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Automatic Bus Fare Collection System Using RFID

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Abstract: ***India is the second largest populated country in the world so most of the people use public transport. During peak hours issuing tickets to each passenger manually is time consuming and tedious task and also a problem. The probability of ticket fraud is also high in this case. Since the tickets are made of papers it leads to deforestation and these tickets are of no use once when the passenger gets out of the bus. So in order to overcome all these difficulties we have a Smart ticketing system that is proposed using RFID to issue tickets to passengers. In order to ensure the passengers journey with no quarrels and mesh we employ this solution that replaces the traditional paper ticketing by electronic cards, vended through automated machine using smart cards, which improves the convenience and security of transaction. This project actually suggests a much more public friendly, automated system of ticketing with the use of RFID based tickets. Automatic Fare Collection System is implemented in this project through RFID (Smart) card. RFID card is given to the passenger and when passenger enters to the bus, he has to scan the card in the RFID reader. All the record will update automatically in the server continuously. RFID system through automated machine enables the passenger to predetermine the transport details. The control circuit is designed using arduino controller that will be interfaced with a DC motor to identify the distance travelled by the passenger to collect the fare amount. In addition a LCD is used for displaying the data.***

I. INTRODUCTION

A. Aim Of The Project

A Smart Ticketing system or the fare collecting system has its benefits while many people may argue that a switch to paperless will be more expensive, in terms of software and hardware requirements than the traditional paper-based system. Going paperless not only has a huge impact on the environment but also saves costs of ink, paper, labor costs associated with it. By taking into consideration the above parameters, a smart ticketing system using a combination of RFID technology, Arduino microcontroller, DC Motor is designed. RFID has proven to be one of the most promising technologies in recent years and can be effectively employed in various applications since it is economical and widely used tool for tracking and locating purposes. A reader will be attached to the bus at the entrance.The main objective of the system is to uniquely identify the passenger and display details. This requires a unique code, which has the capability of distinguishing different products. This is possible by the new emerging technology RFID (Radio Frequency Identification). The main parts of an RFID system are RFID tag (with unique ID number) and RFID reader (for reading the RFID tag). The microcontroller internal memory is used for storing the details.

B. Literature Survey

A methodology has been introduced for introducing RFID based smart transportation system. The main aim of this research work is to offer an effortless transportation facility by minimizing the problems faced by passengers, drivers and the concerned authorities with the help of a handy android application. Our system uses Radio Frequency Identification [RFID], Global Positioning System [GPS], and an android application for passenger management and real-time tracking features for offering a satisfying bus fare calculation.

In the proposed framework, the passenger is identified automatically and the fare based on the distance travelled is deducted automatically, the use of RFID tags along with GPS is used to make the identification of passenger and the fare more accurate. The traditional paper-based tickets can be replaced by the RFID system as they are reusable and provide higher accuracy and hence they are much better. This replaces the existing paper-based bus ticketing system and also prevents corruption/unaccounted money. RFID tags are being used as tickets which are reusable and deducted the fare based on the distance travelled using GPS system by the user. This system minimizes human errors and effort. For the past decades, the usage of public transport especially bus has lost its number of passenger and people started using other private means of transport. Advancement in the technology has shown various features to attract people, give them more comfort while traveling. Based on the results from IR sensor, number of passengers can be counted and analyze the peak hours.

This paper attempts to review the various technologies required to arrive at the right advancement. An automated system for ticketing in the Public Transport System (PTS) which is based on passenger identification which will automatically identify the passenger and deduct the passenger's fare according to the distance travelled The Radio Frequency Identification (RFID) card. The cards being reusable, they are much more convenient compared to the paper-based ticketing system. The unique ID in the RFID cards is stored in a database in the internet along with personal data and creates accounts for each person. In the proposed system the smart application that will automatically allocate the seat to passenger, can reserve ticket digitally and mode of payment will be cashless thereby promoting digitalization and smart cities initiatives. The source of the user will be added automatically when connected to the device installed at the bus stop. The user can check the availability of seats, book tickets, get the seat automatically through efficient novel algorithm and the expected waiting time. If seats are not vacant, our algorithm will efficiently allot the seat that will be vacant in shortest time.

