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Electronic Toll Tax Collection and Security System

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***Abstract*— The main focus is on using radio frequency identification technology for collecting toll taxes. The proposed RFID system uses active tags (registered cards) that are mounted on the windshields of vehicles, through which information embedded on the tags are read by RFID readers. Data information (toll debts, balance etc) 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. When vehicle is stolen the owner complains with its registered card number and the vehicle is blacklisted in the database to be able to identify by the e-toll system.**

***Index Terms*— Toll tax, TFID, Toll tax collection.**

I. Introduction

Electronic toll collection (ETC) is a technology enabling the automatic 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 car is registered or not, and then informing the authorities as well as the motorists of toll payment violations, debits, and participating accounts. The benefits for the motorists include:

1. Fewer or shorter queues at toll plazas by increasing toll booth service speed.
2. Faster and more efficient service (no exchanging toll fees by hand);
3. The ability to make payments by keeping a balance on the registered card itself.
4. Fuel saving, reduced mobile emissions.
5. Toll debit and pertaining information via SMS alert.

For the toll operators, the benefits include:

5. Monitoring toll data (vehicles crossing the tollbooth) on a PC.
6. Better audit control by centralized user accounts; and
7. Expanded capacity without building more infrastructures.

II. LITERATURE SURVEY

In the recent past, researchers have tested a wide array of technologies in an attempt to find improvedmethods of monitoring traffic conditions. This research in traffic surveillance has ranged from studies oftraditional loop detection methods to the use of anti-submarine warfare technology. AVI comprises oneof but many of the areas of current research. A brief survey of technologies explored during the pastdecade and a half is given below to provide an understanding of the level of research interest in traffic surveillance technologies.

Bohnke and Pfannerstill acknowledged a need for more reliable traffic data acquisition than localizeddata collection generated by traditional loop detectors (1986). The pair introduced a pattern recognitionalgorithm which could utilize unique vehicle presence signatures generated by successive series ofinductance loop detectors. By identifying and re-identifying platoons of vehicles traveling across linksbounded by loop detection equipment, vehicle travel times could be obtained.Ju and Maze performed simulations on incident detection strategies using the FREQ8PE simulationmodel (1989). Their research evaluated a comparison of incident detection strategies using police patrolversus the use of motorist call boxes at 1 km spacing. The motorist call boxes formed the backbone ofthe modeled freeway surveillance and control system (FSCS). This FSCS yielded a benefit-to-cost ratioof 2.69 as it generated benefits from travel-time reduction and reduced fuel consumption. These benefitswere brought about by reduced incident detection time afforded by the motorist call boxes.AT&T experimented with the use of applied acoustic and digital signal processing technology to producea vehicular traffic surveillance system (Nordwall, 1994). Labeled the SmartSonic Traffic SurveillanceSystem (SmartSonicTSS-1), the project was intended by AT&T to replace buried magnetic loop9detection systems. This technology was originally developed from research used by the U.S. Navy forsubmarine detection purposes. Mounted above passing vehicles, the SmartSonic TSS-1 listens to theacoustic signals of vehicles and is capable of distinguishing between larger trucks or buses and smallervehicles. Applications were to include traffic monitoring and vehicle counting, with the potential forincident detection being an area for further research.

Prior to the installation of an AVI system in Houston, a cellular phone demonstration project wasperformed (Levine and McCasland, 1994). Researchers recruited 200 volunteers to participate in theprogram, which required them to call a traffic information office when they passed specific freewaylocations during their morning and evening commutes. The lessons learned from the cell phone projectaided in the development of the data analysis, processing and dissemination techniques used for the AVIsystem that was later constructed. In a similar scenario, prior to installing a large-scale AVI system inthe Puget Sound area, a small-scale test of AVI was performed (Butterfield et. al., 1994). In this test,AVI was "piggy-backed" with existing loop detectors. Results yielded an AVI detection rate of about80% for a fleet of tag-equipped buses.In a 1996 report by Turner, a variety of techniques for travel time data collection were discussed, alongwith the advantages and disadvantages of each. These data collection techniques included Electronicdistance measuring instruments (DMI's), License plate matching, Cellular phone tracking, Automaticvehicle location (AVL), Automatic vehicle identification (AVI) and Video imaging. Turner specificallynoted that travel time information was of particular importance for applications including congestionmeasurement and real-time travel information.

In their discussion of video-based surveillance, Berka and Lall continue the discussion of improving uponthe use of loop detection to gather traffic data (1998). The authors claim that loop detection reliability islow, and that maintenance and repair of such a pavement-based system creates safety risks for repaircrews. Berka and Lall maintain that non-intrusive technologies such as video surveillance providesreduced traffic disruption during installation or repair. In addition, video surveillance is capable ofdetecting incidents on the sides of roadways, outside of the detection range of loop detectors.

