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A

PROJECT WORK ON

"OPTIMIZING TRANSPORTATION FOR SMART BUS MANAGEMENT SYSTEM"

Carried out

by

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Submitted in partial fulfillment for the award of

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IN

ELECTRONICS AND COMMUNICATION ENGINEERING

Under the guidance of

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CERTIFICATE

This is to certify that the project work entitled

"OPTIMIZING TRANSPORTATION FOR SMART BUS MANAGEMENT SYSTEM"

is a work carried out by

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is a bonafide work carried out at K.S. institute of Technology, Bangalore in partial fulfillment for the award of Bachelor of Engineering Degree in Electronics and Communication from Visvesvaraya Technological University, Belgaum during the year 2023-2024. It is certified that all corrections and suggestions indicated during internal assessment have been incorporated in the report deposited in the department library. The project report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for Bachelor of Engineering Degree.

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DECLARATION

We SHREYA H bearing USN:1KS20EC096, SHWETA DEEPAK bearing USN:1KS20EC099, SUMANA N bearing USN:1KS20EC102 and VAISHNAVI A bearing USN:1KS20EC110 students of 8th semester B.E., Department of Electronics and Communication Engineering, K.S. Institute of Technology, Bengaluru declare that the project entitled "OPTIMIZING TRANSPORTATION FOR SMART BUS MANAGEMENT SYSTEM" has been carried out by us and submitted in partial fulfillment of the course requirements for the award of degree in B.E. in Electronics and Communication, Visvesvaraya Technology University, Belgaum during the academic year 2023-2024. Further, the matter embodied in dissertation has not been submitted previously by anybody for the award of any Degree or Diploma to any other University.

Signature of the candidates

Place: Bengaluru
Date:

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ABSTRACT

In today's fast-paced world, efficient time management is paramount, particularly in the realm of public transportation. Recognizing this need, a smart ticket collection system is proposed as a solution to streamline the traditional bus ticketing process. By leveraging RFID technology, this system aims to enhance both the efficiency of fare collection and the overall passenger experience. RFID cards serve as the linchpin of this innovative approach, enabling swift ticket validation and eliminating the need for manual ticketing processes. Beyond facilitating fare collection, RFID technology also allows for the real-time monitoring of seat availability on buses. This information is seamlessly integrated into passenger-facing interfaces, providing commuters with up-to-date schedules and seat availability status. The system's real-time updates empower passengers to make informed decisions about their travel plans, allowing them to opt for alternative modes of transportation if necessary. By offering continuous updates at bus stops, the system enhances transparency and convenience for passengers, ultimately saving their valuable time and improving overall transit experience. Overall, the smart ticket collection system represents a significant step towards optimizing public transport operations and meeting the evolving needs of modern commuters.

Chapter -1

INTRODUCTION

Public transportation serves as the backbone of urban, providing vital connections for millions of people and playing a pivotal role in facilitating economic development and societal progress. However, conventional bus systems often struggle with various shortcomings, including overcrowding, frequent delays, inconsistent scheduling, limited seating capacity, and vulnerabilities to fraudulent activities in ticket collection. Recognizing the imperative for a more efficient and passenger-centric transit solution, we have developed an optimized bus management system. Our innovative approach leverages advanced technology, particularly Radio Frequency Identification (RFID), to overcome the challenges inherent in traditional bus systems. RFID technology enables seamless tracking and identification of buses and passengers, revolutionizing the way we conceptualize and manage urban transit. By implementing RFID tags on buses and RFID cards for passengers, our system enables precise tracking of bus locations, efficient fare collection, and real-time monitoring of passenger flow. RFID-enabled fare collection systems enhance revenue security and streamline passenger boarding processes, reducing boarding times and improving overall efficiency. Moreover, by providing passengers with greater transparency and convenience in accessing transit services, our system enhances passenger satisfaction and fosters a more positive perception of public transportation.

Chapter -2

LITERATURE SURVEY

Santosh Sambare, Abhishek Aru, Vikas Kalokhe, Tushar Jashav, and Swapnil Bhosale are all focused on "RFID BASED BUS TRACKING SYSTEM." RFID technology and GSM connectivity are used by the proposed bus monitoring and management system to provide real-time tracking and data exchange. Each bus has a black box with an emergency button, GSM modem, and RFID reader interfaced with a microcontroller. RFID devices communicate as the bus gets closer to a tagged bus stop, and information is transmitted by GSM to the Superstation to update the central database. In the event of an emergency, the driver can notify the Superstation by pressing an emergency button. Bus modules also communicate location data. The Superstation handles data, tracks emergencies, and provides Bus-Stop modules with position data. Bus-Stop modules increase passenger convenience by displaying bus locations and anticipated arrival times. The system's objective is to reduce bus un-utilization and waiting times, benefiting both administrators and passengers.[1]

Ms. Supriya K. Adak, Ms. Akshata M. Annadate, Ms. Swarupa A. Deshmukh, and Mrs. Snehal Bhosale's most recent work focuses on creating an RFID-ENABLED SMART BUS TRACKING SYSTEM. Three terminals are part of the system: the master device on the bus stand, the device on the bus stop, and the device on the bus itself. The bus's equipment communicates wirelessly with the bus stop device, sending its ID along with other data. The bus stop device uses RS 485 to send the data it has collected to a PC that displays a map showing the whereabouts of the buses. The gadget on the bus transmits SMS updates on the status of the bus to the master device at the bus station. The RFID tag used is the EM18 with Wiegand protocol, connected to a microcontroller. The RFID reader continuously transmits an electromagnetic field, and when an RFID card enters its 10cm range, it powers up and provides a 26-bit ID to the reader. The Weigand protocol is interrupt-based, requiring the microcontroller to interpret data from interrupts on data lines connected to its external interrupt pins.[2]

Sudhir Divekar, Sagar R. Patil, Satish Shelke have introduced an innovative Smart Bus System. Two components make up the project: a receiver system at a bus terminal and a transmitter installed inside a bus. The transmitter is made up of an LCD display, door switch, relay unit, RF transmitter, GPS module, GSM modem, voice recording/playback unit, and PIC microcontroller. The GPS module uses latitude, longitude, and altitude to calculate bus locations by receiving signals from satellites. When a match is found, the stop name is announced through a speaker IC and the location name is shown on the LCD by the microcontroller, which has stored and compared the coordinates. In order to prevent mishaps, the microcontroller also monitors the status of the doors and stops the bus from leaving if it is open. Details about the bus, such as the route, bus number, and vacant passenger seats, is transmitted via RF transmitter to the bus stand as the bus approaches. The receiver system at the bus stand detects this information, displays details on a display, and makes automatic announcements. The system utilizes GPS technology and microcontrollers for an efficient bus location announcement system.[3]

Karthikeyan G, Jawahar M L have introduced a SMART BUS MANAGEMENT SYSTEM. The proposed system uses a GPS module that is fixed inside each bus to continuously retrieve latitude and longitude data. NodeMCU processes this data and sends it to a cloud server that is connected to Google Maps so that bus tracking may be done in real-time. Through the mobile application, users may keep an eye on the bus's location. In addition, the system keeps track of bus stand entries, starts a timer when the bus arrives, and sounds a buzzer when the bus stays longer than the allotted amount of time. When there are infractions, the bus stand supervisor is notified and given information; they have the authority to issue fines. The bus owner receives monthly reports that include information on fines and regulation infractions. The bus stand in-charge has the ability to turn the system off in an emergency by using the emergency OFF switch. When necessary, alarms and notifications are transmitted from the GPS data to the cloud server, which compares it with the positions of the bus stops. The mobile application offers a full solution for bus monitoring, compliance, and accountability, with real-time updates throughout the entire process.[4]