C. Motivation

The motivation behind developing an Automatic Bus Fare Collection System using RFID (Radio Frequency Identification) technology stems from several key factors:

Efficiency: Traditional bus fare collection methods involving cash transactions or paper tickets can be time-consuming and inefficient, leading to long queues and delays. By implementing an RFID-based system, fare collection becomes faster and more streamlined, reducing boarding times and improving overall efficiency.

Convenience: RFID technology allows for contactless payment, making it more convenient for passengers to board buses without the need to fumble for cash or tickets. This enhances the overall passenger experience and encourages more people to use public transportation.

Cost savings: Automating fare collection through RFID can help transit agencies reduce operational costs associated with manual ticketing systems, such as printing and distributing paper tickets, handling cash, and staffing ticket booths. Over time, these cost savings can be significant and contribute to the financial sustainability of public transportation services.

Data collection and analysis: RFID systems can generate valuable data on passenger usage patterns, travel routes, and peak hours, which transit agencies can use to optimize service planning, scheduling, and resource allocation. This data-driven approach can lead to better-informed decision-making and improved service quality.

Fraud prevention: RFID technology offers enhanced security features compared to traditional ticketing methods, reducing the risk of fare evasion and fraudulent activities. By requiring passengers to tap their RFID cards or devices to board buses, transit agencies can better track and monitor fare payments, ensuring revenue integrity.

Overall, the motivation for implementing an Automatic Bus Fare Collection System using RFID is to modernize fare collection processes, improve operational efficiency, enhance the passenger experience, and ensure the financial sustainability of public transportation services.

D. Problem Statement

The current manual bus fare collection system is inefficient and prone to errors, leading to long queues, revenue losses due to fare evasion, and increased operational costs for transit agencies. There is a need for an Automatic Bus Fare Collection System using RFID technology to streamline fare collection processes, improve efficiency, reduce revenue leakage, enhance passenger experience, and ensure the financial sustainability of public transportation services.

II. DESIGN OF SYSTEM

A. Hardware Used

1) RFID Reader
2) RFID Cards
3) Liquid Crystal Display(LCD)
4) Arduino UNO Controller
5) Transformer
6) Rectifier
7) Filter
8) Regulator
9) Relay
10) Global System for Mobile communication (GSM)

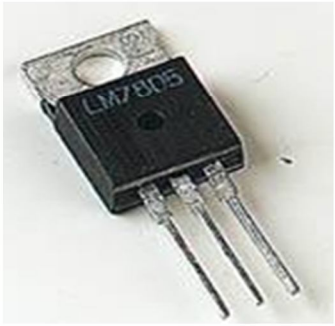
Arduino uno

RFID Cards

LCD

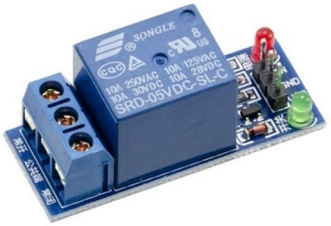
RFID Reader

Transformer



Regulator

GSM Module



Relay

Fig.2.1 : Components of Project

B. Block Diagram

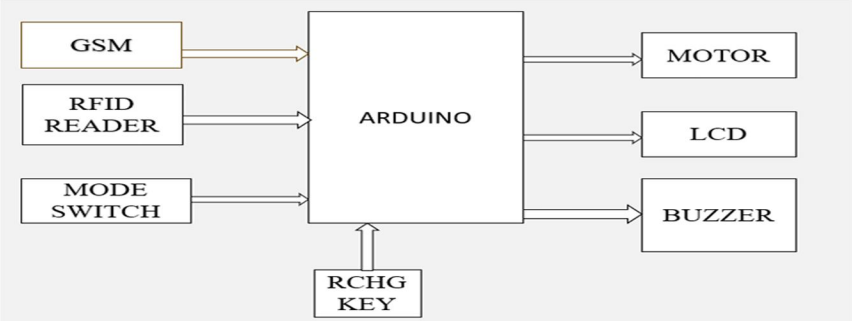


Fig.2.2.Block Diagram of Automatic Bus Fare Collection system

Automatic Fare Collection System is implemented in this project through RFID (Smart) card. RFID card is given to the passenger and when passenger enters to the bus, he has to scan the card in the RFID reader. If there is sufficient balance in the RFID card, then he will be allowed to board. If the balance is very less or not present, a buzzer will be activated and the user has to recharge the RFID card with some amount. Once he comes out of the bus stand at any stop, while coming out, again the RFID card is to be scanned at that station. There by the fare amount will be deducted automatically from his card depending on the station he got in which is stored in the data base and the remaining balance in his card will be displayed in the LCD. All the record will updated automatically in the server continuously.

