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Electronic Toll Tax Collection and Security System

V. U. Patel, Prashant S. Kasture, Sumedh S. Kulkarni, Sushant S. Kulkarni

Assistant Professor, Dept. of E&TC, MAEER's MIT College of Engineering, Pune, India

B.E. Student, Dept. of E&TC, MAEER's MIT College of Engineering, Pune, India

B.E. Student, Dept. of E&TC, MAEER's MIT College of Engineering, Pune, India

B.E. Student, Dept. of E&TC, MAEER's MIT College of Engineering, Pune, India

ABSTRACT: The contemporary, or the manual method of toll collection consumes a lot of time resulting in long queues and also resulting in excess fuel consumption. This paper proposes a method of implementation of automated toll system which will reduce traffic waiting time substantially. The system involves usage of RFID technology to help determine the registration of each vehicle, execute toll payments, communicate the transaction with the motorists and monitor violations and debts. The benefits of automated toll system for the motorists are:

- More efficient service, reducing queues.
- Ability to make payments via registered cards.
- Fuel savings and reduced vehicle emissions.

The benefits for the toll operators include:

- Better monitoring facility over toll transactions.
- Increased capacity making use of the existing infrastructure.
- Theft monitoring system.

The focus of this paper is also to maintain a centralized database server of the vehicles using DBMS and also to enhance communication between the motorists and toll authorities using GSM.

I.INTRODUCTION

The electronic toll collection system using passive Radio Frequency Identification (RFID) tag emerges as a convincing solution to the manual toll collection method employed at tollgates. Time and efficiency are a matter of priority of present day. In order to overcome the major issues of vehicle congestion and time consumption RFID technology is used. RFID reader fixed at tollgate frame (or even a hand held reader at manual lane, in case RFID tagged vehicle enters manual toll paying lane) reads the tag attached to windshield of vehicle. The object detection sensor in the reader detects the approach of the incoming vehicles' tag and toll deduction takes place through a prepaid card assigned to the concerned RFID tag that belongs to the owners' account. This makes tollgate transaction more convenient for the public use.

The main idea behind implementing RFID based toll collection system is to automate the toll collection process their by reducing the long queues at toll booths using the RFID tags installed on the vehicle. In addition to this, it can not only help in vehicle theft detection but also can track vehicles crossing the signal and over speeding vehicles. This system is used by vehicle owners, system administrator. Pertinent information can be stored in small RF tags (registered cards) and the system can also work in harsh environment. If a person reports a complaint of his/her stolen vehicle, then the centralized database server would help in identifying the vehicle whenever it crosses any toll station.

II.RELATED WORK

In the recent past, researchers have tested a wide array of technologies in an attempt to find improved methods of monitoring traffic conditions. This research in traffic surveillance has ranged from studies of traditional loop detection

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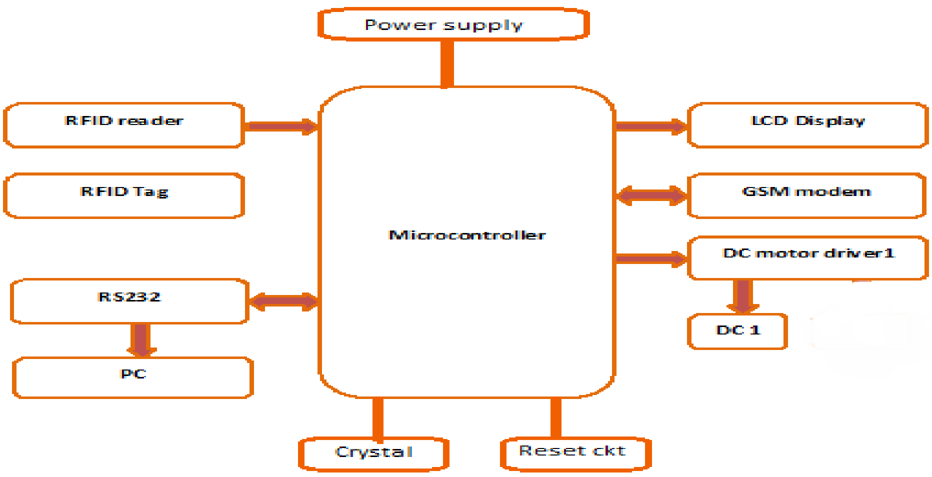
methods to the use of anti-submarine warfare technology. AVI comprises one of but many of the areas of current research. A brief survey of technologies explored during the past decade and a half is given below to provide an understanding of the level of research interest in traffic surveillance technologies.

