Vision Based Automatic Toll tax Collection System using Image Processing and Wireless Technology

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Abstract- **A Toll Tax is a tax that has been often used historically on roads and bridges to pay for state bridge and road projects. What eventually has been observed is heavy traffic lead to congested roads leading to heavy time loss. Thus we have proposed a system which not only takes care of the long queues but also ensures security of vehicles and hence achieving prevention from theft. This paper focuses on an automatic toll collection (ATC) system using radio frequency identification (RFID) technology. The proposed RFID system uses tags that are mounted on the vehicles, through which information embedded on the tags are read by RFID readers. The proposed system eliminates the need for vehicles and toll authorities to manually perform ticket payments and toll fee collections, respectively. With the advancement in computation, the era of automatic systems is rapidly taking over. Image processing is an essential tool being widely used in effective solutions concerning such systems. Thus we have also proposed an effective method to extract the digits from the license plate of a vehicle which can be used to fully automatize the access system at the barrier gate. The algorithm accounts for various anomalies in the system which may include movements at the gates and so on .Thus the final project will be comprising of a combined process of RFID and Image Processing.**

Keywords –Congested roads, Automatic toll collection (ATC),RFID tags ,Image Processing.

I. INTRODUCTION

Among the few things which characterize our major populated cities in our nation is the amazing local transport system, which mainly compromises of the Railways and equally important land transportation systems which regulates the proper functioning of the local trains almost round the clock. Taking into consideration the large amount
of traffic commuting everyday on roads the land transportation system is responsible for safe and sound transportation of the people of this perennially busy city which never sleeps. We have
proposed a system which solves the issue of long queues and eventually achieving traffic control which are observed at toll region .

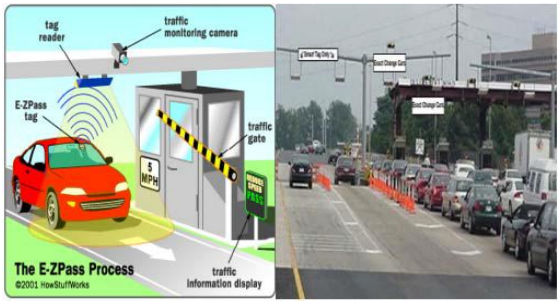

Fig 1.Toll Tax System.

The highly instrument-based system is intended to perform functions like detecting vehicles and then data-formatting and transfer to the use. In short, the transport and traffic sectors would be the major gainers of the system. Whenever a vehicle passes through the toll gate, crucial data such as vehicle number, the toll fee payments, and so on are all recorded and hence are retrievable by the personnel concerned. These series of actions ensure the building up of a database and second the collection of toll fee thus eliminating the chances of misuse or loss of revenue due to non deposit/collection of toll tax. Each vehicle will be provided by an RFID tag containing a unique ID. This tag will continuously emit RF signals. When the vehicle will reach at the toll booth the RF receiver will detect these RF signals. The signals are amplified and are passed to microcontroller. This microcontroller will display the ID on LCD. Here we carry on two processes simultaneously one is using RFID and the other is image processing. We generate a database containing the vehicle's owner information such as Name, Address, Type of vehicle, Toll amount and Balance. Along with it there is a column for ID generated by the tags generated by Tx and Rx ,thus the RFID process is carried on by matching the ID received by the vehicle near toll with the IDs stored in the database. Also we are using a camera which captures the number plate image of the vehicle and then it send it for further processing using Visual Studio 2000 using C# .net and eventually the image is stored in the system for matching process , when the image matches with the number of the plate stored in the

database , toll is detected ,this also provides an additional feature of preventing auto theft.