III. WORKING

Automatic Fare Collection System is implemented in this project through RFID(Smart) card. RFID card is given to the passenger and when passenger enters to the bus, he has to scan the card in the RFID reader. If there is sufficient balance in the RFID card, then he will be allowed to board. If the balance is very less or not present, a buzzer will be activated and the user has to recharge the RFID card with some amount. Once he comesout of the bus stand at any stop, while coming out, again the RFID card is to be scanned at that station. There by the fare amount will be deducted automatically from his card depending on the station he got in which is stored in the data base and the remaining balance in his card will be displayed in the LCD. All the record will updated automatically in the server continuously. The demo module of the project work is designed using RFID tag (card) as the ticket which is to be recharged with some amount at the bus stands. When entered into the bus, the RFID card is to be scanned so that the details like balance amount will be displayed. If there is no balance, buzzer will be activated and the card has to be recharged and at the destination point again the card has to be scanned. By this, the embedded system deducts the amount from the card depending on the destination and the balance amount in the form of credit is stored into the details. RFID system through automated machine enables the passenger to predetermine the transport details. The control circuit is designed using arduino controller that will be interfaced with a DC motor to identify the distance travelled by the passenger to collect the fare amount. In addition a LCD is used for displaying the data.

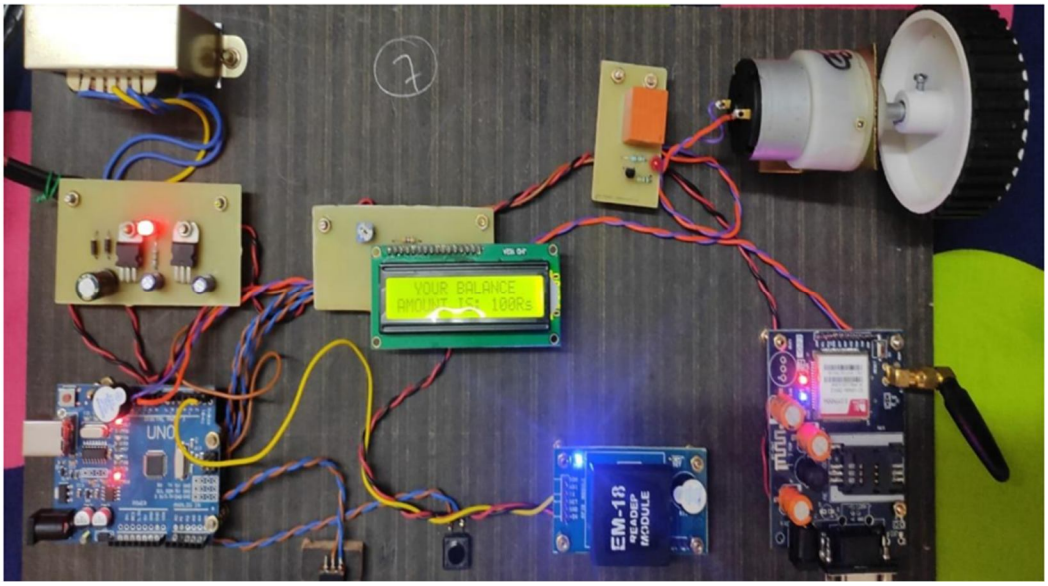


Fig.3.1 Initially when the card is scanned on boarding

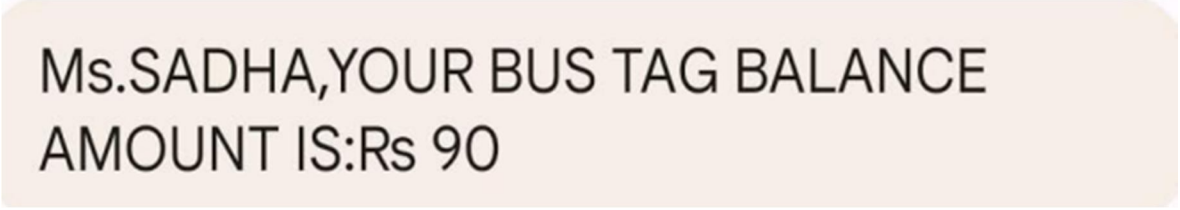


Fig.3.2 Message sent to the registered mobile

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IV. HARDWARE DESCRIPTION

A. RFID Reader

RFID reader is device that is used to interrogate an RFID tag the reader has an antenna that emits radio waves the tag responds by sending back its data. A number of factors can affect the distance at which a tag can be read the frequency used for identification the antenna gain, the orientation and polarization of the reader antenna as well as the placement of the tag on the object to be identified will have an impact on the RFID system read range..

B. RFID TAGS

A radio-frequency identification system uses tags, or labels attached to the objects to be identified. Two-way radio transmitter-receivers called interrogators or readers send a signal to the tag and read its response. The tag's information is stored electronically in a non-volatile memory. The RFID tag includes a small RF transmitter and receiver. An RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and responds with its identification information. This may be only a unique tag serial number, or may be product related information such as a stock number, lot or batch number, production date, or other specific information. RFID tags contain at least two parts: an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, collecting DC power from the incident reader signal, and other specialized functions; and an antenna for receiving and transmitting the signal.

C. Liquid Crystal Display (LCD)

The LCD used is to display the balance amount. The LCD panel used in this block is interfaced with micro-controller through the output port. The details of the patient along with his health report will be displayed in the LCD. This is a 16 character x 2 Line LCD module, depending up on the availability of LCD panel 3 lines or 4 lines panels can be used for the purpose, so that more information can be displayed simultaneously. These panels are capable of displaying numbers, characters and graphics. The display contains two internal byte-wide registers, one for commands (RS=0) and the second for characters to be displayed (RS=1). It also contains a user programmed RAM area (the characterRAM) that can be programmed to generate any desired character, which can be formed using a dot matrix. To distinguish between these two data areas, the hex command byte 80 will be used to signify that the display RAM address 00h is chosen.

