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Automatic Toll Collection System

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Abstract
Delay at tollbooths is nowadays quite common in almost all the major highways. This leads to increases in congestion, inconvenience and fuel consumption. Automatic Toll Collection System brings a new idea to eliminate the delay at tollbooths. Here a micro controller based automatic system using infrared sensors is being utilized. IR sensors have been used as these are economical, have perfect line of sight, hence less interference. Automatic toll collection system aims to collect toll from the vehicles without making the vehicle stop at the tollbooth. Each user is provided with a module that is to be mounted on the windshield of the vehicle which consists of transmitter, receiver, microcontroller and a LCD unit. The toll booth is equipped with another module for collecting toll from each user. The computer at the toll booth holds the database consisting of details regarding each user along with a unique code. The Automatic Toll Collection System include benefits to both toll authorities and facility users, in terms of time and cost saving, improved security, increased capacity and greater convenience.
Keywords: *Automatic toll collection system, congestion, IR sensors, LabVIEW, image acquisition*

1. Introduction

Toll collection is common in almost all major highways in India. In the existing system the vehicle has to be stopped at the tollbooth and toll is paid as cash or using smart cards. This manual process of toll collection is time consuming and leads to increase in Congestion, inconvenience, energy and fuel consumption. Day by day no of vehicles are increasing and the condition is being worsened. Our project discusses how to eliminate the delay at tollbooths. Automatic toll collection System assists in the management of toll operations by providing valuable data such as traffic volume, vehicle classification etc. This is a microcontroller based system which reduces man power and eliminate the drawbacks of the existing systems.

2. Working

To design an automatic toll collection system 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 an amount will be used as toll tax. Each vehicle will have to get the transmitter/receiver module from the main tollbooth office. All the control operations such as identifying the vehicle using the received ID, withdrawing the toll amount etc. are performed using the LabVIEW software installed in the tollbooth. The operator will then attach a transmitter/receiver module to the computer; a serial communication will take place. A vehicle approaching the toll station receives a code at 38

KHz frequency in order to understand that its from a toll station, send by the toll booth transmitter.

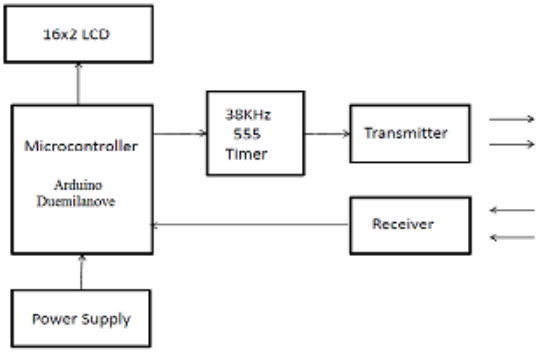

Figure 1. Block diagram of vehicle unit

When this code is received by the receiver at the vehicle, the transmitter gets triggered and the unique vehicle code is transmitted. The receiver at the tollbooth collects this unique vehicle code and passes this information to the computer. The complete data associated with the unique code is decoded by the computer and the required amount is withdrawn from the owner's account as toll depending upon the vehicle. After collecting the amount, the gates get opened.

The detail of balance amount is again transmitted to user side and is displayed at the LCD unit. When the vehicle crosses the photo sensor fixed after the tollbooth, the gate is automatically closed. If the user hasn't enough balance then the gate remains closed. In-between, when the receiver at the tollbooth receives unique vehicle code, camera is triggered.

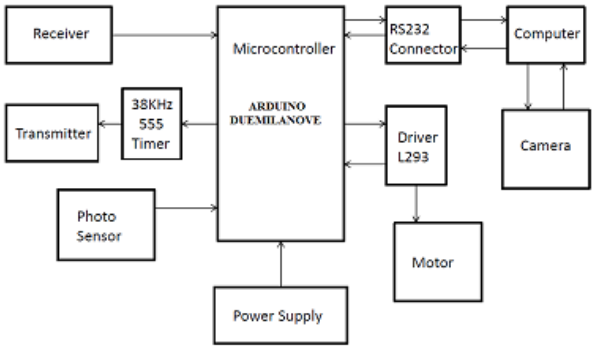

Figure 2: Block diagram of tollbooth

The photograph along with the vehicle details is again stored as separate database which can be checked for corruptions manually and culprits can be fined afterwards.