M. Malleswari, M.Koteswara Rao, K.V.Supriya, K.Pavan Krishna, B.Ravi Teja have introduced a RFID BASED COLLEGE BUS MANAGEMENT SYSTEM. The proposed system comprises two modules: the in-bus module and the base station module. The in-bus module is fixed in buses to track passengers' entry and exit. Passengers swipe identity cards, and the RFID reader sends the tag number to the microcontroller. The microcontroller checks if the person belongs to the bus, and if so, it sends the tag number, along with GPS-derived location and time, to the base station module via a GSM modem. In case of an unauthorized person, an error is displayed on the in-bus module's LCD. The base station module, equipped with a GSM receiver, microcontroller, and computer, receives the information, searches for the tag number-related data, and stores it for further use. The system aims to efficiently track passenger movement and provide real-time data to the base station for monitoring and record-keeping.[5]

Priyanka Godge, Kalyani Gore, Apurva Gore, Aishwarya Jadhav, and Anuradha Nawathe presented a paradigm change in SMART BUS MANAGEMENT AND TRACKING SYSTEM automation procedures. This allows for remote monitoring and control, and the suggested framework consists of two sections: admin login and station master login. It is possible to add, examine, and edit bus and stationmaster details using the admin module. At a particular bus stop, the Stationmaster module makes it possible to view bus information. During the application launch process, station masters and administrators must authenticate. Adding busses and station masters, as well as accessing bus and station master details, are examples of administrative procedures. Details like bus type, bus number, arrival/departure timings, current bus location, and stops between the source and destination are all stored in the Station master module. A bus's location is tracked using GPS and the RFID reader, which scans the bus's tag when it arrives at a station. After that, the server receives this data and updates the database records. With passive RFID systems using transmitted signals for tag activation and data reflection back to the reader, the RFID system acts as a reader that can retrieve unique IDs and other information from tags.[6]

Surendranath.H, Sai Ram.B, Praveen Kumar.N, S.Akshay, Pavan have introduced a SMART BUS TRACKING SYSTEM. For real-time bus tracking, the suggested solution makes use of an Arduino Mega 2560 microcontroller interfaced with an LCD, Wi-Fi module, GPS, and infrared sensors. The GPS module uses satellite communication to get coordinates, which Arduino subsequently sends to a database. An LCD displays the GPS data that has been retrieved and uploaded to Firebase. Additionally, the number of students getting on and off the bus is detected by the system. The LCD and Firebase are notified of the bus's current location remotely using push button switches. Students can track bus information using GPS coordinates and a smart phone app. The Bus Stop Module shows the current bus status by retrieving data from the database. The system architecture involves Arduino Uno and Arduino Mega 2560, powered through USB or a power supply. The Mega 2560 offers 54 digital I/O pins, 16 analog inputs, and 4 UARTs for complex projects. The LCD module provides a user interface, while the Wi- Fi module enables connectivity to networks. GPS offers global position information, and IR sensors cater to sensing and remote controls in the infrared spectrum. The project aims to enhance bus tracking efficiency and student awareness at respective stops.[7]

Jeyakkannan Nagavel, Karthik Chandran, and Vivek Lukose made the use of wireless sensor networks in an INTERNET OF THINGS-BASED SMART BUS SYSTEM. The project uses an Arduino Uno controller and an ATmega328 microprocessor to incorporate an alcohol sensor, GPS, GSM, and RFID modules. The technology uses the alcohol sensor to detect the presence of alcohol before allowing the bus to start in the morning mode. A warning message is issued to the authorities and the bus cannot start if alcohol is found. The relay is then severed. Only after passing an alcohol test may another driver start the bus. The position of the bus is shown on the LCD and is communicated to parents via GSM via the system. Students' RFID cards are scanned for admission at each stop, and after the RFID module has confirmed the code, the door is opened for them. Similar alcohol checks take place in the evening mode, and students board the bus using their RFID cards. Higher data speeds are possible with the GPRS-enabled GSM module, and the project’s goal is to improve communication and safety in school bus transportation.[8]

Saniya U. L. Kokate, Shravani Sanjay Bagade, Purva Balasaheb Biradar, Pranali Ramesh Dhumal Imtiyaj Shiragave have focused on IOT BASED SMART PUBLIC TRANSPORT BUS. Every bus has an Arduino Nano-based system that uses GPS to determine latitude and longitude, GSM to provide wireless internet access, and infrared sensors at the entry and departure doors to count passengers. Arduino continuously retrieves GPS coordinates while the ignition is on and sends the information, along with the number of passengers, to a webpage. The IR sensors monitor passenger enters and exits when the ignition is off, updating the count appropriately. The website shows the bus number, route, and timings that are manually supplied by the authorities. At every bus stop, QR codes provide the public with access to transit information, enabling users to scan and see the webpage's details. Internet commands establish connectivity between the GSM module and the webpage, enabling data transmission. With a user- friendly interface via QR codes, the proposed solution improves public access to real- time bus information and passenger counts. Individual program units are created as part of the system design in order to read GPS data, establish GSM connectivity, and send data to the webpage. These program units are then connected to provide the entire system with functionality.[9]

Abhishek S, Parveez Shariff1, Ashwini R G, Sneha G, and Shradha have all proposed a system for the smart bus ticketing system. A smart card that is connected to each traveler's service provider account is given to them. Travelers may check bus locations and occupancy estimates with an Android mobile app. Passengers use the RFID reader to board, and it deducts the tariff according to the start and finish points of the voyage from their account. Seat availability predictions are made possible by the GPS module, which provides the server with real-time bus whereabouts. Passengers can select a bus based on projected occupancy by using the smart phone app, which shows a map view of the buses in operation. To maintain security, only travelers with a minimum balance and verified identity may board. After every journey, the system refreshes the database, improving oversight, openness, and anti-corruption efforts. [10]

2.1 PROBLEM STATEMENT

2.1.1 The government receives the majority of its money from public transportation. The old method of collecting tickets is usually chaotic and should be improved to minimize the need to cut down trees.

2.1.2 Many frauds take place where people travel without ticket making a loss to the government. Therefore, it is important to have a smart collecting system which aims to collect proper fair.

2.1.3 Along with the collection of fair one more problem identified is the uncertainty of seats in the arriving bus and also the schedule of the arrival time, passengers wait for a long time then get disappointed by the seat availability so it's important to keep the passengers updated with the information of seat availability and arrival of bus.

2.2 OBJECTIVES

1. To streamline fare collection.
2. To provide accurate passenger counting.
3. To ensure efficient door operation.
4. To display seats availability.
5. To establish wireless communication.

Chapter -3

METHODOLOGY

The passenger entries and departures are facilitated by placing IR sensors near the bus doors. These sensors detect the presence of passengers and trigger occupancy increments or decrements accordingly.

The RFID scanners installed near the entry & exit door verifies the validity of the card ensuring that only authorized passengers are granted access. The exit door remains locked until the same RFID card scanned during entry is presented for exit and corresponding fair amount is deducted.

The system leverages ZigBee technology to provide real-time updates at the LCD screen of the bus stop. Information's such as the bus's current occupancy status and route details are displayed, keeping waiting passengers informed and reducing uncertainty.