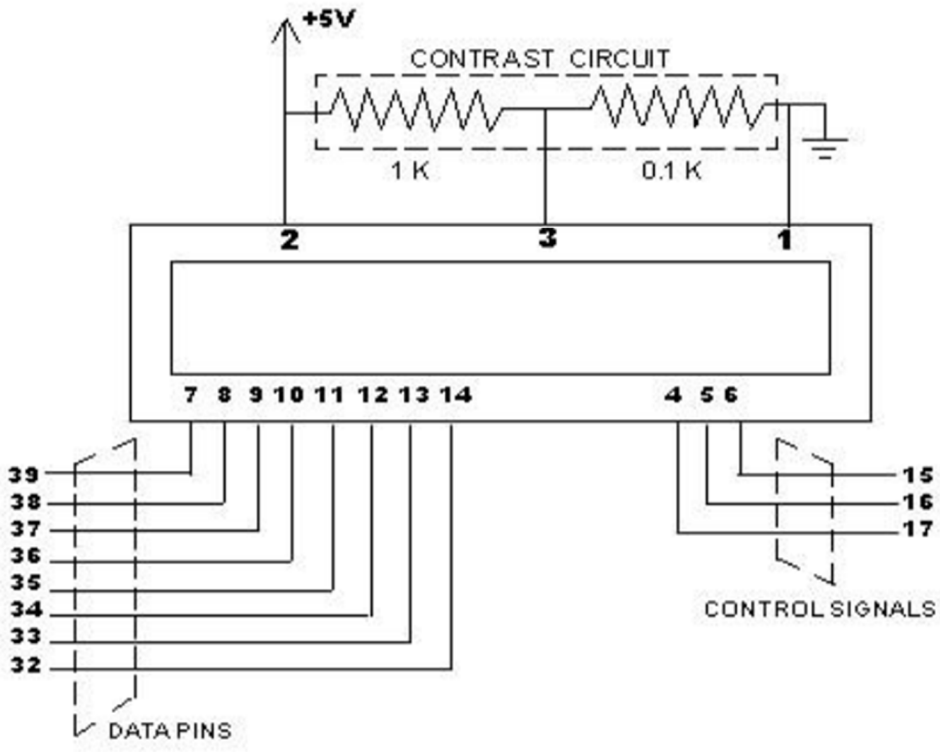

Fig.4.3.1 Liquid Crystal Display

1) Interfacing the display unit to the micro Controller

Pin Symbol I/O Description
1 V ss -- Ground
2 V cc -- +5V Power Supply
3 VEE -- Power supply to Control Contrast
4 RS I RS = 0 to select command register,
RS=1 to select data register
5 R/W I R/W =0 for write,
R/W=1 for read
6 E I/O Enable
7 DB0 I/O The 8-bit data bus
8 DB1 I/O The 8-bit data bus
9 DB2 I/O The 8-bit data bus
10 DB3 I/O The 8-bit data bus
11 DB4 I/O The 8-bit data bus
12 DB5 I/O The 8-bit data bus
13 DB6 I/O The 8-bit data bus
14 B7 I/O The 8-bit data bus

D. Arduino UNO Controller Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier toput into DFU mode. Revision 3 of the board has the following new features: • pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes. • Stronger RESET circuit. •Atmega 16U2 replace the 8U2. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Summary
• Microcontroller ATmega328
• Operating Voltage 5V
• Input Voltage (recommended) 7-12V
• Input Voltage (limits) 6-20V
• Digital I/O Pins 14 (of which 6 provide PWM output)
• Analog Input Pins 6
• DC Current per I/O Pin 40 mA
• DC Current for 3.3V Pin 50 mA
• Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader
• SRAM 2 KB (ATmega328)
• EEPROM 1 KB (ATmega328)
• Clock Speed 16 MHz

E. Transformer

A transformer is an electrical device which is used to convert electrical power from one Electrical circuit to another without change in frequency. Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase in output voltage, step-down transformers decrease in output voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage to a safer low voltage. The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up. The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

Turns ratio = Vp/ VS = Np/NS

Power Out= Power In VS x IS=VP x IP

Vp = primary (input) voltage

Np = number of turns on primary coil

Ip = primary (input) current

Fig.4.5.1 An Electrical Transformer

F. Rectifier

A circuit which is used to convert a.c to dc is known as RECTIFIER. The process of conversion a.c to d.c is called "rectification".

Types of Rectifiers

1. Half wave Rectifier
2. Full wave Rectifier

(i). Centre tap full wave rectifier.

(ii). Bridge type full bridge rectifier.

Full-wave Rectifier