Bohnke and Pfannerstill acknowledged a need for more reliable traffic data acquisition than localized data collection generated by traditional loop detectors (1986). The pair introduced a pattern recognition algorithm which could utilize unique vehicle presence signatures generated by successive series of inductance loop detectors. By identifying and reidentifying platoons of vehicles traveling across links bounded by loop detection equipment, vehicle travel times could be obtained. Ju and Maze performed simulations on incident detection strategies using the FREQ8PE simulation model (1989). Their research evaluated a comparison of incident detection strategies using police patrol versus the use of motorist call boxes at 1 km spacing. The motorist call boxes formed the backbone of the modeled freeway surveillance and control system (FSCS). This FSCS yielded a benefit-to-cost ratio of 2.69 as it generated benefits from travel-time reduction and reduced fuel consumption. These benefits were 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 produce a vehicular traffic surveillance system (Nordwall, 1994). Labeled the SmartSonic Traffic Surveillance System (SmartSonic TSS-1), the project was intended by AT&T to replace buried magnetic loop 9 detection systems. This technology was originally developed from research used by the U.S. Navy for submarine detection purposes. Mounted above passing vehicles, the SmartSonic TSS-1 listens to the acoustic signals of vehicles and is capable of distinguishing between larger trucks or buses and smaller vehicles. Applications were to include traffic monitoring and vehicle counting, with the potential for incident detection being an area for further research.

III.PROPOSED ALGORITHM

A. *Block Diagram*



B. *Description of block diagram*

The microcontroller is to be interfaced with devices as such RF decoder/reader, LCD, Computer, DC motors, GSM module SIM900 can be directly interfaced to the microcontroller or can be connected to the computer itself. It is essential to use MAX232 IC to establish serial communication protocol between the microcontroller and the desktop. DC motors would to be used to operate the gate terminals at the toll station. The PC at the toll station is to be used to feed in data to the centralized database such as in/out time of the vehicles passing the toll station, blacklist vehicles (for theft identification) etcetera. Any standard language such as C# could be used to maintain the database.
The 8051 microcontroller requires 5V power supply whereas the ARM7 series and above requires 3.3V of power supply. It is thus imperative to design a 3.3 V power supply circuit.