The above can be concise in the following steps:

1. Passengers entering and departing when the stop button is pressed.
2. IR sensors are placed near the doors to increment and decrement the occupancies; entry door is opens only if there is occupancy.
3. RFID scanner placed near the entry door takes the entry count of passengers and the scanner at the exit door deducts the amount from the card.
4. Exit door opens only when the same RFID card scanned at the entry is scanned during exit.
5. Information is updated at the LCD screen of bus stop if the bus is within the ZigBee range.

3.1 PROPOSED SYSTEM ARCHITECTURE

3.1.1 BUS MODULE

The central module is the Arduino UNO, acting as the brain to the entire operation. The system starts with a power supply which provides electrical power to all components in the system. As passengers board, IR sensors positioned at the entry and exit points detect their movements. A set of switches controls the power state of the bus, allowing for smooth activation or deactivation.

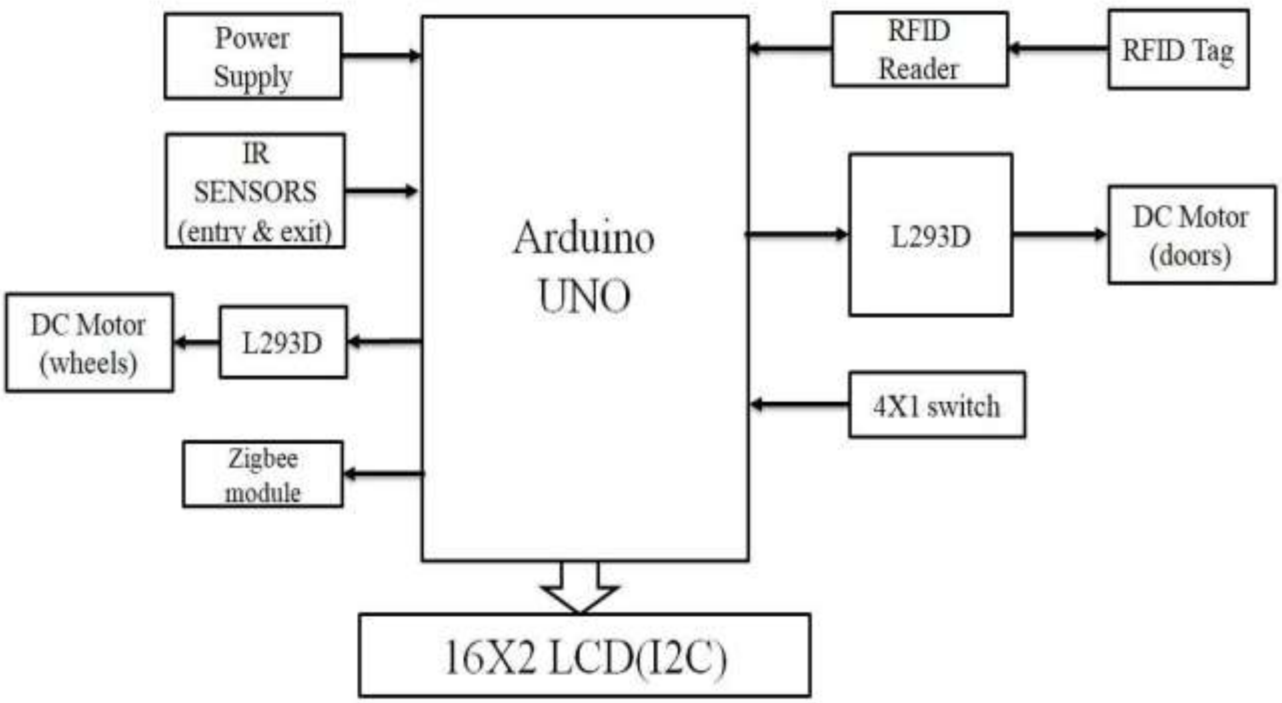

Fig 3.1.1 Block diagram of the bus module

The L293D IC drives the DC motor responsible for the bus's motion. Meanwhile, Zigbee modules facilitate wireless communication. RFID reader and cards contribute to passenger identification and tracking, enhancing security and management efficiency. To provide real-time information and instructions, a 16x2 LCD is integrated into the system.

At the bus module,

1. The power supply is directly given to the Arduino UNO, which acts as the central hub connecting all components within the bus module.

2. The RFID reader scans RFID cards carried by passengers. Simultaneously, the IR sensors detect passenger presence at entry and exit points, providing data on passenger movements within the bus for increment and decrement of seat availability.

3. The Arduino UNO which acts as the central processing unit, receives and analyzes data from the RFID reader and IR sensors. It processes this information, makes decisions accordingly, like it determines when to open or close doors based on seat availability detected by the IR sensors.

4. Once the Arduino UNO has processed the data and made decisions, it sends commands to control the motors via the L293D motor controllers. These controllers regulate the operation of DC motors, which are responsible for opening and closing doors and driving wheels.

5. The Zigbee module enables wireless data exchange between bus and bus stop modules essential for real-time monitoring of bus operations.

6. LCD screen: It receives data from the Arduino UNO and displays information such as seat availability, passenger entry, the amount deduction.

3.1.2 BUS STOP MODULE

The focal point is once again the Arduino UNO, establishing a wireless connection with the inside bus module through Zigbee modules.

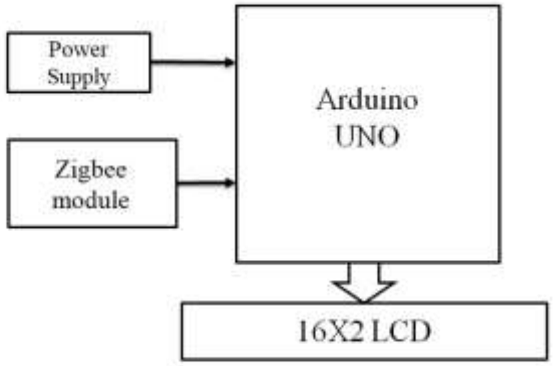

Fig 3.1.2 Block diagram of the bus stop module

For visual communication, a 16x2 LCD display at the bus stop conveys real-time bus schedules, announcements, and any other information.

At the bus stop module,

1. Arduino Uno: Receives and processes data from other components.
2. Zigbee Module: Facilitates data exchange between the bus stop module and the bus module.
3. 12 X 6 LCD: Displays relevant information to passengers waiting at the bus stop.

Communication between the bus module & bus stop module:

1. The Zigbee module in both the bus module and the bus stop module enables wireless communication between them.
2. The Arduino Uno in the bus module can send data, such as the current seat availability and bus route, to the Arduino Uno in the bus stop module via the Zigbee module.
3. The Arduino Uno in the bus stop module can then display this information on the LCD screen for passengers waiting at the bus stop.

3.2 FLOWCHART

The flowchart for the smart bus management system, consists of several components working together to provide an efficient and convenient fare collection solution.

