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Automatic bus ticketing system

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ABSTRACT

This paper presents an automatic bus ticketing system using Radio Frequency Identification (RFID) and Controller Area Network (CAN) bus technology. The system is intended to replace the traditional human-oriented ticketing system. It gives the solution to problems occurred in traditional systems as well as saves passengers ticketing time. The system uses an RFID card for passenger identification and uses the same for fare payment corresponding to the distance traveled. This system has an RFID reader module installed in a transport vehicle which is mainly used to verify the passenger, a central control unit used to monitor things like account balance, tickets charge, etc. The system involves a distance measuring unit which uses the GPS or vehicle's odometer/trip meter to detect the location of the bus, boarding place and alighting place of the passenger to estimate distance. Users needs to scan their card in front of the RFID reader which sends the data of that card to the central unit for further processing. In case the vehicle is traveling in an area that can't gain access to the satellite i.e. if GPS is not giving proper location then the distance is calculated by an odometer.

Keywords — Microcontroller, GPS interfacing unit, LCD module, RFID module, CAN bus module, CPU cards, Enclosures, Interfacing Hardware.

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I. INTRODUCTION

A. Overview

India is widely dependent on the public transport system for commute, majorly in an urban area. The public transport system is presently controlled with a conventional ticketing system and needs a conductor as a major human resource. Some time creates chaos about the fare system. The conductor has to issue proper tickets to all the passengers, this process is more time-consuming. So it is essential to develop an efficient system for bus fare collection. Hence this experiment is conducted using advanced technology, to design a system that addresses most of the problems regarding the existing bus fare collection system. This system automates the entire bus fare collection.

The system uses a Radio Frequency Identification (RFID) card and associated technology. RFID module is used for calculating the fare according to distance traveled by the passenger. As the passenger is regularly carrying the reusable RFID card, it also reduces the wastage of papers that are used for tickets purpose. An RFID card contains a unique digital data in it. User needs to scan their tag by the RFID reader to identify the tag ID. The tag ID contains the data of passenger i.e. passenger name, card balance, the traveling distance of passengers. The reader circuit sends the data into the Central Conteol Unit (CCU) system which has all the details of the particular passenger. It checks the identity of the person. Again passenger needs to hold the tag in front of the reader while alighting from the bus. The related fare is deducted from the tag as per the distance traveled by the passenger. RFID is a well-known technology that is used in many fields for identification and security goals. Here, two RFID modules are used at two different boarding places in the vehicle. Passengers can easily scan their RFID tags from places. The current location of the vehicle is identified by the Global Positioning System (GPS) and the traveling distance of passengers is sent to the system where it is shown by using Liquid Crystal Display (LCDs). To detect vehicle location and to find out the traveling distance the GPS technology is used. Controller Area Network (CAN) module is mainly used for synchronization between all these RFID modules.

B. Motivation

In the human-oriented ticketing system, the ticketing process is controlled by a conductor. The conductor collects money from each passenger and issue a ticket. Initially, printed papers or tokens are used as tickets. This system has many disadvantages. The passenger has to carry the ticket till the end of travel, the conductor should ensure that everyone has got the ticket. The time taken for ticketing is comparatively more and more amount of paper is needed to print the ticket. Nowadays, handheld machines are used to print tickets. In this system, the conductor is trained to operate the handheld ticketing machine. For example, if a passenger is to travel on the bus. He has to carry money and get a ticket from conductor. This has to repeat for all passengers. Even a handheld ticketing machine is comparatively slow and needs a trained person to operate it. After the implementation of RFID based ticketing system passenger does not require to carry money in cash and ticketing process become less time- consuming.

C. Objectives

1. To develop an efficient electronic bus fare collection system that can replace the traditional ticketing system.
2. To design and implement the solution for problems that occurred in traditional systems.
3. To save passengers ticketing time because the traditional ticketing system is more time-consuming.
4. To create the system which is more secure and gives confirmed notification. In traditional ticketing system passengers are required to pay for the ticket every time. Hence, it is proposed to design such a system in which the passenger requires to purchase the card only once.

