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http://www. irphouse.com /ijict.htm

Microcontroller Based Automatic Toll Collection System

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Abstract

This paper represents the design and development of "Micro controller based automatic toll collection system". This is a micro controller-based automatic system using infrared sensors. Automatic toll collection system aims to collect tolls from the vehicle without making the vehicle stop at a tollbooth .In this system, the user only has to get the transmitter from the main toll office .The transmitter will be charged by the operator of the booth office and the data will be stored in the micro controller. Visual Basic 6.0 is used to feed the various details of the users and the database will be maintained in Microsoft Access. The user will then mount this transmitter on its car. On pressing a button, the data transfer will take place. It will be get sensed by the IR. receiver mounted at the toll plaza, the fare will get deducted automatically according to the toll charged and the remaining amount will be displayed. Stepper motor is used to open and close the gate. The gate will get opened for the legitimate user and for others it will remain close. This system is designed in order to control congestion, convenience and safety of a patron.

Keywords: Automatic toll collection system, Congestion, IR Sensors, RF Sensors.

1. Introduction

These days delay at tollbooths is quite common in almost all the major Highways. This leads to increases in Congestion, inconvenience, energy and fuel consumption. The present work discusses here how to eliminate the delay at tollbooths. Automatic toll System assists in the management of toll operations by providing valuable data such as traffic volume, vehicle classification, and fare expected / collected. Multiple payment methods are supported using Cash, Smart Cards and Bar coded tickets [1]. The adoption of this system is expected to bring a number of significant advantages [2].

It will:
(1) Relieve congestion.
(2) Be more convenient to drivers since they do not have to carry cash.
(3) Streamline toll collection operations.
(4) Environment friendly system [3].

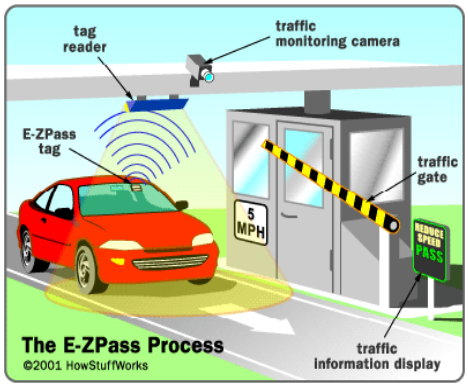

Figure 1: Automatic Toll Collection.

2. Problem Description

To design an automatic toll collection system, it will make use of IR sensors. IR sensors have been used; as these are economical, have perfect line of sight, hence less interference. A system has been designed to collect toll from the vehicle driving on toll road. For every vehicle class Rs 100 (say) will be used as toll tax. Each vehicle will have to get the transmitter from the main booth office. The toll operator will use Visual Basic to feed the details of the user and will maintain a database in a Microsoft Access. The operator will then attach a transmitter to the computer; a serial communication will take place. The data will be transferred from Computer to microcontroller of the transmitter. The operator than handover the transmitter to the user. The same process will be repeated with number of users with different recharge values. Toll operator will now attach receiver to the computer to transfer all the data collected till now to the microcontroller of the receiver.

Once all the code has been transferred, the receiver will be mounted at the toll plaza [1, 2]. As the vehicle passes, the user will press the button on the transmitter and the data transfer will take place. It is a wireless communication link between a transponder on a vehicle and IR sensors [12] mounted at toll plaza and provide real-time information service. The receiver will match a data with a data stored in its memory, if it matches. Automatically, the money will get deducted. The barrier gate will get open to allow the vehicle to pass .If the code doesn't match, the gate won't get open. All the toll related information can be displayed using LCD [23]. The guidance can be obtained from sensors or from dedicated short range communication, which enables short wave communication between roads and vehicles. A stepper motor is used to open and close the gate.

3. Hardware Implementation

3.1 Transmitter Circuit

In this circuit, the transmitter circuit works off at 5V supply. It is build around IC NE555, which is wired in astable mode (at pin 39) to generate 38 KHz frequency. The timer output is amplified by BC548; a very high current gain will be produced to drive the IR LED's. Resistor R4 limits the current flowing through the LED. When switch is closed the current flows through the circuit. The PC COM port is interfaced with the microcontroller through MAX 232 .It is attached with the port 3 pin 10 and 11.All the data which is fed by the user is fed into the micro controller through this interface. Another resistance at pin 28 (Port 2) of 330Ω is used to limit the current flowing through the circuit. Pin 29 (PSEN) is grounded since we are programming the chip [23, 25]. Make sure that the LED is properly oriented towards the IR sensor module of the receiver circuit. Its transmission wavelength lies between 900 to 1100nm (near IR range) that lies in the peak receptivity range of TSOP1738 receiver module.