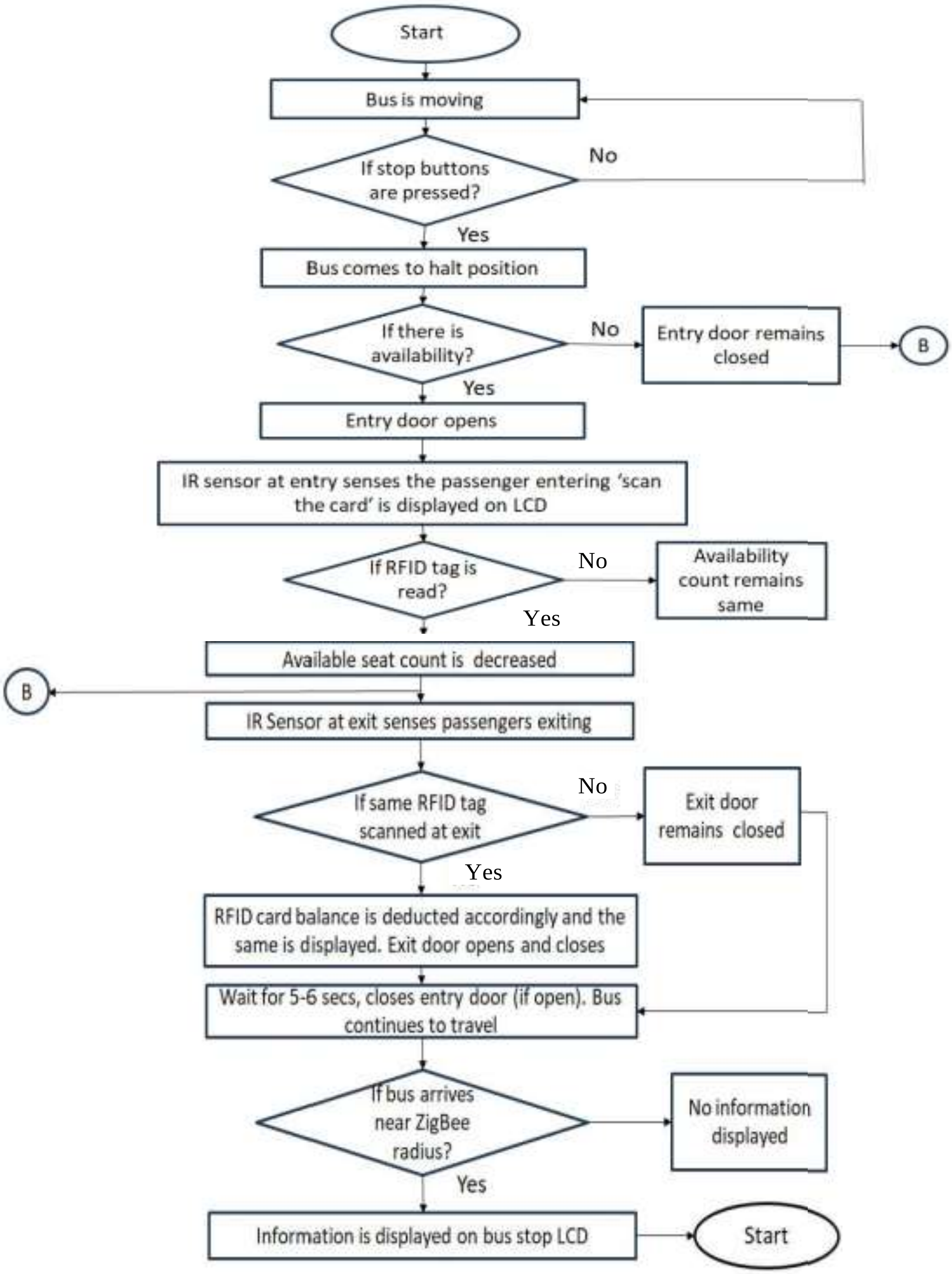

Fig 3.2 Flow chart of the integrated bus system.

An elucidation of the process depicted in the flowchart:

1. Upon receiving power supply, the bus initiates movement.
2. If the stop button is pressed, the bus halts, otherwise, it continues moving.
3. When the bus comes to a stop, it checks for seat availability.
4. If seats are available, the entry door opens, otherwise, it remains closed.
5. Upon entry door opening, sensors detect passengers entering, and a "scan the card" message displays on the bus's LCD.
6. RFID readers and IR sensors near the entry and exit doors facilitate ticketing and passenger tracking.
7. If the RFID reader reads the passenger's card, a "passenger entry" message with a seat count decrement appears on the LCD.
8. If the IR sensor detects motion for passenger exit, the RFID reader checks if the same card scanned at entry is presented at exit.
9. If the card matches, the exit door opens, the RFID card balance decreases, and the LCD displays the deduction and the seat count increases by one for each passenger exit.
10. If the card doesn't match, the exit door remains closed.
11. After a 5-6 second wait, the entry door (if open) closes, and the bus resumes movement.
12. When the bus nears a Zigbee radius, seat count and route information will be display on the LCD at the bus station module.
13. Otherwise, no information is displayed, and the whole process repeats.

Chapter -4

HARDWARE AND SOFTWARE COMPONENTS

4.1 HARDWARE COMPONENTS

4.1.1 Arduino UNO (ATmega328P)

The heart of the Arduino Uno is the ATmega328P microcontroller, which is an 8-bit AVR RISC-based microcontroller. It operates at a clock speed of 16 MHz and has 32 KB of flash memory for storing program code, 2 KB of SRAM for dat storage, and 1 KB of EEPROM for non-volatile storage.

Fig 4.1.1 Arduino UNO

1. **Digital I/O Pins:** The Arduino Uno has a total of 14 digital input/output pins, of which 6 can be used as PWM (Pulse Width Modulation) outputs. These pins can be used for interfacing with external devices such as sensors, LEDs, motors, and other digital components.

2. **Analog Input Pins:** The Uno features 6 analog input pins, labeled A0 through A5, which can measure analog voltage levels in the range of 0 to 5 volts. These pins are often used to interface with sensors that provide analog output signals, such as temperature sensors, light sensors, and potentiometers.

3. **Serial Communication:** The Uno supports serial communication through its built-in USB interface, which allows it to be connected to a computer for programming and serial communication. It also has hardware UART (Universal Asynchronous Receiver/Transmitter) serial communication ports that can be used to communicate with other serial devices.
4. **Power Supply:** The Uno can be powered via USB connection, an external power supply, or a battery. It has a built-in voltage regulator that can accept input voltages ranging from 7 to 12 volts DC. Additionally, the board can be powered directly from the USB port, which provides 5 volts DC.
5. **Programming:** The Arduino Uno can be programmed using the Arduino Integrated Development Environment (IDE). Users can write and upload their programs to the board via USB connection, making it easy to develop and deploy custom applications.

4.1.2 RFID READERS AND CARDS

RFID readers and cards offer a versatile and reliable solution for a wide range of applications requiring identification, tracking, and access control, with options available to suit various frequency bands, form factors, and security requirements.

4.1.2.1 RFID Reader

An RFID reader is a device that wirelessly communicates with RFID tags or cards to read and sometimes write data to them. There are different types of RFID readers, including fixed readers (stationary), handheld readers (portable), and integrated readers (embedded into other devices). RFID readers operate at various frequencies, including low frequency (LF), high frequency (HF), and ultra-high frequency (UHF), depending on the application requirements.

They typically consist of an antenna to transmit and receive radio signals, a radio frequency (RF) module for signal processing, and a communication interface (e.g.,

Fig 4.1.2.1 RFID reader module

USB, serial, Ethernet) for connecting to a computer or controller. RFID readers can be passive (powered by the RF signal from the reader) or active (powered by an internal battery).

