>
</tr>
<tr>
<td>7</td>
<td>Input 2 for Motor 1</td>
<td>Input 2</td>
</tr>
<tr>
<td>8</td>
<td>Supply voltage for Motors; 9-12V (up to 36V)</td>
<td>Vcc 2</td>
</tr>
<tr>
<td>9</td>
<td>Enable pin for Motor 2; active high</td>
<td>Enable 3,4</td>
</tr>
<tr>
<td>10</td>
<td>Input 1 for Motor 1</td>
<td>Input 3</td>
</tr>
<tr>
<td>11</td>
<td>Output 1 for Motor 1</td>
<td>Output 3</td>
</tr>
<tr>
<td>12</td>
<td>Ground (0V)</td>
<td>Ground</td>
</tr>
<tr>
<td>13</td>
<td>Ground (0V)</td>
<td>Ground</td>
</tr>
<tr>
<td>14</td>
<td>Output 2 for Motor 1</td>
<td>Output 4</td>
</tr>
<tr>
<td>15</td>
<td>Input 2 for Motor 1</td>
<td>Input 4</td>
</tr>
<tr>
<td>16</td>
<td>Supply voltage; 5V (up to 36V)</td>
<td>Vcc 1</td>
</tr>
</tbody>
</table>

There are 4 input pins for this L293D, pin 2, 7 on the left and pin 15, 10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or...
LOGIC 1: Let's consider a Motor connected on left side output pins (pin 3, 6). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

- Pin 2 = Logic 1 and Pin 7 = Logic 0 | Clockwise Direction
- Pin 2 = Logic 0 and Pin 7 = Logic 1 | Anticlockwise Direction
- Pin 2 = Logic 0 and Pin 7 = Logic 0 | Idle [No rotation] [Hi-impedance state]
- Pin 2 = Logic 1 and Pin 7 = Logic 1 | Idle [No rotation]

In a very similar way the motor can also operate across input pin 15, 10 for motor on the right hand side.

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC).

Sensor

An infrared detector is a detector that reacts to infrared radiation. An infrared sensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. Usually it is used for collision detection or obstacle detection.

![IR Sensor](image)

**Fig 8. IR Sensor**

The module consists of an IR transmitter and IR receiver pair. The LED is used as transmitter and photo diode is used as receiver. The IR pairs are placed parallel to each other. The output of the receiver is given to a 358 comparator which compares and given input and the reference input and gives information to the microcontroller.

Infrared sensors are broadly classified into two main types:

- Thermal infrared sensors – use infrared energy as heat. Their photo sensitivity is independent of the wavelength being detected. Thermal detectors do not require cooling but do have slow response times and low detection capabilities.

- **Quantum infrared sensors** – provide higher detection performance and faster response speed. Their photo sensitivity is dependent on wavelength. Quantum detectors have to be cooled in order to obtain accurate measurements.

**Flow chart**

Infrared sensor

RFID reader reads the information on the tag

If valid information, vehicle proceeds

If invalid information, vehicle stops

Clear info manually

Send data to microcontroller

Display data on LCD

Send info to user’s mobile

4. PROJECT OUTCOME

![Automatic Toll Collection System Using RFID & GSM Technology](image)

**Fig 9. Automatic Toll Collection System Using RFID & GSM Technology**

Here, when a vehicle comes the IR sensor gives the information to the microcontroller and the RFID reader reads the information on the tag in the vehicle. Microcontroller processes it and the transaction takes place. The details will be displayed on the LCD as well as it is send to the user’s mobile.

When person enters the toll plaza with an invalid card, with a card having no balance or without any card the
microcontroller intimates the motor to close the gate. By this way we can control the trespassing in the toll plaza.

By introducing this method we can avoid the inconveniences experiencing in the toll plaza and we can also have a more convenient and new generation toll plazas.

5. CONCLUSION

We had introduced the automatic toll gate system controlled by ATMEGA microcontroller i.e. AT89S52. It is a 40 pin IC having the property of burning a program while running another program. It is reliable, flexible and of low cost.

By practically implementing ‘Automatic Toll Gate System using RFID& GSM Technology’ we can provide a convenient transportation for the public i.e. we can avoid traffic congestion. It is the most efficient way of toll collection which can reduce the manual effort at toll plaza. We are avoiding the emergency vehicles such as ambulance, fire force etc. from the toll collection. In this busy world we give preference for time and efficiency, so for fulfilling this we can implement this kind of toll collection system.

6. FUTURE SCOPE

Designed a system to give complete solution for traffic and transport related problems such as Toll gate control, traffic signal control, traffic rules violation control, parking

Management and special zone alert using the latest RFID technology. It is proposed as a low cost optimized solution using RFID and GSM mobile technology. At the toll plaza, there will be a large LCD screen for displaying details of the transaction.

At the same time, it will show:

1. Total cost of that road
2. The duration of toll plaza.
3. And the remaining balances after each transaction
4. Embedded System can design for easy to Pay Toll Fees Using RFID and Alcohol sensor to Prevent Accidents on the Highways.
5. Implementation of image processing for centralizes data recording: In our present concept we are only using the RFID system for vehicle detection. So we can extend the scope of this concept in other way for centralize data recording. For that purpose we can use the IR courting at the entry gate which is followed by the Camera which will be continue sly capturing the images of the vehicles entering into the toll plaza. And the third step the RFID is collecting the vehicle number. Now when the vehicle passes through the IR courting it tresses the outline of the vehicle, in the next step the camera will take the image of the vehicle & followed by the RFID to record the data related to the vehicle. The load cell weighs the vehicle & classifies it into two categories as light & heavy vehicle respectively. The whole data collected together & sent to the centralize server which will store it for stipulated time. This application will help in detecting the vehicles in the crime cases like terrorism & smuggling of goods & it will also reduce the load on check posts.

6. Automatic control using RFID system for toll collection powered by compound power generation from speed breakers and solar cells with GSM technology: a compound electricity generation system using speed breakers and solar cells to power the whole automated system and it does not consume electricity from the power utility companies hence there is no transmission & distribution losses.

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