III. BLOCK DIAGRAM

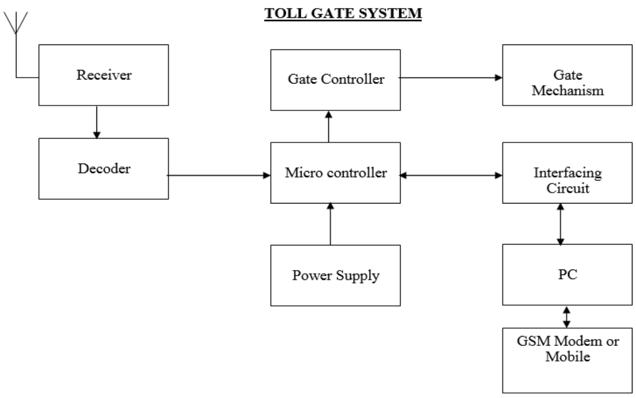


Figure 1: Block Diagram

The important blocks included in above block diagram are following

- Microcontroller LPC 2138
- RFID Tag and Reader
- Power Supply
- LCD Display(16x2)
- GSM module

IV. SYSTEM DESCRIPTION

A. Microcontroller

LPC 2138 Microcontroller(ARM7)

- Operating voltage - 3 to 3.6 v
- Operating current – 50mA
- 64 pins IC
- 16/32 modes
- 512kb flash RAM
- ISP and IAP
- Special function registers- 1)ADC
  2)I2C
  3)SPI
  4)UART
  5)Timers
- 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.
- EmbeddedICE RT and Embedded Trace interfaces offer real-time debugging with the on-chip RealMonitor software and high-speed tracing of instruction execution.
- 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 μs.
- On-chip integrated oscillator operates with external crystal in range of 1 MHz toν 30 MHz and with external oscillator up to 50 MHz.
- Power saving modes include Idle and Power-down.

B. Power Supply Circuit:

The following circuit is used for the power supply generation from mains.

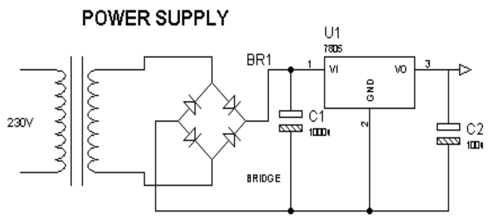


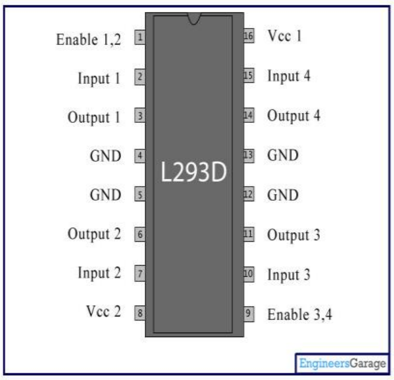
Figure 2: Power Supply

We are designing a power supply for constant 5 volts DC supply. The key component in this circuit is the regulator IC LM7805.

The step down transformer feeds the rectifier bridge with lower voltage and the rectified output is given to the regulator(IC LM7805) and the constant 5 volt output is obtained.

C. DC MOTOR DRIVER(L293D):

- *VCC=5V*
- *Voltage Requirement=3.2 V*
- *Current Reqirement=200mA*
- *Motor 0uput=pin 3,pin 6*
- *Motor Input=pin 2,pin 7*



D. RFID Tag and reader

We are using EM-18 RFID Reader Module which is having following key features:

- Serial & TTL output
- Excellent read performance without external circuit
- Compact size & cost effective

RFID Reader Module, are also called as interrogators. They convert radio waves returned from the RFID tag into a form that can be passed on to Controllers, which can make use of it. RFID tags and readers have to be tuned to the same frequency in order to communicate. RFID systems use many different frequencies.

An RFID system consists of two separate components: a tag and a reader. Tags are analogous to barcode labels, and come in different shapes and sizes. The tag contains an antenna connected to a small microchip containing up to two kilobytes of data. The reader, or scanner, functions similarly to a barcode scanner; however, while a barcode scanner uses a laser beam to scan the barcode, an RFID scanner uses electromagnetic waves. To transmit these waves, the scanner uses an antenna that transmits a signal, communicating with the tags antenna. The tags antenna receives data from the scanner and transmits its particular chip information to the scanner.

This information is fed to the microcontroller and the vehicle identification is performed.

E. LCD Display

An LCD display is used to check the status of the system working with all constraints described and hence is interfaced with the controller in the 4-bit mode.