3. Hardware Implementation

Hardware mainly consists of two modules. One transmitter/ receiver module fixed on the vehicle and other at the tollbooth.

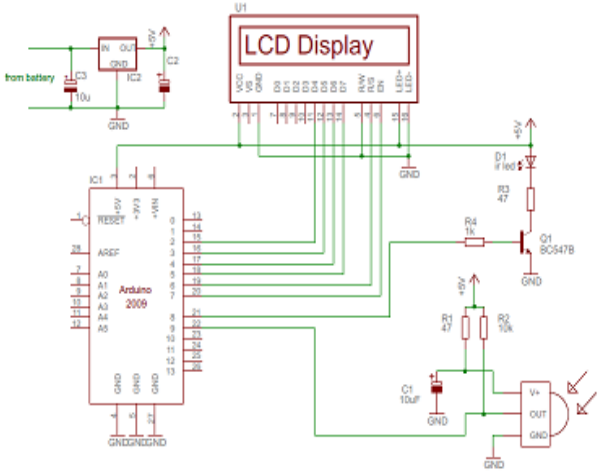

Figure 3 : Circuit Diagram of vehicle unit

The vehicle unit mainly consists of a micro-controller, LCD display, IR transmitter and IR receiver. The microcontroller used is Arduino Duemilanove (ATMEGA 328p). It controls all the operation at the vehicle side. The LCD unit (16*2) displays the information regarding the amount collected and balance amount information etc. IR signals generated is transmitted by using an IR LED. The IR Receiver, TSOP 1738 is a member of IR remote control receiver series and it receives 38Khz signals.

The module at the tollbooth mainly consists of a personal computer or laptop loaded with LabVIEW. LabVIEW is the main controlling software used here. The computer holds the database of all vehicles registered. The microcontroller Arduino used as a DAQ (Data Acquisition) module. It monitors the status of al registries, i/o ports etc. The required information is transferred to computer as requested by LabVIEW. The computer also has a camera connected to it so as to capture the image of vehicle passing through the tollbooth. The transmitter receiver unit facilitates the communication between the tollbooth and the vehicle. A servo motor is attached to the

microcontroller to open and close the toll gate. The vehicle out sensor detects whether the vehicle has passed the toll gate or not. The power is supplied from a 230v AC supply which is rectified using full wave rectifier and regulated 5V output is obtained using the regulator IC 7805 and regulated 9V output is obtained using the regulator IC 7809.

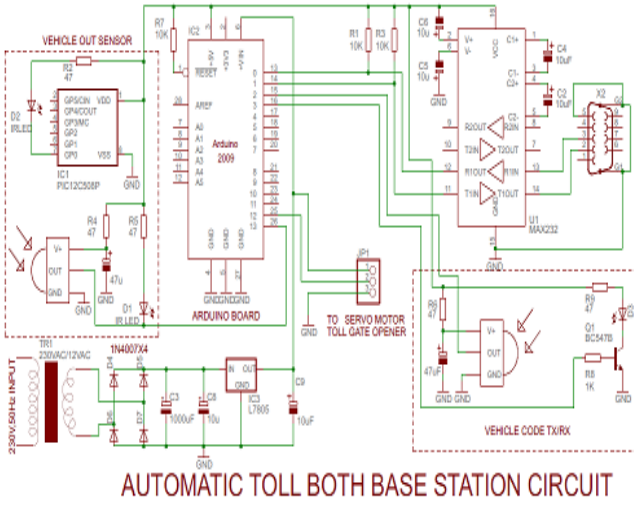

Figure 4 : Circuit Diagram of tollbooth

4. Software Implementation

The main softwares used in our project are LabVIEW, Arduino IDE and Proteus.LabVIEW (short for Laboratory Virtual Instrument Engineering Workbench) is a system-design platform and development environment for a visual programming language from National Instruments. , LabVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms including Microsoft Windows, various versions of UNIX, Linux, and Mac OS X. LabVIEW ties the creation of user interfaces (called front panels) into the development cycle. A key feature of LabVIEW is the extensive support for accessing instrumentation hardware. Drivers and abstraction layers for many different types of instruments and buses are included or are available for inclusion. These present themselves as graphical nodes. The provided driver interfaces save program development time. The sales pitch of National Instruments is, therefore, that even people with limited coding experience can write programs and deploy test solutions in a reduced time frame when compared to more conventional or competing systems. LabVIEW can effectively interfaced with camera, servo motor and Arduino. This features forced as to choose Lab VIEW as our main software environment. A database regarding the vehicle details is created by using Microsoft excel and can be accessed and manipulated by LabVIEW. Image acquisition is made easierusing LabVIEW and this captured image can be used for further verifications.