II. LITERATURE REVIEW

Foisal Mahedi Hasan, GolamTangim, Kaiful Islam, Rezwanal Khandolkar have proposed the system which has an RFID-based Ticketing System for public transport. In this, authors have used RFID tags (Tickets) which has the right of entry to any bus service of the city only incoming passenger's current location and passenger destination point on the keyboard attached to each bus. The data is transferred to the server's main database and the equivalent credit will be stored in the corresponding bus account. Also, the display at every bus stop reports the passengers, leaving time of the last bus of any path. [1]

Dedy Wahayu Herdiyanto, Istas Pratomo, has implemented a system that contains RFID cards as an electronic ticket, On-Board Unit (OBU), access point at end place, network and managing returns server. A passenger may do the payment by OBU that installed in the transport system receiver by drumming the RFID card if they go into and out the vehicle. OBU system will read RFID data in the passenger card and sends it to the server. To access the server, OBU is connecting to the network throughout the access point at the bus stop. The server collects data from OBU two times for every passenger. Each of the data contains a passenger ID as well as the end location. The alighting location indicated passenger's present location and used to compute the fare required for service by analyzing boarding and alighting location. The finest range for OBU to connect via Wi-Fi is about 4-6 meters. [2]

Deepali Kayande, Sarita Saldanha, Sisil Sunny, and Bianca Alphonso developed a system has Near Field Communication(NFC) and RFID. The system is based on ticketing and tracking of the bus. The system recommends a user-friendly automated ticketing system which will automatically remove the passenger's fare based on the distance traveled and do real-time tracking of the bus so that the passengers know exactly when the bus will arrive.[3]

An automatic fare collection system using Radio Frequency Identification (RFID) without the need of a conductor according to the distance traveled by the passenger. The system uses a PIC controller for controlling interface purposes. The IR sensor is used for counting the number of passengers entering the bus and the computation will be sent to the PIC microcontroller which prepares it. U-slot sensor, as well as motor, is used to compute the range and the relevant amount is deducted from the RFID. [4]

Applying an automatic ticketing system enables operators such as transport authorities to save time and personnel costs; fare collection can be created more efficiently.

This system has low maintenance costs and reduced fraud induce losses represent further advantages. [5, 6]

Research about passenger identification and e-ticketing has been ongoing in many countries. Some of them are already implemented and used by the public. But, this topic still has much potential to be developed. And also, each country and city want to have their system so it can be integrated easily. In general, automated fare collection requires three points, robustness, scalability, and flexibility [7].

The result of the survey has led to a very positive approach to the impact of automatic bus ticketing systems and technologies. The approaches studied had various pros and cons in view of the time required for operations or complexity or flexibility and user interactions. With technology advancing everyday new systems, referred in [1, 2], CAN bus technology is proposed to use instead of a Wi-Fi module for communication purposes. This will add to the benefit that network failure problems will not disturb the overall function of the system. GPS is used for detecting the starting and ending locations of the passengers and to compute the fare according to the distance traveled by the passenger. In case the vehicle is traveling in an area that can't gain access to the satellite i.e. if GPS is not giving proper location then the distance is calculated using odometer available with the vehicle.

The EMI and pollution will be reduced, as the wi-fi module is not used in this system and wastage of papers is reduced by this system. The overall system is cost-effective and efficient when compared to another type of automation system.

III. SYSTEM DESIGN AND IMPLEMENTATION

A. System Flow Chart

The functional program flow is as shown in figure 1 and figure 2. Figure 1 shows the flow chart for the Central Control Unit and Figure 2 shows the flow chart for the Door Control Unit (DCU). In these systems, RFID reader checks

the card's validity which is held by the passenger near the DCU. If the card is valid then it reads/identifies RFID tag and sends the information to the Centarl Control Unit (CCU).