The display used in our project is a simple 16x2 LCD display

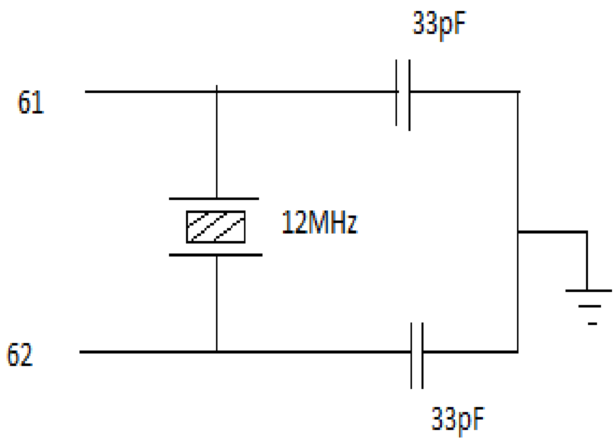
F. GSM 900 module

The GSM/GPRS module is used to establish communication between a computer and a GSM-GPRS system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher data transmission rate. GSM/GPRS module consists of a GSM/GPRS modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc) for computer. The MODEM is the soul of such modules**.**

In our project this module is interfaced with the controller through the RS 232 communication IC.

This mainly performs the task of sending the intimation messages to the owner and the security persons available in the society if any of the inappropriate action is undergone.

G. Crystal and Reset Circuit

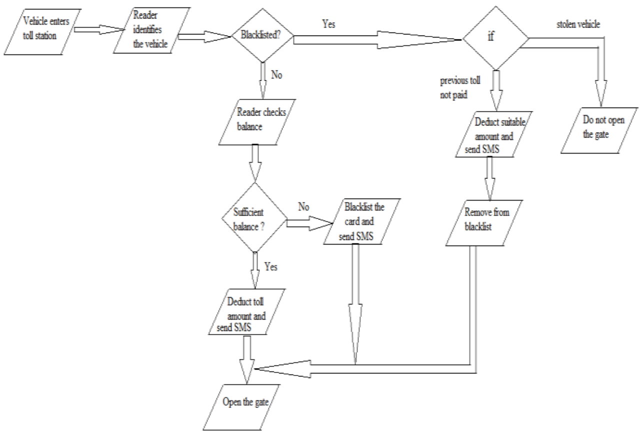


- Crystal frequency = 12MHz
- Timer frequency = crystal frequency/4 = 3MHz
- Instruction execution time = 1/3MHz = 0.3 micro seconds.
- Therefore, 0.3 u sec = 12 clock pulses = 1 machine cycle.
- T = R x C
  = 10k x 10uF = 100ms

V. WORKING OF SYSTEM:

- All motorists need to register their vehicles with the RTO authority.
- 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 (PC).
- User needs to deposit some minimum amount to this account.
- Every time a registered vehicle approaches the toll booth, the RF zone will detect the presence of the vehicle. It will in turn make the RFID circuit to read the RFID smart card (registered card) fixed on the windscreen of the vehicle. Transaction will begin, depending upon the balance available toll will be deducted directly.
- The software further updates the details in the centralized database server. It also triggers mechanism to generate the bill and send to user as a text message.
- On the other hand, whenever any vehicle owner registers a complaint to RTO regarding theft respective entry (barred or blacklist) is made in the database.
- Now any vehicle arriving at toll booth with same ID as already present in blacklist category will be easily identified as the ID assigned with it is unique.
- The centralized database is common across all toll stations. Updates of any sort of transaction (in and out time for a vehicle) will be immediately updated to local database and centralized server.
- This concept does not require any major changes in the infrastructure of the existing toll booths.

VI. ALGORITHM OF THE SYSTEM



Software Requirment:

- Keil uvision-4 for programming the microcontroller with all the interfaced devices in embedded C
- Flash magic to burn the code on the microcontroller, hyper-terminal to display the data and updates of the toll station.
- Active wave Inc - Smart key Access Control Systems have a client – server model based system with an SQL server handling multiple vehicle monitoring systems.
- They have designed a user interface using the Microsoft .NET Framework.

Hardware Requirements:

- Microcontroller **LPC2138, L293D motor driver**
- **DC motors** are used to physically drive the application as per the requirement provided in software.
- Many device today work on **MAX 232** logic such as PC, GSM modem, GPS etc. so in order to communicate with such devices we have to bring the logic levels to the 232 logic (+/-9v).
- **GSM (Global System for Mobile communications**) The **SIM300** module is a Tri-band GSM/GPRS solution in a compact plug in module featuring an industry-standard interface.

VII. FUTURE SCOPE

There can be various future modifications and additions can be done in our project such as:

- RFID is a highly stable and reliable technology. The RFID Automatic toll gate system can automatically detect the identities of the vehicles, reading items in motion and tracking of the vehicles can be done accurately using RFID.
- At first the system may seem like very costly but after a year of the system implantation high benefits will be obtained as it will lead to lower operational costs and increased revenue generation.
- It not only reduces the traffic related problems of the country but also proves to be a major technological development in the nation which is the need of the hour as different countries all over the world are becoming technically strong.

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