The Proteus Design Suite is wholly unique in offering the ability to co-simulate both high and low-level micro-controller code in the context of a mixed-mode SPICE circuit simulation. With this Virtual System Modeling facility, you can transform your product design cycle, reaping huge rewards in terms of reduced time to market and lower costs of development. Proteus Virtual System Modeling (VSM) combines mixed mode SPICE circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete micro-controller based designs. For the first time ever, it is possible to develop and test such designs before a physical prototype is constructed. This is possible because we can interact with the design using on screen indicators such as LED and LCD displays and actuators such as switches and buttons. Here instead of HT12E transmitter we were connected a LED to the corresponding pin. If the LED is ON, it indicates that the micro-controller is transmitting a signal.

The Arduino development environment (Arduino IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Figure 5 explains the Algorithm of the Arduino program loaded on the vehicle side.

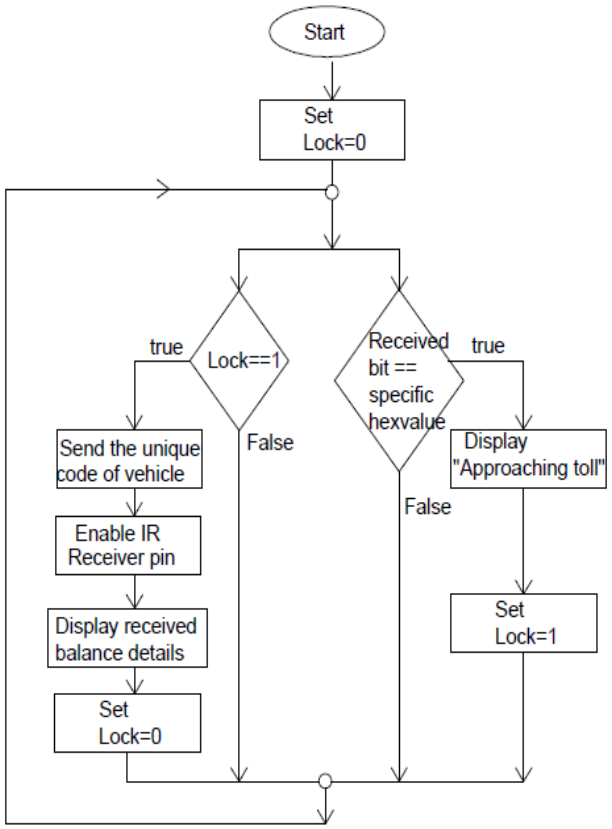

Figure 5. Flowchart - vehicle unit

The code from the tollbooth will be accessed by the IR sensors on the vehicle. If the received code matches with a specific hex value stored in it,LCD unit display that "Approaching Toll".Then the unique code from the vehicle is transmitted through IR LED. After the processing of the data balance details will be available on the vehicle unit through IR receiver pin and displayed on LCD.

Figure 6 shows the flowchart of arduino programming at the Tollbooth. Here Arduino is used as DAQ (Data Acquisition Card).It means that whatever data appear at the input of Arduino, it will be transmitted serially to computer. The DAQ firmware for Arduino is provided freely by the National Instruments. LabVIEW has provision for interfacing with Arduino, so data transmission will be fast enough.Its operation is such that if a data is received through IR receiver, it is transmitted serially to LabVIEW and wait till the processed data arrives and send that received data through IR LED.If the test condition is false it send the 8 bit code for the approaching vehicles to identify tollbooth and enable the receiver pin.