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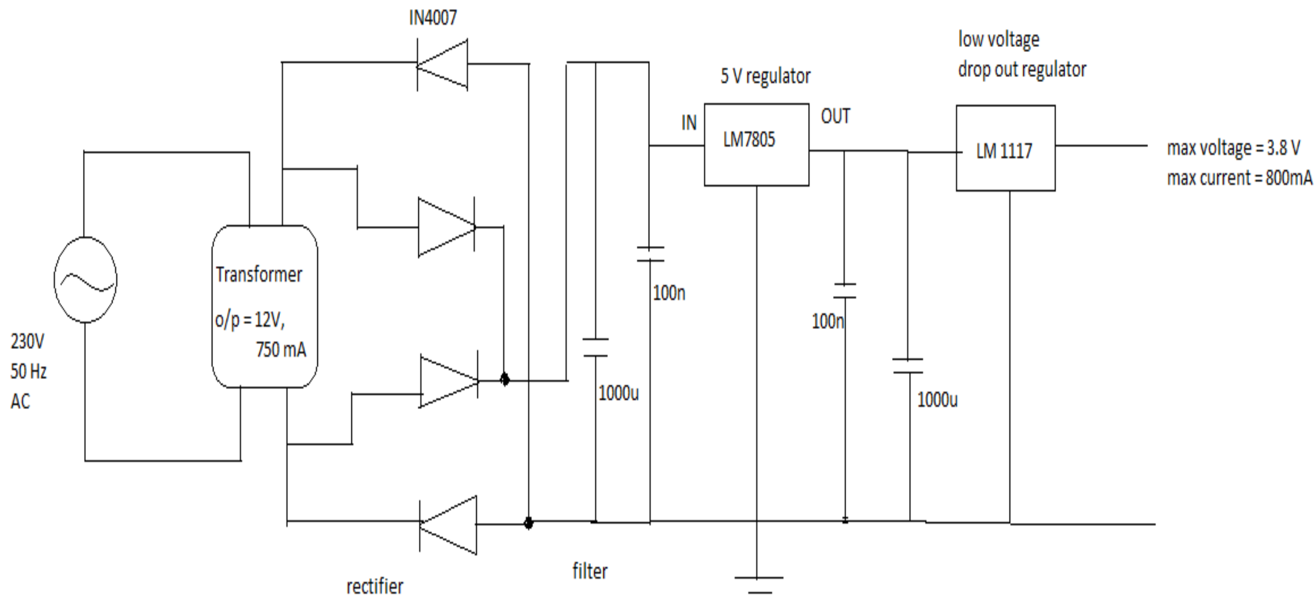
C. *Power supply*

Appropriate power supply is to be provided to the microcontroller in order to ensure that the current to the components directly interfaced with the microcontroller does not fall short. The current consumption table is shown:

LPC2138 uC	50 mA
LCD	110 mA
MAX232	50 mA
L293D	150 mA

Including the current requirement of the RF reader, the total current requirement is approximately 500 mA. Thus, a power supply giving output current up to 750 mA is designed to ensure that the current never falls short in any component. The linear power supply consists of transformer, rectifier, filter capacitor, voltage regulator and low voltage drop out regulator.

A linear regulated 3.3V power supply is designed and shown below:



D. *Use of RFID technology*

Each motor vehicle is to be allotted a unique RF tag/card with specific information to be installed on the windshield of the vehicle. It is better to use RF readers having a reasonable reading range and using Wiegand protocol of data transmission. The particular data to be stored on the RF tag of a single vehicle is:

1. Name of the motorist
2. Name of the vehicle
3. LMV/HMV
4. Balance in rupees.
5. Contact number.

Since the data stored on an RF tag is in the form of bits and a standard RF tag is able to store approximately 2K bits of information the above requirement is safely sufficed. Depending on the vehicle type (light/heavy motor) appropriate amount would be deducted from the rechargeable RF tag and the transaction would be communicated through GSM.