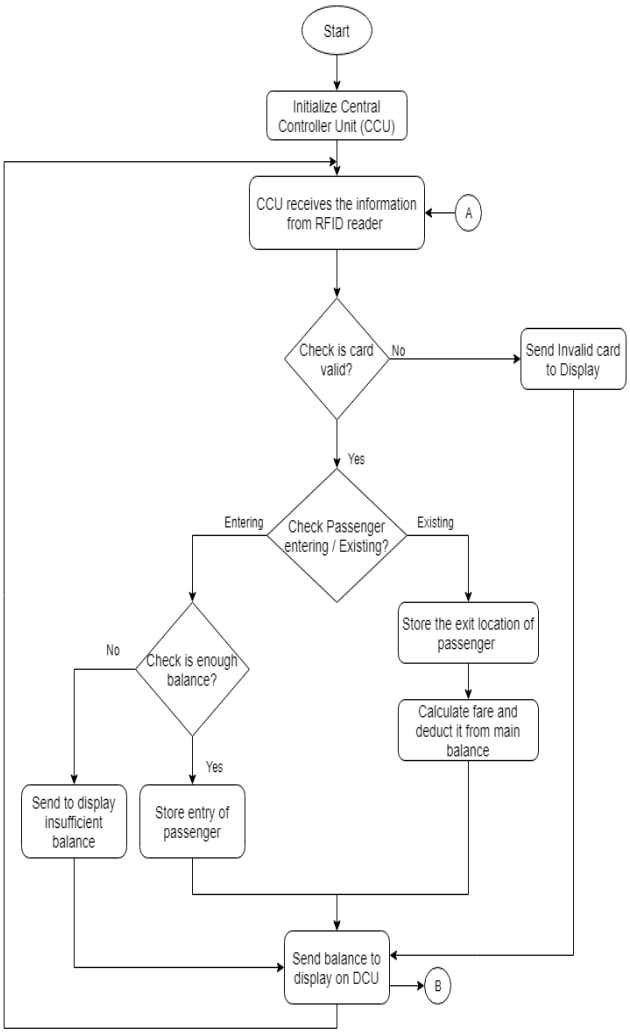

Figure 1. Flow chart for CCU

At the CCU it receives the information from RFID reader checks the card's validity. If the card is invalid then it sends "Card is Invalid" to the display and if the card is valid then it sends the "Card is Valid" to the display and checks passenger is entering/exiting. If a passenger is entering the bus then it checks for enough balance in the card. If the balance is less then it sends "Zero Balance Please Recharge The Card" to the display or if balance is enough then it stores the entry of passengers. When a passenger is exiting, it stores the alighting location of the passenger as well as calculates fare according to distance traveled by the passenger. The calculated amount is deducted from the main balance of the card and the remaining balance is sending on the display on DCU.

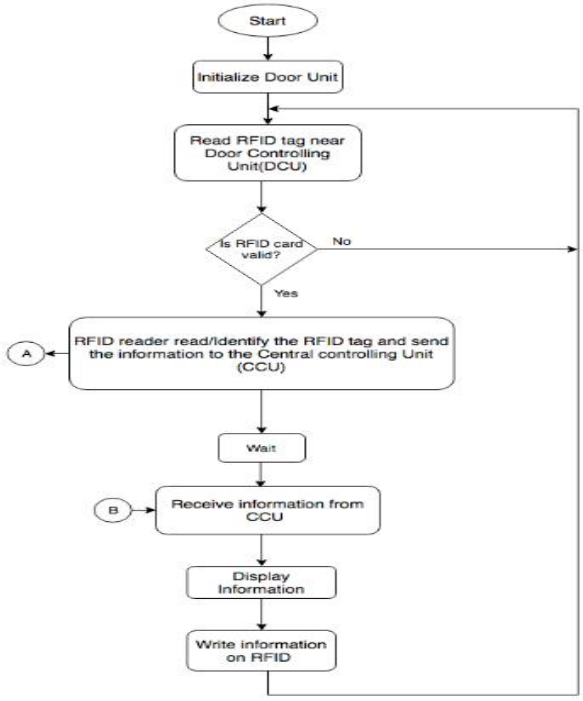

Figure 2. Flow chart for DCU

B. The functioning of the System

The block diagram for the "Automatic Bus Ticketing system" is as shown in figure 3. In the figure, RFID module, GPS module, and LCDs are interfaced with the Arduino Uno controller by using CAN bus. The RFID reader is used to verify the passenger. A control unit that uses the database to monitor factors likes fare, account balance, etc. The system also involves a distance measuring unit which uses the GPS module to find the place of boarding and alighting and to calculate the traveling distance. CAN module is used to establish communication as well as synchronization between multiple DCU's and CCU. This gives high-speed data transmission and long-distance communication. A CAN-BUS is designed to meet the standard requirements of communication without the use of a host computer.