4.1.2.2 RFID Card

An RFID card, also known as an RFID tag or transponder, is a small electronic device that contains a unique identifier and sometimes additional data. RFID cards come in various form factors, including key fobs, stickers, wristbands, and cards similar to credit cards. They typically consist of an integrated circuit (IC) and an antenna, encapsulated within a plastic or paper housing.

Fig 4.1.2.2 RFID cards

The data stored on an RFID card can vary depending on the application, ranging from a simple identification number to more complex information such as access permissions, product details, or sensor readings.

4.1.3 16X2 LCD DISPLAY

A 16X2 LCD display provides a compact and cost-effective solution for displaying basic information in a wide range of electronic devices and embedded systems. Its simplicity and versatility make it a popular choice for various applications where space and display requirements are limited.

1. **Resolution:** A 16X2 LCD display has a total of 16 columns and 2 rows, providing a total of 32 characters or pixels. Each character or pixel occupies one cell in this grid.
2. **Character Size:** The character size on a 16X2 LCD display depends on the specific model and manufacturer. Typically, each character occupies one cell in the grid and is formed by a matrix of dots or segments.
3. **Display Technology:** LCD displays use liquid crystal molecules to control the passage of light through individual pixels, creating characters or images. They are commonly used in electronic devices such as digital clocks, calculators, instrumentation panels, and consumer electronics.

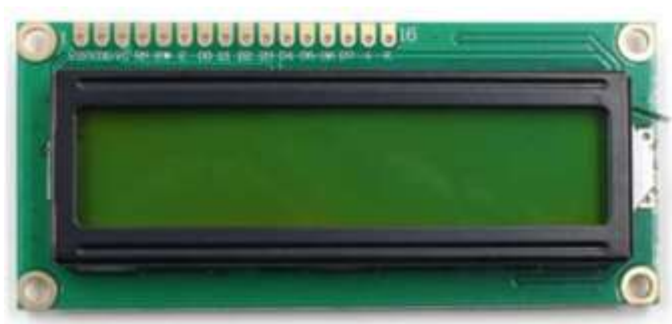

Fig 4.1.3 16X2 LCD display

4. **Interface:** The interface of a 16X2 LCD display depends on the specific model and application. It may use parallel or serial communication protocols to connect to a microcontroller, microprocessor, or other control circuitry.

LCD displays often include an integrated controller chip to handle the display's operation and communication with external devices. The controller chip interprets commands received from the host system and generates the necessary signals to control the display's pixels.

4.1.4 I2C module

An I2C (Inter-Integrated Circuit) module, also known as an I2C interface or I2C controller, facilitates communication between microcontrollers, sensors, actuators, and other integrated circuits using the I2C protocol.

1. **Communication Protocol:** I2C is a synchronous, multi-master, multi-slave, serial communication protocol developed by Philips Semiconductor (now NXP Semiconductors). It uses two bidirectional lines: SDA (Serial Data) and SCL (Serial Clock), allowing multiple devices to communicate over the same bus.

2. **Master-Slave Architecture:** In an I2C communication system, one or more master devices control the bus and initiate communication with slave devices. Slave devices respond to commands and data transmitted by the master device(s).

Fig 4.1.4 I2C module

3. **Data Transfer**: Communication on the I2C bus occurs through the exchange of data bytes between the master and slave devices. Data is transmitted and received sequentially, with each byte typically consisting of 8 bits.

An I2C module, often integrated into microcontrollers or microprocessor chips, provides hardware support for implementing the I2C protocol. It includes features such as clock generation, data buffering, and protocol management, simplifying the software interface for developers.

4.1.5 ZigBee module

Zigbee is a wireless communication protocol based on the IEEE 802.15.4 standard. It operates in the 2.4 GHz ISM (Industrial, Scientific, and Medical) band and uses a mesh networking topology, allowing devices to communicate with each other directly or through intermediate nodes (routers) in the network.

Fig 4.1.5 ZigBee module

Zigbee modules are designed for low-power applications, making them suitable for battery-operated devices and energy-efficient systems. They utilize power-saving techniques such as duty cycling, sleep modes, and efficient data transmission to minimize energy consumption.

4.1.6 IR sensor

IR sensors detect infrared radiation in the form of heat emitted by objects or surfaces. They typically consist of an infrared emitter and an infrared detector. The emitter emits infrared radiation, which is reflected by nearby objects and detected by the detector. The presence or absence of reflected infrared radiation is used to determine the presence or absence of objects or changes in temperature.

IR sensors typically provide output signals proportional to the detected infrared radiation or changes in temperature. Depending on the application, these signals may be analog (voltage or current), digital (binary), or serial (UART, I2C, SPI). The output signals can be processed by microcontrollers, microprocessors, or other control systems for further analysis or action.

Fig 4.1.6 IR sensor

IR sensors provide a versatile and reliable solution for detecting infrared radiation and monitoring various parameters in diverse applications, ranging from consumer electronics to industrial automation and safety systems.

4.1.7 L293D IC

The L293D IC is designed to control the direction and speed of DC motors, stepper motors, and other inductive loads. It consists of two H-bridge circuits, each capable of driving a single motor in both forward and reverse directions. An H-bridge is a circuit topology that allows bidirectional control of a motor.

The L293D IC contains two independent H-bridge circuits, designated as H-bridge A and H-bridge B. Each H-bridge can drive one motor, with separate inputs for controlling the direction and speed of rotation.

Fig 4.1.7 L293D IC

The L293D IC can supply a maximum output current of 600mA per channel (H-bridge), with a peak current of 1.2A for short durations. This makes it suitable for driving small to medium-sized DC motors and other inductive loads.

The L293D IC is a versatile and widely used motor driver IC suitable for a wide range of applications; including robotics, automation, motor control systems, and electronic projects requiring precise control of DC motors.

4.1.8 DC motor

DC motors operate based on the principle of electromagnetic induction. When electrical current flows through the motor's winding (coil), it creates a magnetic field. This magnetic field interacts with the magnetic field produced by the motor's permanent magnets or field windings, resulting in a force that causes the motor shaft to rotate.

DC motors provide high starting torque, making them suitable for applications requiring rapid acceleration or heavy loads. The torque-speed characteristics of a DC motor depend on its design, including the number of poles, winding configuration, and armature construction.

Fig 4.1.8 DC motor

DC motors are versatile, reliable, and widely used in countless applications where precise control, high torque, and efficient operation are required. Their simplicity, ruggedness, and ease of control make them a fundamental component in the field of electromechanical systems and automation.

4.1.9 KC11B04 AD Keypad

The KC11B04 AD keypad typically consists of a 4x4 matrix of buttons, providing 16 keys in total. These keys are arranged in a grid of 4 rows and 4 columns. Each button on the keypad corresponds to a unique combination of row and column connections in the matrix. Pressing a button connects one row pin to one column pin, allowing the microcontroller to detect which button was pressed based on the resulting row/column intersection.

Fig 4.1.9 KC11B04 AD KEYPAD

To detect key presses, the microcontroller typically performs keypad scanning, where it sequentially activates each row and reads the corresponding column inputs. By scanning through each row/column combination, the microcontroller can determine which button was pressed.

4.2 SOFTWARE COMPONENTS

4.2.1 ARDUINO IDE

The Arduino IDE is compatible with major operating systems, including Windows, macOS, and Linux, making it accessible to a wide range of users.

The Arduino IDE features a simple and intuitive interface designed to accommodate users of all skill levels, from beginners to advanced developers. It provides a text editor for writing code, a toolbar for compiling and uploading sketches, and various menus for accessing additional features and settings.