From the above comparison we came to know that full wave bridge rectifier as more advantages than the other two rectifiers. So, in our project we are using full wave rectifier circuit.

G. Filter

A Filter is a device which removes the a.c component of rectifier output but allows the d. c component to reach the load

Capacitor Filter We have seen that the ripple content in the rectified output of half wave rectifier is 121% or that of full-wave or bridge rectifier or bridge rectifier is 48% such high percentages of ripples is not acceptable for most of the applications.

Ripples can be removed by one of the following methods of filtering.

1) A capacitor, in parallel to the load, provides an easier by –pass for the ripples voltage though it due to low impedance. At ripple frequency and leave the D.C. to appear at the load.

2) An inductor, in series with the load, prevents the passage of the ripple current (due to high impedance at ripple frequency) while allowing the d.c (due to low resistance to d.c)

3) Various combinations of capacitor and inductor, such as L-section filter section filter, multiple section filter etc. which make use of both the properties mentioned in (a) and (b) above. Two cases of capacitor filter, one applied on half wave rectifier and another with full wave rectifier.

Filtering is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC 12 GNITS-ECE DEPT voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output. Filtering significantly increases the average DC voltage to almost the peak value (1.4 × RMS value).

To calculate the value of capacitor(C),

C = ¼*√3*f*r*Rl

Where

f = supply frequency,

r = ripple factor,

Rl = load resistance

Note: In our circuit we are using 1000µF hence large value of capacitor is placed to reduce ripples and to improve the DC component.

H. Regulator

Voltage regulator ICs is available with fixed (typically 5, 12 and 15V) or variable output voltages. The maximum current they can pass also rates them. Negative voltage regulators are available, mainly for use in dual supplies.

Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection'). Many of the fixed voltage regulators ICs have 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. The LM7805 is simple to use. You simply connect the positive lead of your unregulated DC power supply (anything from 9VDC to 24VDC) to the Input pin, connect the negative lead to the Common pin and then when you turn on the power, you get a 5 volts supply from the output pin.