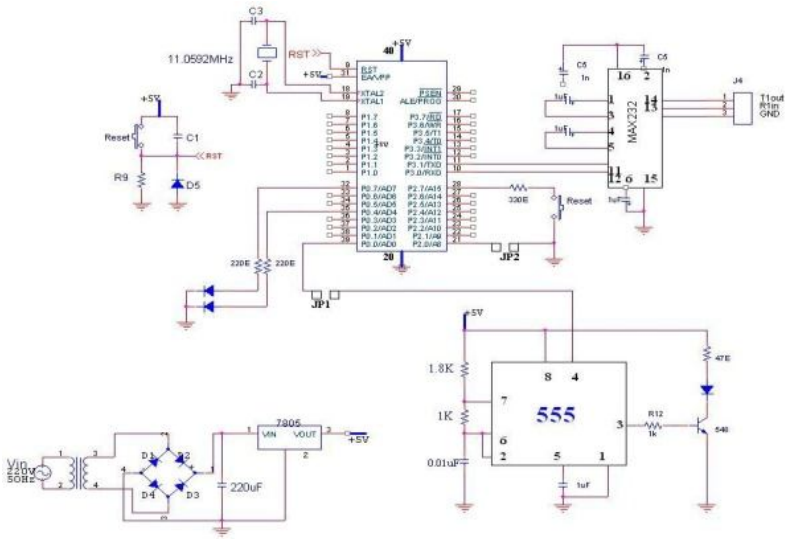

Figure 2: Transmitter Circuit.

3.2 Receiver Circuit

The receiver circuit comprises of IR sensor TSOP1738, 89C51, power supply; LCD display and a PC interface [23]. The receiver and transmitter circuit should be aligned face to face so that the IR rays get interrupted when someone stands in between the two .As long as the IR beams falls on the sensor, its output remain low, transistor does not conduct. When any one interrupts the IR beam falling on the sensor, its output goes high to drive the transistor into conduction. All the data collected about different users (in the computer) will be fed into the micro controller through MAX 232 (Pin 10 and 11) .LCD is interfaced with the micro controller through port 1 to display fare related information. Stepper motor is interfaced through L297 controller with micro controller (Port 0) to open and close the door for legitimate user.

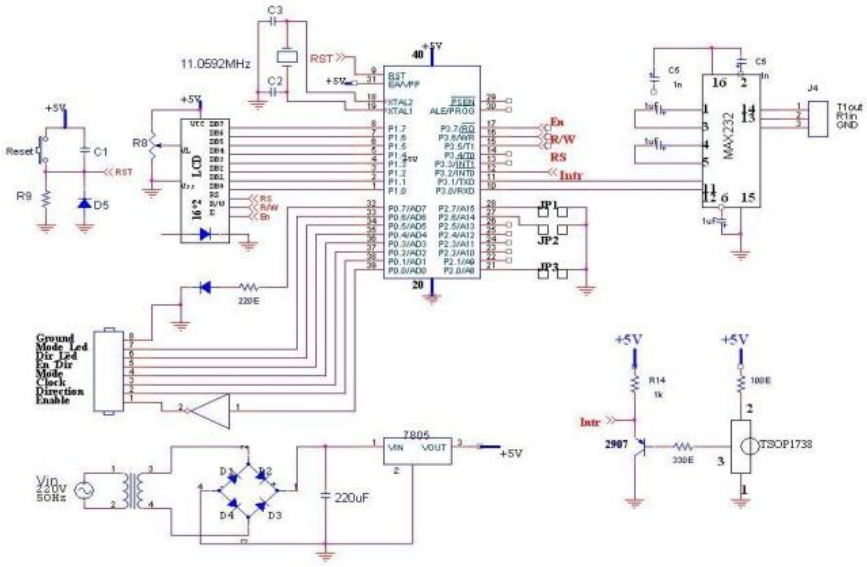

Figure 3: Receiver Circuit.

4. Software Implementation

The microcontroller chosen for the development system was the AT89C51RD2BD. This device is much cheaper than the windowed PIC16C73A-JW. The AT89C51 has 64K of program memory and has the capability to write to its own memory.

4.1 Programming Structure and Flowchart

The micro controller along with its various interfaces requires software to work on. The logic involved in achieving the desired operation has been carefully prepared and is noted down in the form of flowchart for easy reference (At the enf for reference). Assembly language software for the micro controller was developed using MS-DOS Prompt. This consists of a project manager, text editor and simulator. Assembly language code was written using the text editor, and then compiled into hexadecimal form for downloading into the microcontroller. The simulator was used for testing of program functions although this was very limited due to the nature of the simulator.

4.2 Result and Methodology:

An ETC system has been developed using infrared sensors. In this system each user has to get the transmitter from the tollbooth office .An operator will use a Visual basic interface to fed the details of the user into the computer .The form named “Automatic Toll System” include various details like name, address, car number ,token number and recharge as its fields. Various options have been provided like Save: - to save the data, New: - to enter new record of a user ,Edit:- if any record need to be appended ,Delete:- To delete the record and Find:- Since token number is used as a unique field so by entering token number the detail of a user can be found out. Visual Basic is used as front end and database has been maintained in Microsoft Access.

