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Microprocessor Smart Cards for Centralizing Fare Collection in Public Services

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Abstract **– In today's world where public transit is the most commonly used and affordable means of transport. Dealing with it includes a lot of variables, especially at the time of payment. This problem is faced by almost every commuter in his/her daily routine. To address the problem, we propose centralizing fare collection system with the help of smart cards which will ease the unnecessary havoc created when asked to give exact fare amount for their journey. In this paper, a complete description on how our system will elevate the existing system with the help of RFID reader/writer module and integrate public services in terms of payment will be detailed. First, it does not require any advanced technology so it can be implemented as low-cost upgrade to the existing system. However, our system not only outperforms the current system in terms of accuracy but also proves to be a relieving point from passenger's point of view when it comes to accessing and utilizing public transport and other public services to its fullest.**

Index Terms **– Accuracy, advanced technology, daily routine, low-cost upgrade, lot of variables, utilizing public transport.**

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I. INTRODUCTION

Smart card technology is fast becoming common place in our daily lives. A smart card, typically a type of chip card, is a plastic card that contains an embedded computer chip either a memory or microprocessor that stores and transacts data. Smart cards are deployed in a variety of applications such as Automated Toll Gate [1], Airline Baggage System [2], and Automatic vehicle toll collecting system [3]. Smart cards improve the convenience and security of any transaction; they provide temper proof storage of user and account identity. Smart card system has proven to be more reliable than any other machine-readable cards like magnetic strip and barcode. Showing low cost of system maintenance and longer card life. Many contactless readers are designed specifically for payment, physical access control, transportation application etc. Let us examine a scenario, in an organization or an enterprise, the cost to manage password or perform crucial password recovery is very high. In such environment making use of smart card proves out to be a cost effective solution. They protect against full range of security threats, from careless storage of user password to sophisticated system hacks.

The information from the card is read with the help of a reader specially designed to read information from the chip, such reader works with a radio frequency that communicates when card comes close to the reader and hence the name RFID module. Along with reader there are also writer modules which write back the new data to the card that is achieved after processing the information stored in the card to perform necessary application. One such reader/writer module which performs both the function of reading as well as writing is Mifare Reader/Writer CR038 [4].

Once the card is read by the RFID module a GSM modem interconnected to the system will send a system generated message to the pre-stored number. SIM 900A GSM module is used for this purpose as it accepts any

GSM network operator SIM card and act just like a mobile phone. It makes use of simple AT commands to send SMS, make and receive calls through a serial interface from microcontrollers and computers. Most programming languages allow sending and receiving serial commands to a serial port and can be used to write software's that can operate the modem without the need to implement any complex interface. This makes SIM 900 a superior choice to work with.

The basic block diagram of Auto/taxi and Toll Plaza system is shown in Fig. 1 and Fig. 2 respectively.

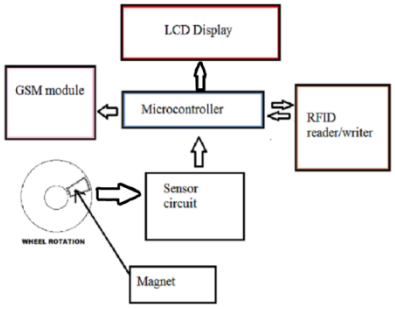

Fig. 1- Block diagram of Auto/Taxi System

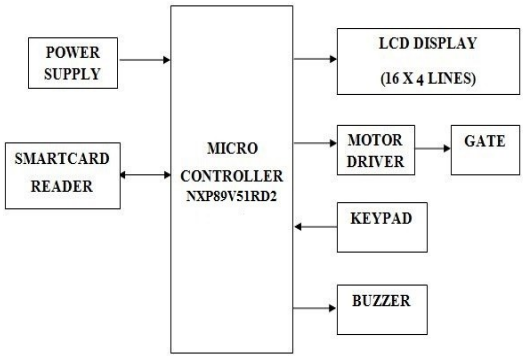

Fig. 2- Block Diagram of Toll Plaza System

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I. PROBLEM DEFINITION

The present public service in India is not centralized. So the passenger has to deal with number of variants for availing individual public service, every time. This creates a distress and discomfort to access public service, each time the passenger is forced to render perfect tariff for the travel, falling to which he/she has to undergo almost every time a serious argument regarding the exact change. In order to overcome this problem, the company tries to roundup the bill to the nearest base number on account of which the passenger has to face a forced burden of additional and unnecessary hike in the amount. The current meters in Auto/Taxi are easily manipulated and thus the passengers are likely to face fraudulent cases.

II. PROBLEM SOLUTION

Here it is assumed that there is an already existing infrastructure from where the cards can be recharged according to the card owner's will and there is also an existing infrastructure from where the driver can collect their earnings by showing the system generated message that they will receive once the transaction is successfully completed.

This paper proposed to provide a centralized system under which all the public related services can operate by standardizing the mode of payment. The best possible and feasible approach is by replacing the existing meters by RFID reader/writer modules with the help of which payment can be done electronically without the fear of rendering exact change and without unnecessary round ups.

The system is named as "Smart Fare Computing System for Auto/Taxi and Other Public Services" which will help us to achieve our goal and its working is explained below-

III. WORKING

In this section, the working of the system project is explained in individual stages and then as an entire one system.

A. Microcontroller Board

It acts as a brain in our system. It co-ordinates the commands received from the different subsystem and synchronizes them to deliver expected results. It receives input from Sensor circuit and RFID reader/writer module & it gives the generated commands to LCD display and GSM module so that they can carry out their function accordingly. Microcontroller NXP89V51RD2 is used and its detailed information is present in reference link [5]. NXP89V51RD2 board along with 16x4 LCD display which is used is shown in Fig. 3.