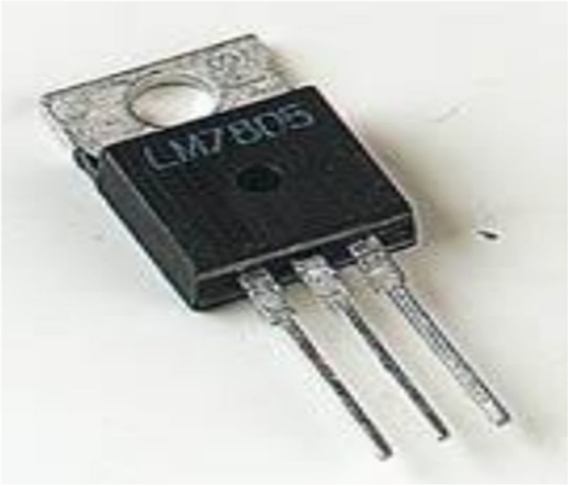

Fig.4.8.1 A Three Terminal Voltage Regulator

I. Relay

Relays are electromechanical switches that use an electromagnet to mechanically operate a switch, making or breaking electrical connections. They are crucial in controlling high-power circuits with low-power signals and are used in a wide range of applications, including automation, telecommunications, power systems, and more.

J. Global System for Mobile Communication (GSM)

GSM (Global System for Mobile Communications) is a digital cellular communications system. It was developed to create a common European mobile telephone standard but it has been rapidly accepted worldwide. GSM is designed to provide a comprehensive range of services and features to the users not available on analogue cellular networks and in many cases very much in advance of the old public switched telephone network (PSTN). In addition to digital transmission, GSM incorporates many advanced services and features like worldwide roaming in other GSM networks.

Applications of GSM Modem: GSM is world's most famous Mobile platform. Mobile phones with SIM cards use GSM technology to help you communicate with your family, friends, and business associates. GSM systems have following advantages over basic landline telephony systems:

1) Mobility
2) Easy availability
3) High uptime

a) GSM Features

One of the remarkable features is the Subscriber Identity Module (SIM). SIM being memory device stores information such as the subscriber's identification number, list of countries and networks where the subscriber is entitled to service, privacy keys etc. A 14

b) Z-ECE Dept

SIM consists of four-digit personal identification number to activate service from any GSM phone. SIM's is available as smart cards that maybe inserted into GSM phone or plug-in modules, which are portable and removable.