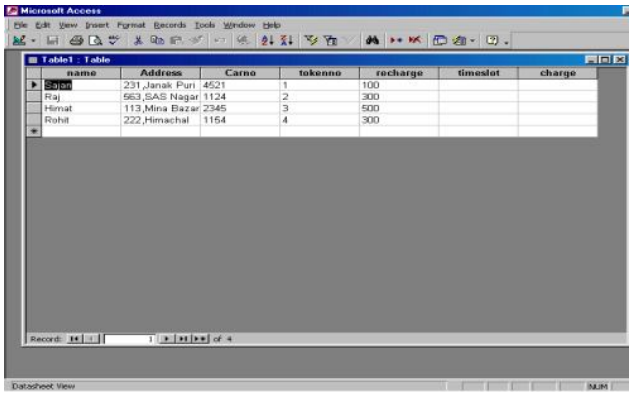

Figure 4: Access Database.

Two more options have been provided named transmitter and receiver in Automatic toll system form. On clicking transmitter button, another forms open up .This form is used to provide a serial communication of computer with microcontroller. An operator can send a specific token number to a transmitter, on clicking on start button the data transfer will take place and this number will echo back to ensure the error free transmission of the data. In this way, a transmitter can be charged with money and a specific token number. Now this transmitter can be given to user. The user will mount a transmitter on its car.

Figure 8: form filled by Toll Operator for User

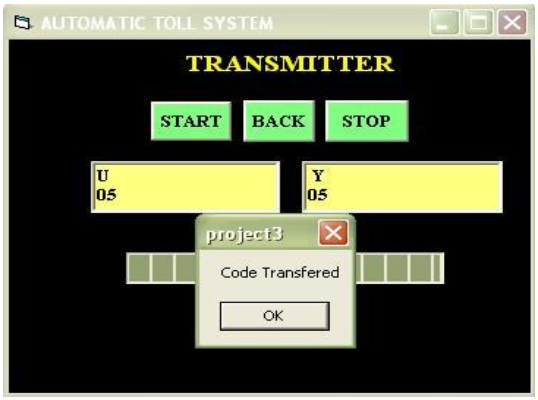

Figure 9: Sucessful code transferred from Computer to Transmitter

The same process can be repeated number of times for different users with their different recharge amount. Now the operator has to save the data collected at the receiver end so that when any user come the receiver mounted at toll booth could match the data and on the basis of this ,it will allow the user to pass or not. So for this, another option need to be clicked marked as receiver .The operator will now provide a serial interface between a receiver and Computer to transfer all the entries made till now into the micro controller program memory of the receiver. Once all data transfer completes, the receiver is now mounted at the tollbooth.

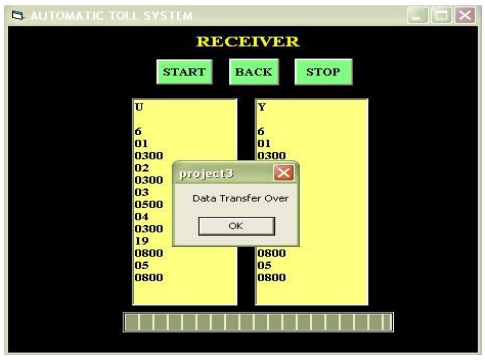

Figure 10: Token numbers has been transferred successfully to receiver.

When any car comes, this has transmitter mounted over it. The user presses a button; a data transfer will take place. The receiver will match a data with a data stored in its memory. Different messages will be displayed on an LCD showing matched record---token number with deducted amount----Please Go----Motor running .So a stepper motor is used for opening and closing of a gate and if the record does not match or no money is left in a user account, A LCD will show messages like Access denied----unauthorized user. The motor won't move and thus doesn't allow a person to go. Thus this system also prevents intruders from entering. In this system we have used Rs 100 as a toll tax amount and this amount get deducted every time the user passes through the booth.

5. Conclusion

The implemented ETC based system significantly contribute to improve travel conditions by addressing delay caused by both recurring and nonrecurring congestion. People hate the delay at tollbooths. This system collects toll from the vehicles driving on toll roads without making the vehicle stop at Tollbooths. This has been accomplished by installing a wireless in both vehicles and tollbooths to exchange toll related information using different data transfer techniques like via cable, infrared, Radio frequency, Bluetooth, etc.. These systems include benefits to both toll authorities and facility users, in terms of time and cost saving, improved security, increased capacity and greater convenience. This system provides a broad overview for collecting toll and thus provides advantage to toll operators and motorist.

6. Future Scope

This work describes the practical implementation of Automatic toll Collecting System using Wires and IR. Since infrared has very low range, this system work fine only for small distances. Various new techniques have been emerged in this field to make his system more reliable and efficient. For greater distances microwave, RF can be used. Using RF the same system with little modifications can be used to locate a person in a building i.e. this system can be used to enhance the security in the building [6]. Further

the system may use any existing local GSM/CDMA network for collection of Toll payment [4]. This can be done using SMS or any other VAS (Value Added Services) related features. The same idea can also be used to improve car parking, traffic control and security systems

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