II. SYSTEM MODEL

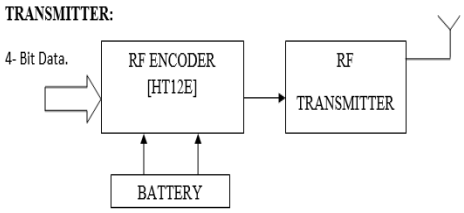

Figure 2. Block Diagram of Transmitter

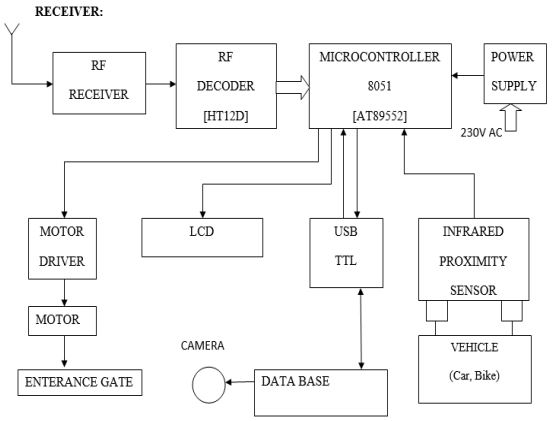

Figure 3. Block Diagram of Receiver

The block diagram is shown above in which we have a RF-Transmitter and a receiver section micro controller (80s52) ,a 2 x LCD Display, IR Sensor ,Camera, USB TTL,PC, a motor Driver circuit connected to a flap which is acting as a gate , and together driven by a 230V power supply. The moment vehicle enters into the vicinity of the toll booth , the RF- Tx section consisting of a encoder and a Transmitter driven by a battery which will be placed in the vehicle will generate an Identification Code (ID) which will be transmitted and will be received at the receiving end of our system installed at the toll booth through RF-Rx consisting of a decoder and a receiver. Each vehicle will be generating its unique generation code which will be fed to the system. The code is then fed to the microcontroller circuit which is connected to a USB TTL circuit which is acting as a interface to the PC and the system. Here the controller circuit is also connected to a LCD Display and a motor driver circuit. The Display circuit will be showing messages like STOP or Proceed on its screen for the vehicle driver. Here at the receiving end an IIR sensor is used which detects the vehicle when in the vicinity of the toll booth. A 230 V power supply is used as shown in the block diagram for driving the circuit. Once the code is transferred to the PC through interface, the Code is stored and along with it the type of vehicle , its toll amount and the balance of the owner will be calculated by using C#.net.

The database will be preserved within their system. As soon as the following process is completed the Motor driver circuit connected to the gate through a motor will be opened , and the vehicle can easily pass ahead, but if the balance amount is zero for the user then an acknowledgement will be sent which will activate the buzzer connected and the siren will start blowing and the motor driver circuit will not be driven due to which the vehicle can't proceed and it will be forced to pay the amount by putting it in the manual lane .The above mentioned process was through wireless technology, here an additional feature is added and that is of image processing , a camera will be installed at a particular height at the toll booth from where the number plate can easily captured , after capturing the image the photo is fed into the PC system , which scans the image through image processing and with optical character recognition each letter is scanned and stored in the database. So along with the ID, Name ,Address Type of vehicle, Toll amount and balance , the Plate number of the vehicle is also stored , this helps in checking the identity of the owner and hence our circuit also helps in preventing theft

A. RF ENCODER HT12E:

This unit is used to encode the 4-bit data before transmitting it in the communication channel. Basically it generates a serial bit stream of the parallel input data bits. It then sends data stream to RF transmitter unit. This unit requires +5V to 12V DC for it proper operation.

B. RF TRANSMITTER:

This unit performs very significant roll i.e. it is responsible for the modulation (ASK, CF-434MHz) of the message or data to be transferred. Once the data is modulated then is transmitted or launched in Air by the help of the antenna. The baud rate is generally 1200bps and the range will be up to 100 ft.This unit requires +5V to 12V DC for it proper operation.

C. THE RF RECEIVER:

This unit performs very significant roll i.e. it is responsible for the demodulation of the message or data after reception from air. This section is internally constructed with Amplifier unit, Filter unit, Peak Detector, Sample and Hold circuit and Level Shifter.

D. RF DECODER HT12D:

This unit is used to decode the 4-bit after receiving it from the RF Receiver unit. Basically it generates a parallel data from the serial incoming bit stream. This unit requires +5 to 12VDC for it proper operation.

E. POWER SUPPLY:

This unit will supply the various voltage requirements of each unit. This will be consists of transformer, rectifier, filter and regulator. The rectifier used here will be Bridge Rectifier. It will convert 230VAC into desired 5V/12V DC.