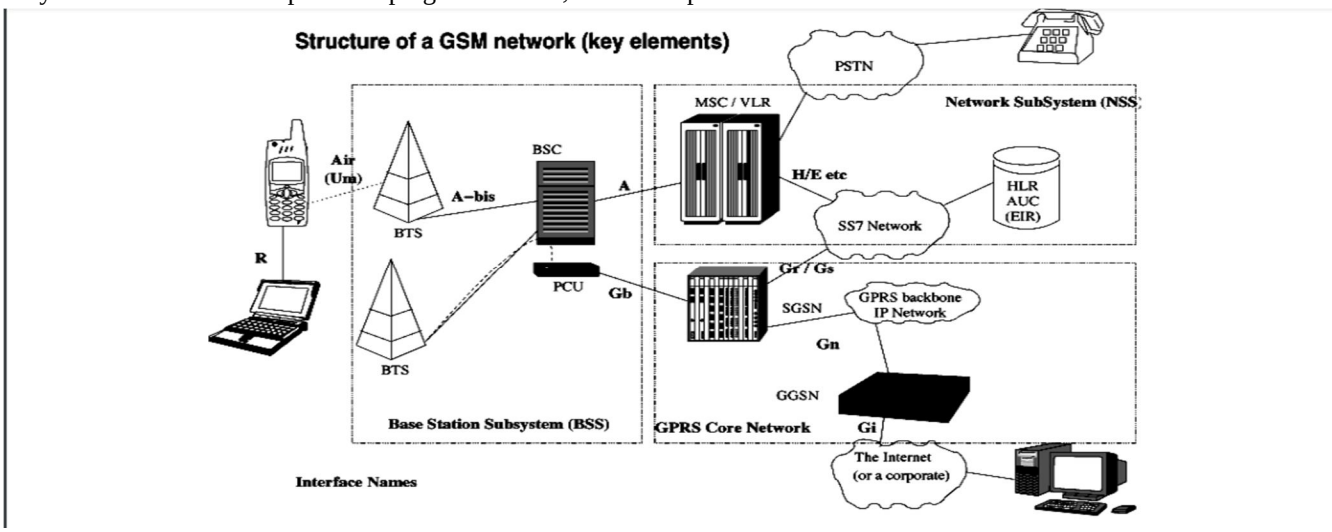

Fig.4.10.1 Structure of GSM network

V. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

A. Advantages

1) Efficiency and Speed

Faster Boarding Process: RFID allows for quick and contactless transactions, reducing the time passengers spend boarding the bus. This efficiency can lead to faster turnaround times at bus stops and improved overall travel times.

2) Convenience for Passengers

Contactless Payments: Passengers can make payments simply by tapping or waving their RFID-enabled cards or devices, eliminating the need for physical tickets or cash. This convenience is particularly appreciated by passengers who prefer not to carry cash or go through the hassle of purchasing tickets.

3) Reduced Cash Handling

Lower Risk of Theft and Fraud: With RFID technology, there is less reliance on cash transactions,reducing the risk of theft or fraud for both passengers and bus operators. This contributes to a safer and more secure transportation system.

4) Data Accuracy and Management

Automated Record Keeping: RFID systems provide accurate and automated data collection, recording each transaction in real-time. This can enhance the accuracy of fare collection records and simplify auditing and reporting processes for transportation authorities.

B. Disadvantages

1) High Initial Cost

Infrastructure Investment: Setting up the RFID infrastructure, including readers, cards, and backend systems, can involve a significant initial investment. For smaller or less financially stable transportation systems, this cost may be a barrier to implementation.

2) Technological Dependency

Vulnerability to Technical Issues: RFID systems depend on technology, and technical glitches or failures can occur. This may result in service disruptions, and the system may require regular maintenance to ensure optimal performance.

3) Limited Accessibility

Exclusion of Non-Tech Users: Some passengers, especially those who are not familiar with or do not have access to RFID-enabled cards or devices, may face difficulties using the system. This can lead to exclusion and dissatisfaction among certain demographics.

C. Applications

1) Public Transportation Systems

Buses: The primary application is in bus transportation systems where RFID technology streamlines fare collection, making the process more efficient for both passengers and transportation authorities.

2) Metro and Light Rail Systems

Trains and Subways: Similar to buses, RFID-based fare collection systems can be implemented in metro and light rail systems, providing a seamless and contactless way for passengers to pay their fares.

3) Integrated Transit Networks

Multi-Modal Transport: RFID technology allows for the integration of fare collection across different modes of public transportation, enabling passengers to use a single card or device for buses, trains, and other transit options.

4) Airport Shuttle Services

Airport Transportation: RFID can be used for fare collection in shuttle services that transport passengers between airport terminals, parking lots, and nearby hotels.

5) Tourist Transportation

City Tours and Shuttles: RFID-based fare collection systems are suitable for tourist buses and shuttles, offering a convenient and efficient way for visitors to pay for transportation services.

6) Educational Institutions

School Buses and Shuttles: RFID technology can be employed for fare collection on school buses or shuttles, providing a secure and automated system for transporting students.

7) Corporate Transportation

Employee Shuttles: Companies can implement RFID-based fare collection for employee shuttle services, facilitating a smooth and secure transportation experience for their workforce.

VI. CONCLUSION

The project work is designed and developed successfully. For the demonstration purpose, a prototype module is constructed; and the results are found to be satisfactory. Since it is a prototype module, a simple module is constructed, which can be used for many applications. While designing and developing this proto type module, we have consulted few experts those who are having knowledge in embedded systems and these professionals working at different organizations belongs to Hyderabad helped us while fabricating this project work. Since it is a prototype module, much amount is not invested. The whole project is constructed with locally available components. Some of the modifications must be carried out in design to make it as real working system.