Fig 4.2.1 Arduino IDE programming

The Arduino IDE includes a library manager that allows users to easily install and manage libraries (pre-written code) for additional functionality. The library manager provides access to a vast collection of libraries contributed by the Arduino community, covering various topics such as sensors, displays, communication protocols, and more.

Chapter -5

RESULTS

The Bus Module and the Bus Stop Module are two essential modules of our system. These modules together increase the operational effectiveness, improve the passenger experience, and enable real-time communication between buses and bus stops.

5.1 BUS MODULE

The Bus Module is equipped with advanced technology to facilitate seamless boarding and alighting processes while providing real-time updates to passengers and the bus stop module.

Fig 5.1.1 Bus module set up

Fig 5.1.1 shows the bus module set up and the complete connections made inside the bus module. By the integration of RFID technology, Arduino control units, LCD displays, and wireless communication modules, this system provides real-time updates to passengers as shown in the following figures leading to smoother boarding processes and optimized bus utilization.

In the Fig 5.1.2, the LCD display showcases a detailed schematic of the entry and exit door mechanism providing real-time status updates so that the users can easily navigate through the interface.

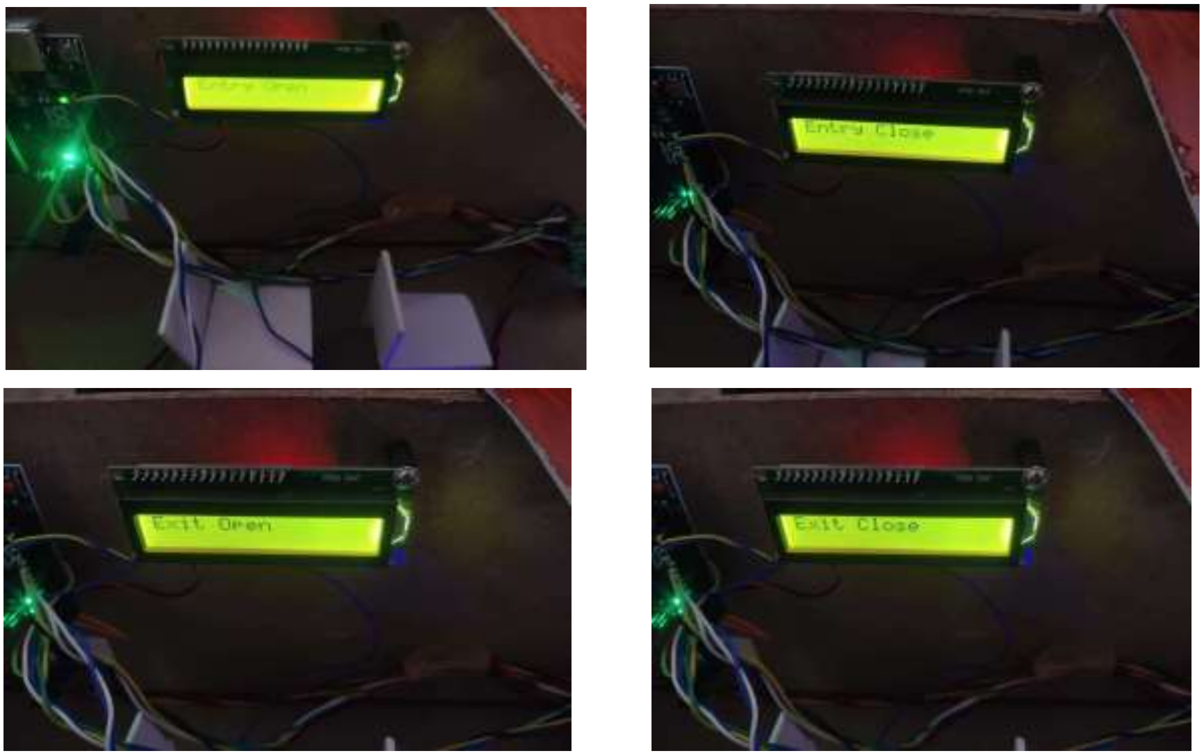

Fig 5.1.2 16X2 LCD displaying the entry and exit door mechanism

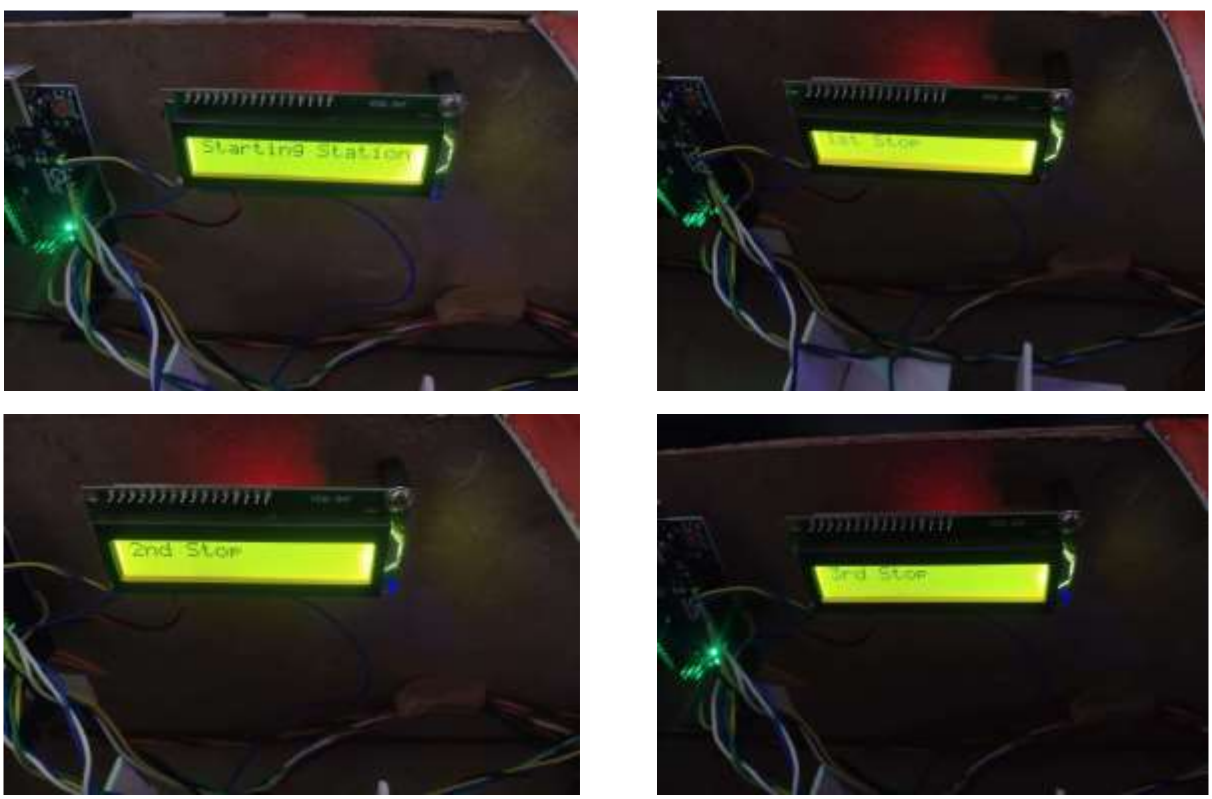

Fig 5.1.3 16X2 LCD displaying the bus station stops

In the Fig 5.1.3, the LCD display presents detailed information for four bus stations. The display showcases real-time data offering users to easily navigate through the interface to access specific station details.