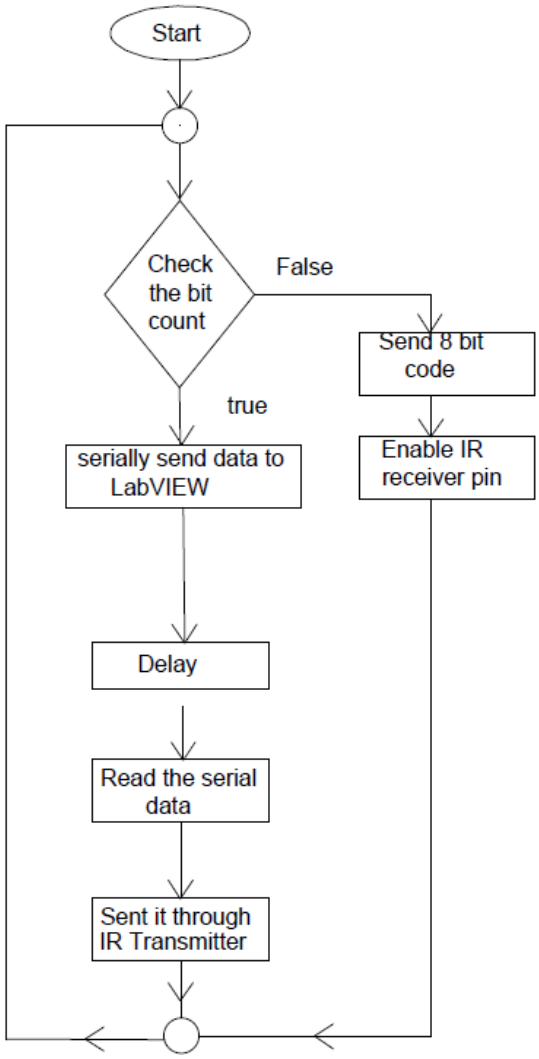

Figure 6 .Flowchart -Tollbooth

Figure 7represent the flow chart of LabVIEW programming.LabVIEW has special modules to interface with Arduino and servomotor which we have made use in this project. LabVIEW has also provisions for image acquisition and for accessing MS Word, Excel etc. The entire details associated with unique ID of the vehicle is stored in PC as MS Excel document. It can be accessed by using LabVIEW. If the account of that vehicle has enough balance, toll amount is deducted, new data is updated and balance details are send serially to Arduino and tollgate is opened. If the balance is less than toll amount a message to recharge the account will be generated. Meanwhile the image of vehicle is captured and stored in PC, which can be used for future verification.

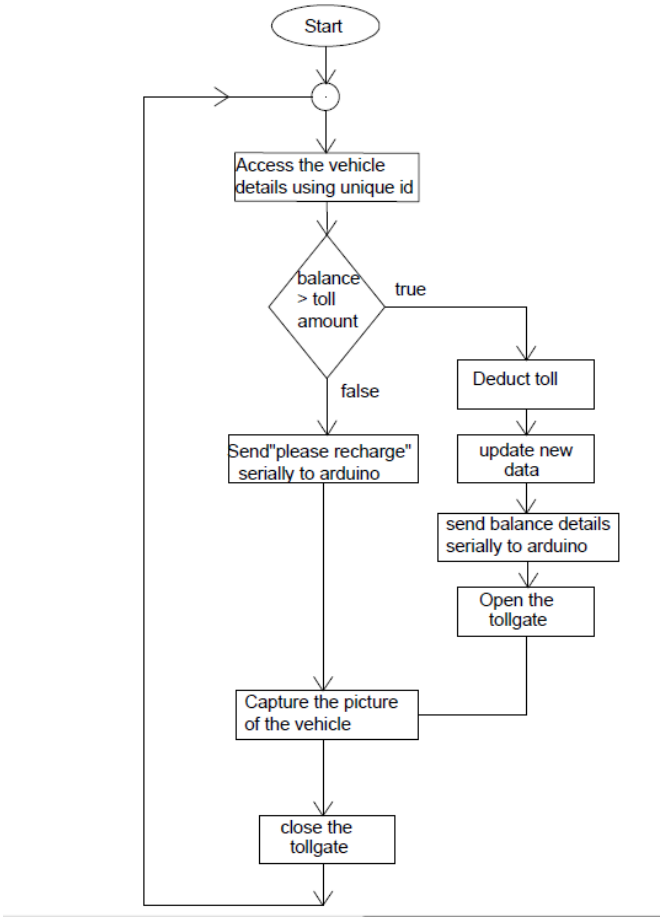

Figure 8: Flowchart for LabVIEW programming

5. Conclusions

The implemented Automatic Toll Collection 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 Infrared signals. 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.

Our project, Automatic toll Collecting System uses Infrared signals for communication. 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 thissystem 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. Further the system may use any existing local GSM/CDMA network for collection of Toll payment .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.

6. Acknowledgement

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