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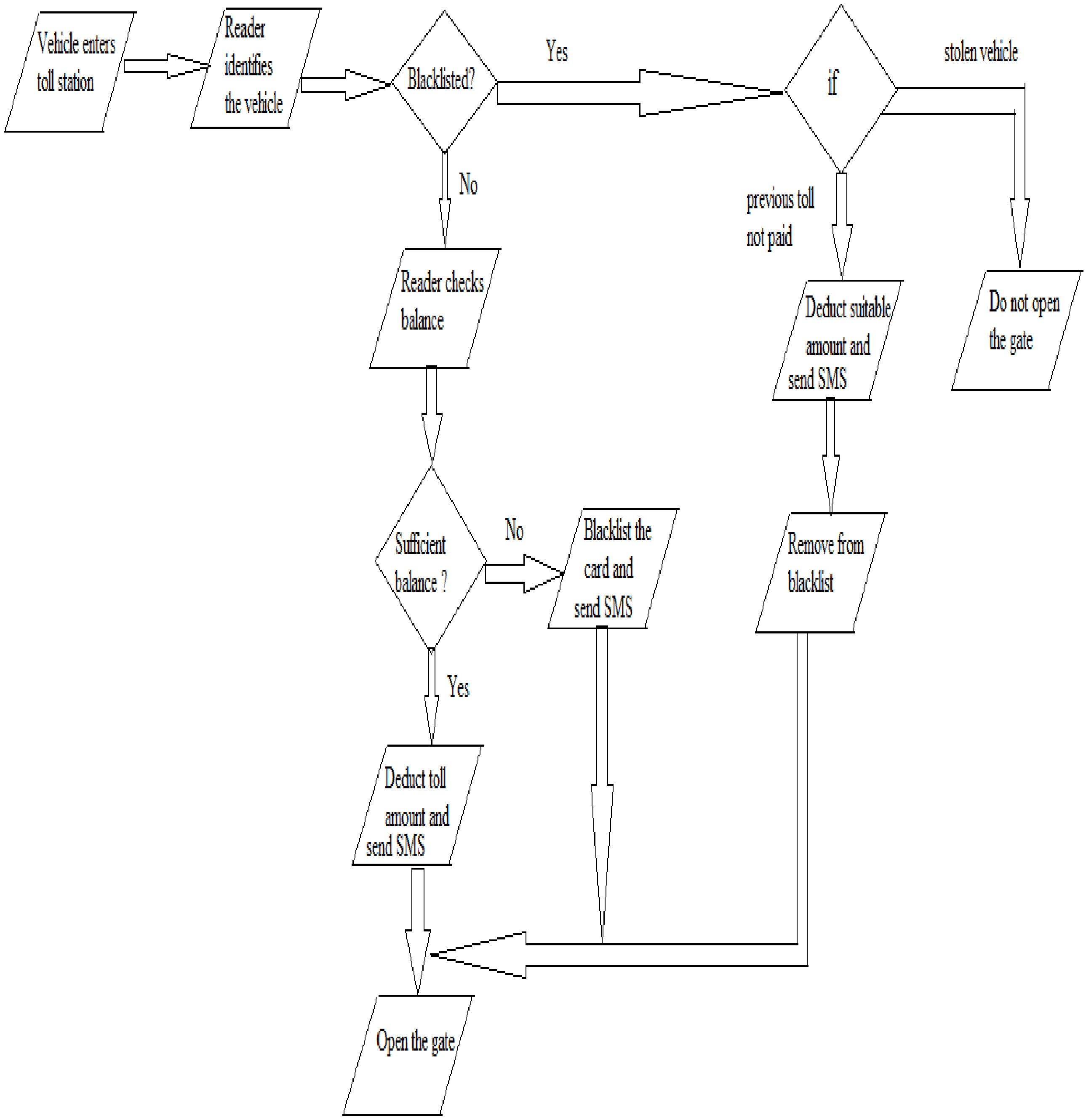
IV.PSEUDO CODE

With all the required components interfaced with the microcontroller it is quintessential to program the microcontroller meticulously, understanding and observing the expected flow of the system. The pseudo code of the Electronic Toll Tax Collection and Security System is depicted in the form of a flowchart (shown below) which would serve as operational basis while programming.