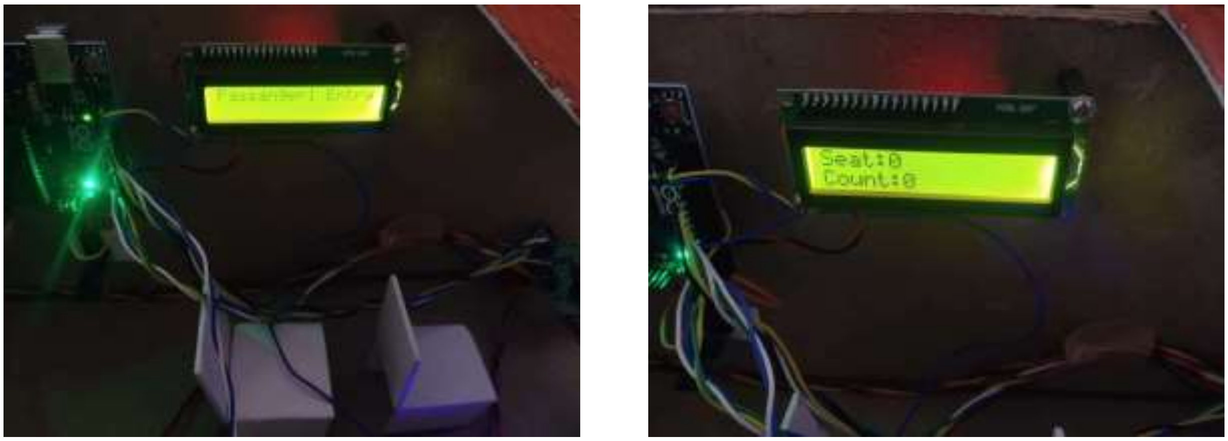

Fig 5.1.4 16X2 LCD displaying the passenger entry and the seat count

The Fig 5.1.4 shows the working of the LCD display integrated into the Bus Module, prominently showcasing passenger entry and seat count in real-time.

Fig 5.1.5 16X2 LCD displaying the seat availability count

In the Fig 5.1.5, the LCD displays the seat availability count corresponding to the increment and decrement of the IR sensor, which detects passenger motion at the entry and exit doors.

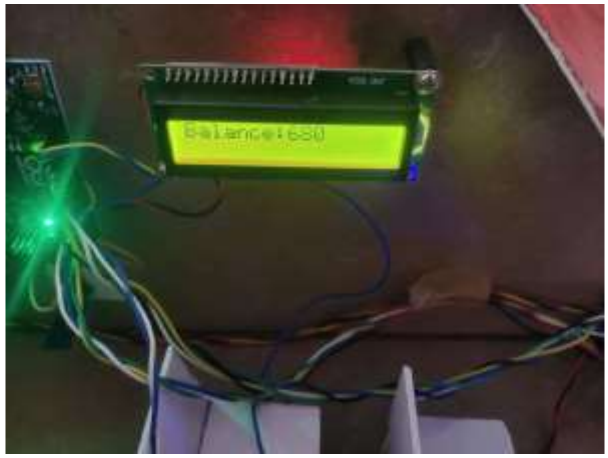

Fig 5.1.6 16X2 LCD displaying the balance of the RFID card after money deduction

In the Fig 5.1.6, the LCD displays the remaining balance of the RFID card after the passenger scans the same card at the exit, which was previously scanned at the entry.

5.2 BUS STOP MODULE

The Bus Stop Module is designed to provide waiting passengers with essential information about approaching buses and available seating capacity.

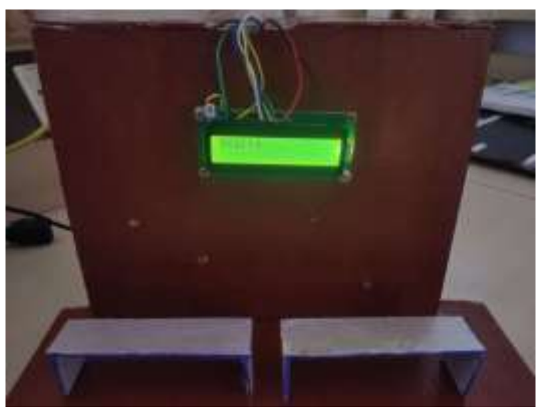

Fig 5.2 16X2 LCD display at bus stop module

The Zigbee module enables wireless communication between the Bus Module and the Bus Stop Module, allowing for the transmission of real-time messages regarding passenger count and bus status. The fig 5.2.1 shows an LCD display that is integrated into the Bus Stop Module, displaying the bus name along with the available number of seats.

Chapter -6

APPLICATIONS

A smart bus management system encompasses various applications aimed at enhancing the efficiency, safety, and convenience of bus transportation. These applications typically include features such as real-time tracking of buses, passenger information systems, ticketing and fare collection, fleet management, route optimization, and communication between buses and control centers.

6.1. Urban Public Transportation

Passengers benefit from streamlined boarding processes, real-time updates on seat availability, and improved communication regarding bus arrivals.

6.2. Corporate Shuttles

Implementing the system on corporate shuttles improves efficiency by automating passenger identification and providing real-time updates on shuttle availability and capacity.

6.3. Travel Agencies

Travel agencies often organize group tours and transportation for their clients, requiring efficient coordination and communication between transportation providers and travelers.

6.4. Senior Citizen Transportation

Caregivers and senior citizens can use the system to coordinate transportation schedules, track passenger movement, and ensure the safety and well-being of senior citizens during their travels.

Chapter -7

CONCLUSION & FUTURE SCOPE OF WORK

7.1 CONCLUSION

The integration of the bus module and bus stop module represents a significant advancement in public transportation systems. By leveraging RFID technology, Arduino control units, LCD displays, and communication modules such as Zigbee, this system streamlines passenger management, enhances communication between the bus and the stop, and improves overall transit efficiency.

7.2 FUTURE SCOPE OF WORK

7.2.1 Future iterations could incorporate additional features aimed at further improving the passenger experience. This might include interactive displays providing real-time route information, entertainment options, or even personalized recommendations based on passenger preferences.

7.2.2 Utilizing data collected from RFID scans, seat counts, and passenger boarding patterns, advanced analytics can be applied to optimize bus routes, schedules, and capacity management.

7.2.3 Developing companion mobile applications could allow passengers to access real-time information, receive alerts on bus arrivals, and even reserve seats in advance.

Chapter -8

PROJECT PLAN

The below table showcases an outline structured approach by the team to successfully execute tasks over a 12-week period.

Table 8.1 Weekly project plan updates

WEEK 1	Listing out all the components.
WEEK 2	Purchasing all the required components.
WEEK 3	To develop the code for IR sensors, 16x2 LCD, RFID.
WEEK 4	Learn the working of Arduino UNO and develop code for DC motor.
WEEK 5	Set up the bus stop module and bus module.
WEEK 6	To develop code and test for data transmission of Zigbee.
WEEK 7	Verifying the functionality of RFID.
WEEK 8	Interfacing all the components with Arduino UNO.
WEEK 9	Testing of the project and errors.
WEEK 10	Resolving all the bugs and errors.
WEEK 11	Final publication of implementation paper.
WEEK 12	Final report and complete demonstration of project.

8.1 **PROJECT COST**

A detailed breakdown of the expenses associated with various components of our project is shown in the below table.