The system is expected to be fully automated, reliable, transparent and convenient. The whole system can also be used in vehicle on highways, their toll payment and in the railway ticketing system with small or no modification. The cards being reusable, they are much more convenient compared to the paper based ticketing system. The card also can be used to be a universal travel pass card that will allow any transportation on any route. Any unwanted events can be avoided as all the person carrying RFID tickets are monitored every time they travel. Also the possibilities of reducing traffic jams, chaos in the bus stoppage that we usually experienced in city are immense. We can also make right travel distance payment to the passengers and tendering exact change problem can also be solved and hence solve the problem of ticketing.

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SIGNETICS - DIGITAL IC's manual

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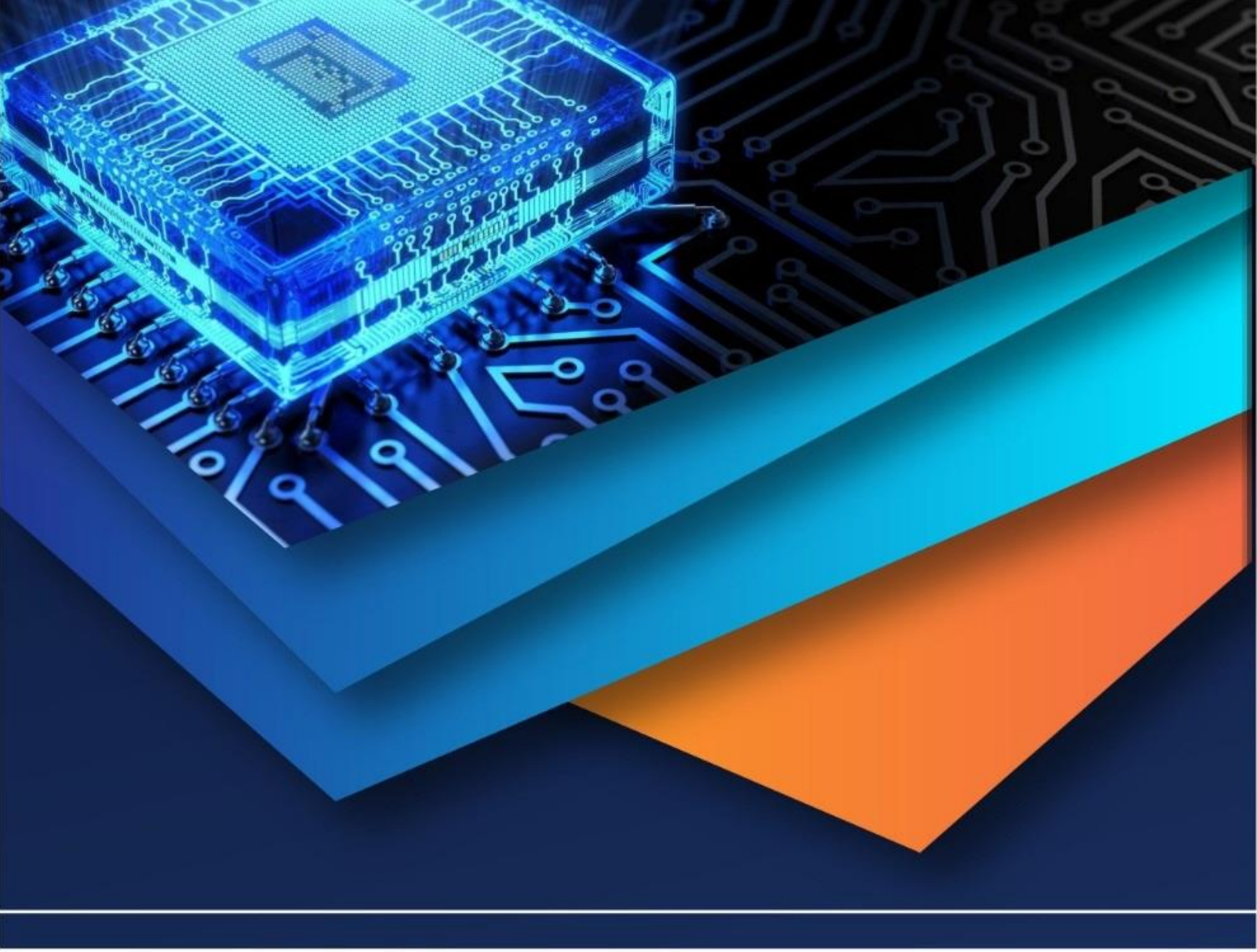

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