F. MICROCONTROLLER:

This unit is the heart of the complete system. It is actually responsible for all the process being executed. It will monitor & control all the peripheral devices or components connected in the system. In short we can say that the complete intelligence of the project resides in the software code embedded in the Microcontroller. The controller here user will be of 8051 family. The code will be written in Embedded C and will be burned or programmed into the code memory using a programmer. This unit requires +5VDC for it proper operation.

G. LCD 16x2:

It is called Liquid Crystal Display. We are going to use 16x2 character LCD. This will be connected to microcontroller. The job of LCD will be to display all the system generated messages coming from the controller. LCD will provide interactive user interface. This unit requires +5VDC for it proper operation.

H. USB TTL:

A USB adapter is a type of protocol converter which is used for converting USB data signals to and from other communications standards. Commonly, USB adaptors are used to convert USB data to standard serial port data and vice versa.

I. IIR SENSOR:

It is an infrared sensor used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

J. MOTOR DRIVER CIRCUIT:

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults. Every electric motor has to have some sort of controller. The motor controller will have differing features and complexity depending on the task that the motor will be performing.

III. EXPERIMENTAL OBSERVATIONS & RESULTS

Fig.4 Step1 :Camera Interfacing

The starting step in the additional process of image processing is as follows- A camera is used which captures the number plate image and then it is fed to the PC working with c#Algorithm along with SQL for database.The camera interface is shown in Fig.4 which is connected to the microcontroller through which the image is fed to the PC for futher process.

Fig.5 Step 2: Image capturing

The captured image is shown above ,here it is important to ensure the camera is at a decent height and also the number plate is at a standard high from the ground level so as to get a proper image with entire digits which are easily visible .

Fig. 6 Step 3: Image Pre-processing(Gray-scale ,noise removal etc)

After the image being captured we are enhancing the image or equalising it using Histrogram.With the pre-processing the following tasks are been performed, from

color filter, grey scale and thresholding.During the process, there is a possiblity of noise occurence and hence it is essinital to remove the noise disturbance and then details encoded through encoder.A gray scale image is shown in Fig.6

Fig.7 Step 4: Blob Detection

Here, using Block detector each character of the number plate is detected through counter analysis.Here the above process can also be achieved using OCR i.e. Optical character Recognition as shown in Fig.7

Fig.8 Step 5: Segregated Characters

As soon as the blob detection process is done , we get the segregated characters as shown in Fig. 8 ,these characters in arranged manner are then send for matching process in the system where the generated image and the vehicle number (already in the database) are matched for toll detection.

No Plate	*ID*	*Name*	*Address*	*Type of Vehicle*	*Toll Amount*	*Balance Left*
HP 67 - 7588	1048	Mr. Ram Nair	A-9, Vajra hanuman Society,Cholegaon, Thakurli(E)	Car	50	950
HR 67- 1234	2993	Mr. Vijay Das	101,TULIP TOWER,Tilak road,Dombivli(W)	Car	50	2900
MH 05 - 6475	1435	Mrs. Reeta Verma	Plot no. 78 ,Nair Niwas , M .G .road ,Thane (E)	Car	50	1050
PJ 04 - 7322	7433	Mr. Sanjay Gupta	D-1001, 2nd Floor, Ram Niwas Society , Near MSST School,Kalyan (w)	Truck	100	800

TABLE I - Final Database Observation

After executing the system it was finally observed , how the vehicles toll tax was automatically detected by the above mentioned process. Finally, the database processing task is done through SQL, were we displayed the number plate image along with the ID genertaed through RFID which in turns detectes the Name ,Address,vehicle type, tax amount and finally the balance left. If in case the balance is low, the buzzer connected to the system goes high and the sound is produced indicating the owner to manually pay the Tax.

CONCLUSION

By the realization of the above proposed system we can make the Toll Tax collection system more efficient and can reduce the traffic logging on the highways. This system will save a lot of precious time of the driver, passengers as well as of the tax collection authorities. By the realization of the above proposed system one can learn many aspects of a digital electronics circuit. This will give the complete knowledge of designing microcontroller based system and developing embedded software .We will also learn the software development strategies and various programming techniques for PC based applications.

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