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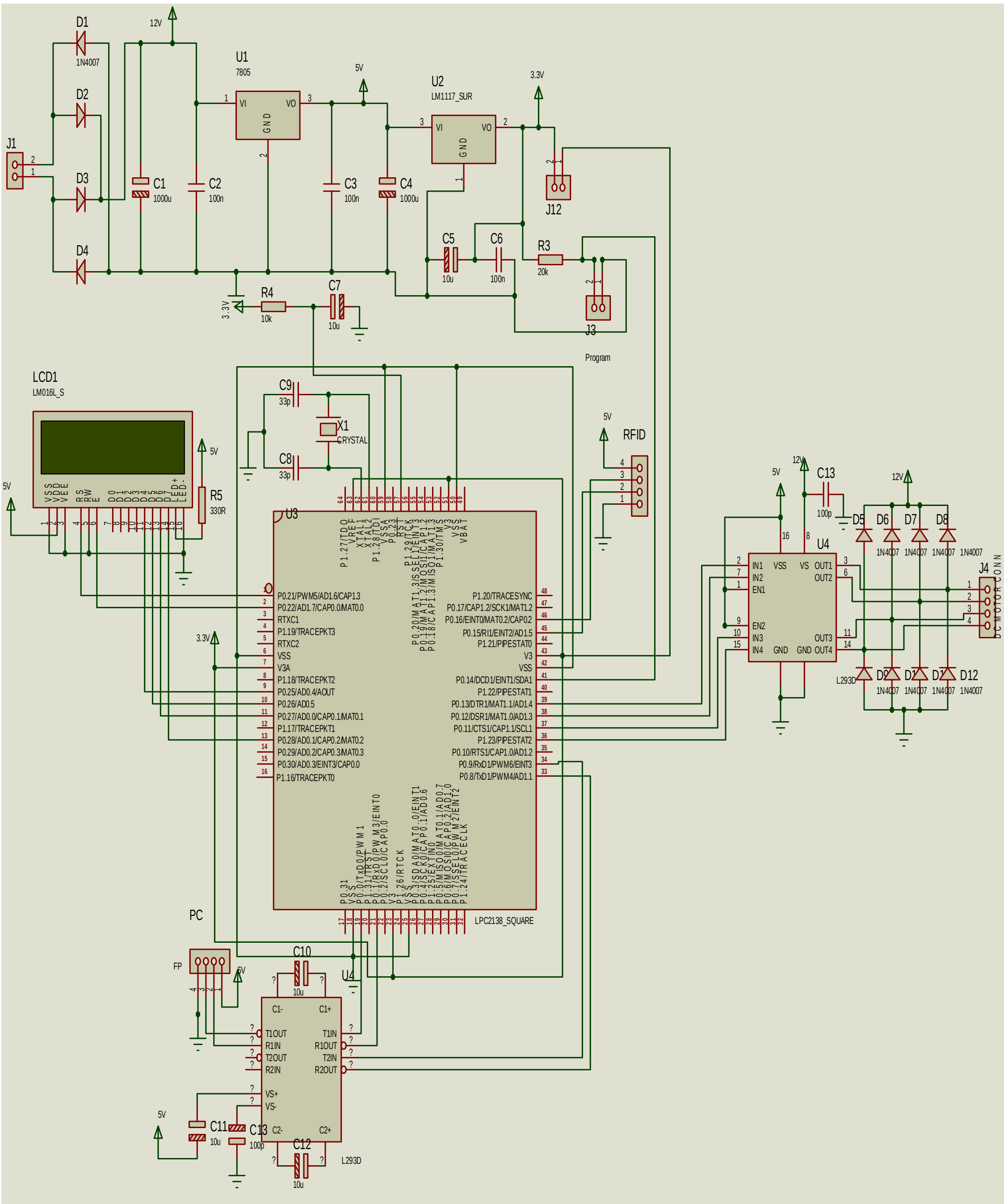
V.SIMULATION RESULTS

As shown in the power supply circuit, the output of 3.3 V and a minimum current of 750mA is verified using Multisim software. The central 64 pin unit is the microcontroller (ARM7 LPC2138). The power supply circuit is at the top with AC mains socket. The MAX232 interfacing circuit is at the bottom, whereas the DC motor driver section using the L293D IC is at the right hand side. LCD, crystal and reset circuits are also simulated at the periphery of the microcontroller. The RF reader is to be connected to the microcontroller with the help of serial transmission protocol using UART.



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VI.CONCLUSION

The entire process of the proposed system: detection of RF card, identifying the vehicle at the toll station with the help of RF tag installed on the vehicle as well as the database displayed on the computer, deducting appropriate amount from the balance in RF card as toll tax, operation of motor driven gates to pass the vehicles, transmission of the transaction details to the motorist as well as providing information about recharge schemes would be operated in real-time. The database would be updated about every toll transaction history. Thus, the system would prove to be a gem in terms of security purpose and providing support throughout irrespective of daytime, weather and other ephemeral conditions.

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