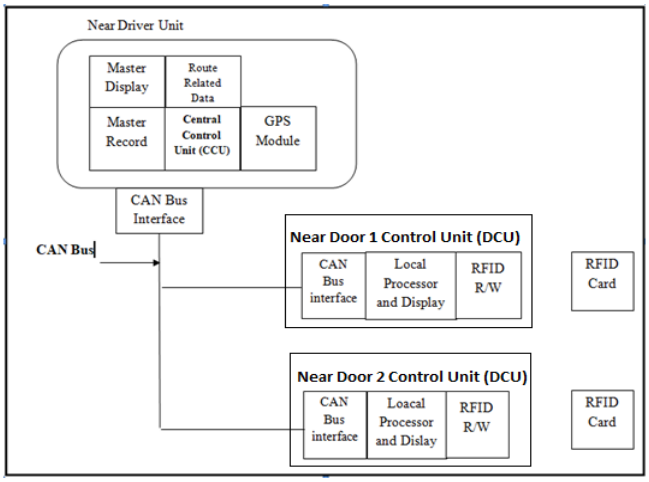

Figure 3. System representation of automatic farm watering system

CAN protocol enables communication between two Microcontrollers (MCUs) or computers. The MCP2515

Chip is a controller produced to simplify applicability that requires interfacing with a Can-Bus. LCD is used to display different parameters like stages of traveling path, deducted amount, distance traveled, balance, etc. After registering the card on the system, the system blocks that card till the next registration from the same card. If any passenger exists without verifying the card then the entire amount was debited from the card/tag and that card's balance remains zero. There are multiple DCUs at different doors of the vehicle. This will make the passenger to easily register his card from any door of the vehicle.

C. Following Components are used for testing and fabrication

1. Microcontroller with support circuitry – Arduino Uno board is used to process the program and controlling the system.
2. GPS interfacing unit – GPS L80 M39 to find the location of the vehicle.
3. LCD Module– 16X2 LCD module is used to display the passenger's information on CCU unit and in CCU units i.e. traveling distance of passenger, passenger name, card balance, number of passengers present in the vehicle.
4. RFID module – EM-18 RFID module is used to scan and read the RFID tag.
5. CAN bus module – CAN MCP2515 is used for communication and synchronization between different units in the system.
6. Enclosures
7. Interfacing Hardware – For interfacing different components in the system with each other.

In the Automatic Bus Ticketing system, the unit on which motor is mounted is a CCU unit and units on which RFID readers mounted are DCU unit1 and DCU unit2 as shown in figure 4. These two units have the same functionality. They are placed at two different doors of the vehicle. Internal wiring and hardware interfacing for the system are shown in figure 5 and figure 6 respectively.
As shown in figure 4, when a user scans their card at any DCU system, display of the CCU unit shows the status of passengers momentarily i.e. passenger name, the current balance of the card and traveling distance of the passenger. Afterward, it shows the number of passengers present in the bus and distance covered by bus. At the DCU unit, the display shows passenger name, the current balance in the card and traveling distance of passengers.

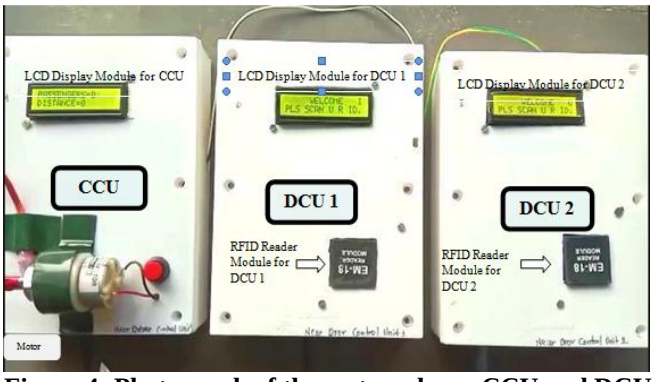

Figure 4: Photograph of the system shows CCU and DCU units for Automatic Bus Ticketing System.

In this system, the Arduino Uno board is used for processing and controlling all the devices in the system. 16×2 LCD module is used to display passenger's information, L80 M39 GPS module is used to measure distance traveled by the passenger, MCP2515 CAN module for high-speed data transfer and connecting CCU with DCU. A3144 Hall effect sensor is an alternative to the GPS module connected to the speedometer of a vehicle that performs the function to compute traveled distance, in absence of GPS module i.e. measures the distance traveled by the passenger in case of GPS failure or GPS is out of range. Arduino Uno board is used for processing, controlling and storing purpose. All the devices in the CCU are interfaced with it.