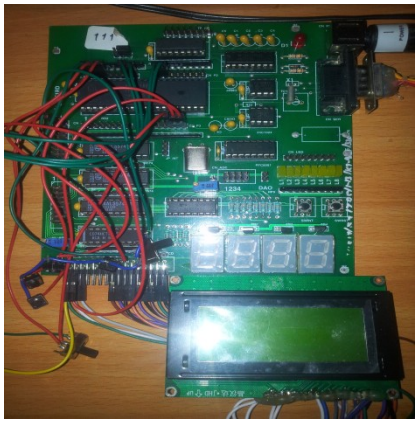

Fig. 3- NXP89V51 microcontroller board.

B. Sensor Circuit

It is used to sense the rotation of the wheel, so as to determine the exact wheel rotation, as shown in YouTube video [6]. This in turn helps to find out the total distance covered by multiplying the total pulses received with the circumference of the wheel. The sensor circuit is made by using Hall Effect sensor. It operates on the basic fundamentals of magnetism. When a magnet with correct pole typically North Pole faces the sensor it short circuits and allows the current to flow. The circuit diagram of sensor circuit consisting of Hall Effect is shown in Fig. 4.

The wheel is attached with a magnet and is located in a close proximity that it falls within the range of the sensor. The rotating wheel makes the magnet to come in front of the sensor each time it completes one complete rotation, thus letting us know that a rotation is completed. The continuous rotation of wheels gives us the count as how many times the wheel has rotated, this can be converted into distance by just multiplying it with the circumference of the wheel.

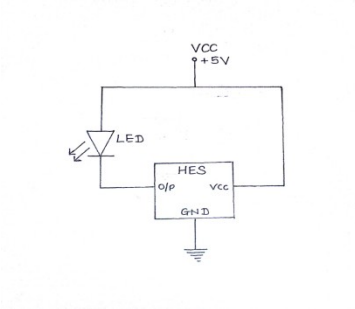

Fig. 4- Hall Effect sensor with LED

C. RFID Reader/Writer Module

This is the heart of the proposed system. Mifare RFID CR038 which is used is shown below in Fig. 5. Its main function is to detect the card placed on the proximity of its sensor, check the balance in it, deduce the fare amount displayed on LCD screen and write the new value back to the card after fare computation.

Fig. 5- RFID reader/writer module

D. GSM Module

The basic function of this module is to send an auto-generated text message to Auto/Taxi drivers of their earnings. The message will consist of the fare deducted from the passengers card, that is the earnings of the driver and the time on which the journey was completed. This will help the driver to keep a record of daily income. SIM 900 GSM modem shown in Fig. 6 is used for this purpose and its detailed information is present in reference link [6].

Fig. 6- GSM Modem

E. The Complete Operation

In case of Auto/Taxi the sensor circuit which is made up of Hall Effect sensor counts the rotation of wheel. The number of times the wheel is rotating is continuously given to the microcontroller as a real time input on its external timer\counter pin. The microcontroller counts each pulse coming from the sensor circuit thus letting us know the rotations that are completed by the wheel. Once the count is known distance is calculated by multiplying the total number of counts with the circumference of the wheel. Once the distance is known fare can be calculated with the help of formula-

Fare = Distance x Fare per kilometer.

where, fare per kilometer is fixed.

So at the end of the journey the final fare will be displayed on the screen. Now the passenger brings the card near RFID reader\writer module, the module senses the card reads the data from it performs the necessary

operations and then writes back the new value generated after the operation back on the card.

Once the operation is completed the GSM module sends a system generated message on a pre-fixed number containing the detailed information about the transaction so as the driver can have a record of his earnings.

In case of Toll Plaza and other public services sensor circuit and GSM modem will be absent while the rest of the system remains as it is. The complete operational setup of the system is shown in Fig. 7.

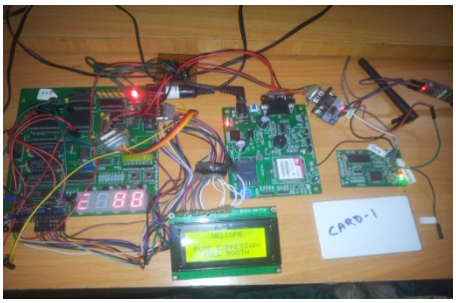

Fig. 7- The complete setup

IV. RESULTS

Demonstration of proposed system gave satisfactory results when used in Auto/Taxi mode as well as in Toll Plaza mode. The resulting snapshots are shown-

Auto/Taxi Operation Stage

Fig. 8- Idle Meter

Fig. 9- Meter in Use

Fig. 10- In transaction stage

Toll plaza Operation Stage

Fig. 11- Toll Plaza Welcome Message

Fig. 12- LCD displays Toll Amount and Real Time Clock

V. CONCLUSION

In this paper, we formalize the problem of centralizing public sector services in terms of payment, and proposed a scheme that helps to centralize payment in public sector services. Towards designing the system, we have used Hall Effect sensor as for distance computation, while we have not made use of any costly technology to have a lower cost of our proposed scheme. Having our system tested we show that 1) our system is more accurate than the current system 2) is more fraudulent proof 3) gives satisfactory result and efficiently makes transactions electronically. Thus our system centralizes complete public sector services and allows the user to access it and utilize it to its fullest with a help of a single smart card.

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