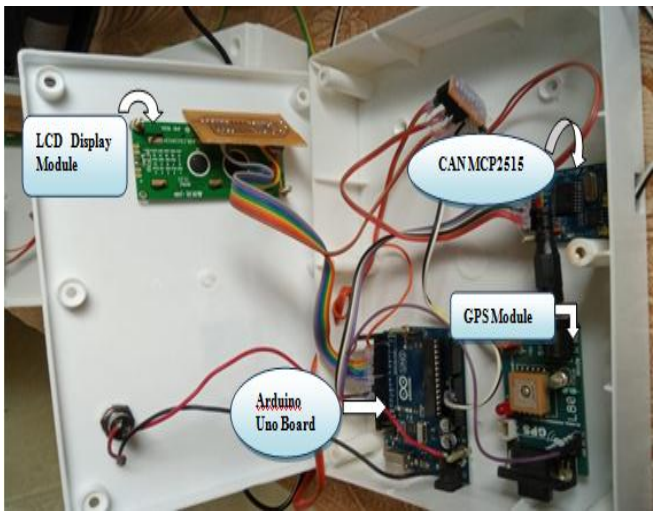

Figure 5: Pin connections of CCU unit for Automatic Bus Ticketing System

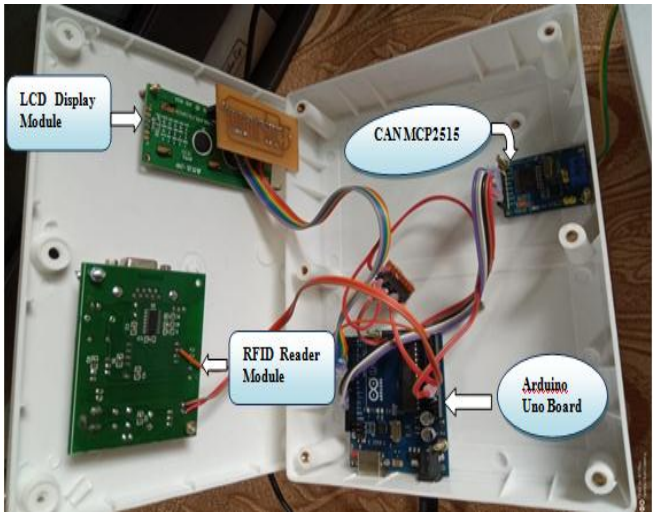

Figure 6: Pin connections of DCU unit for Automatic Bus Ticketing System

IV. CONCLUSION

The system is fully automated, reliable, transparent and convenient. In this system, there are three units one CCU system and two DCU systems. At the DCU unit, the RFID tag/card is scanned by the RFID reader; it identifies the passenger entering/existing and checks the validity of the card. The card information is displayed on the LCD screen.

After traveling some distance, the card is again scanned by the passenger and the system deducts the calculated amount from the tag/card according to the traveling distance of the passenger. The display shows the remaining balance of the card.

The Tags/cards being reusable and they are more beneficial as compared to the paper-based ticketing system. Also, fare calculation is performed automatically fare is crystal clear. Cash is no longer necessary, contactless Tags/cards can be loaded with great amounts of money; passengers no longer need to carry and give the correct change.

The system reduces most of the disadvantages in the existing paper-based ticketing system. The card is reusable and rechargeable so people do not need to purchase the tickets every time from the conductor. Hence human interface is eliminated and also reduces wastage of paper. Also by including payment features through mobile for scanning the card from mobile, people can make their payment online. These systems are also helpful for other applications like school buses, metro railways, etc. Different trials are taken for different tags and satisfactory results were received as per consideration.

V. FUTURE SCOPE

1. The same system can be implemented by developing an android application for mobile phones. In that, the function of an RFID card will be performed by users mobile. Instead of LCD, we can use a mobile screen to show passengers information to driver and passenger i.e. Users name/image, current balance, traveling distance, current location, etc. The mobile phone consist the built-in application used as a user's card and GPS receiver which receives a signal from a GPS tracker in the vehicle. Using this GPS reading, the current location of the vehicle can be received. Also when the user is boarding into the bus scans their mobile at the DCU unit placed at the vehicle door, using GPS the current location of the user can be obtained and stored in the database. While alighting the vehicle user scans the phone at DCU unit which will give the destination location of the user. Based on the source and the destination the total traveling distance will be obtained and corresponding travel fare will be debited from the user's account.

2. By making some modifications in the same system it is possible to develop such a system that has many features in one application that can be used from various platforms. These features consist of travel packages, booking airline tickets, buses, trains, hotel reservations, tour guides, looking for nearby attractions, car & motorcycle rentals, etc. So people can travel anywhere and easily applicable to local transport systems.

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