Table 8.2 Project cost

Component	**Quantity**	**Estimated Cost**	**Actual Cost**
Arduino UNO	2	5000	4300
RFID Reader	2	600	518
RFID cards	4	500	300
Zigbee module	2	1500	1016
16X2 LCD	2	615	400
IR sensors	2	150	100
L293D IC	2	556	400
DC Motors	2	750	600
Switches	4	250	100
Power supply	2	560	400
I2C module	2	254	100
Jumper wires	1 set	100	60
Miscellaneous costs		2000	1000
Total		12,835	8,394

Chapter -9

DEMONSTRATION PLAN

The image depicts a sophisticated public transportation system comprised of two integral modules: the bus module and the bus stop module.

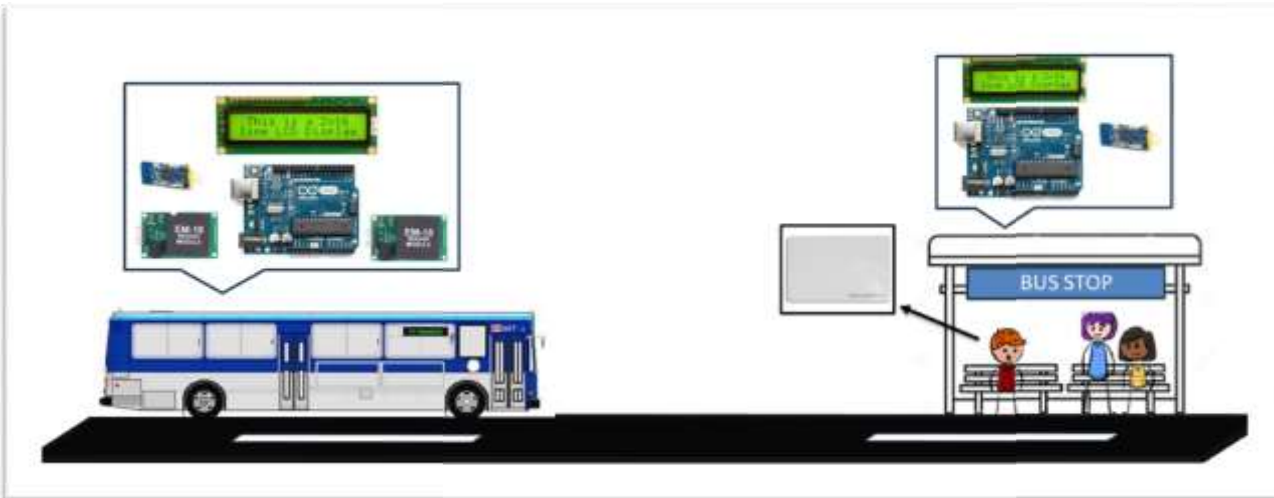

Fig 9.1 Demonstration plan

In the bus module, the focus lies on seamless passenger management and communication. At the entry and exit points of the door, two RFID scanners are prominently featured, facilitating efficient boarding and alighting processes. An Arduino Uno serves as the central control unit, orchestrating the interactions within the module.

An LCD display, integrated with an I2C module and Zigbee module, dynamically showcases real-time information such as passenger entry and seat count, ensuring passengers are informed of available seating. Furthermore, it functions as a communication hub, relaying vital data to the bus stop module, enabling synchronization between the bus and the stop.

The bus stop module is designed to enhance the overall passenger experience and streamline operations. An I2C module seamlessly integrates with an LCD display, prominently presenting essential details. The display prominently exhibits the bus name alongside the number of available seats, enabling waiting passengers to make informed decisions regarding their journey.

Chapter -10

INDIVIDUAL AND TEAM CONTRIBUTION

The table 10.1 shows lists of specific tasks undertaken by each team member, along with their contributions and outcomes. It provides a detailed breakdown of who did what within the project.

Table 10.1 Individual and team contribution

Team members	Individual contributions
SHREYA H	Developed the code to control the DC Motors, to read data from RFID Reader and the integration with IR sensors.
SHWETA DEEPAK	Wired the components together and handled LCD integration with the I2C module for both the bus and bus stop displays.
SUMANA N	Focused on the L293D controls and DC Motors for the bus model and programmed the Arduino Uno for both the bus model and bus stop model.
VAISHNAVI A	Handled the Zigbee communication setup by writing code to establish communication between the bus model and bus stop model.

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OPTIMIZING TRANSPORTATION FOR SMART BUS MANAGEMENT SYSTEM

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Abstract—In today's fast-paced world, efficient time management is paramount, particularly in the realm of public transportation. Recognizing this need, a smart ticket collection system is proposed as a solution to streamline the traditional bus ticketing process. By leveraging RFID technology, this system aims to enhance both the efficiency of fare collection and the overall passenger experience. RFID cards serve as the linchpin of this innovative approach, enabling swift ticket validation and eliminating the need for manual ticketing processes. Beyond facilitating fare collection, RFID technology also allows for the real-time monitoring of seat availability on buses. This information is seamlessly integrated into passenger-facing interfaces, providing commuters with up-to-date schedules and seat availability status. The system's real-time updates empower passengers to make informed decisions about their travel plans, allowing them to opt for alternative modes of transportation if necessary. By offering continuous updates at bus stops, the system enhances transparency and convenience for passengers, ultimately saving their valuable time and improving overall transit experience. Overall, the smart ticket collection system represents a significant step towards optimizing public transport operations and meeting the evolving needs of modern commuters.

***Keywords*–RFID Reader, RFID tags, ticket collecting system, sensors, motors.**

I. INTRODUCTION

Public transportation serves as the backbone of urban, providing vital connections for millions of people and playing a pivotal role in facilitating economic development and societal progress. However, conventional bus systems often struggle with various shortcomings, including overcrowding, frequent delays, inconsistent scheduling, limited seating capacity, and vulnerabilities to fraudulent activities in ticket collection. Recognizing the imperative for a more efficient and passenger-centric transit solution, we have developed an optimized bus management system.Our innovative approach leverages advanced technology, particularly Radio Frequency Identification (RFID), to overcome the challenges inherent in traditional bus systems. RFID technology enables seamless tracking and identification of buses and passengers, revolutionizing the way we conceptualize and manage urban transit. By implementing RFID tags on buses and RFID cards for passengers, our system enables precise tracking of bus locations, efficient fare collection, and real-time monitoring of passenger flow. RFID-enabled fare collection systems enhance revenue security and streamline passenger boarding processes, reducing boarding times and improving overall efficiency. Moreover, by providing passengers with greater transparency and convenience in accessing transit services, our system enhances passenger satisfaction and fosters a more positive perception of public transportation.

II. LITERATURE SURVEY

Parveez Shariff1 et al. have all proposed a system for the smart bus ticketing system. A smart card that is connected to each traveler's service provider account is given to them. Travelers may check bus locations and occupancy estimates with an Android mobile app. Passengers use the Radio Frequency Identification (RFID), reader to board, and it deducts the tariff according to the start and finish points of the voyage from their account. Seat availability predictions are made possible by the Global Positioning System (GPS) module, which provides the server with real-time bus whereabouts. Passengers can select a bus based on projected occupancy by using the smart phone app, which shows a map view of the buses in operation. To maintain security, only travelers with a minimum balance and verified identity may board. After every journey, the system refreshes the database, improving oversight, openness, and anti-corruption efforts. [1]

U. L. Kokate et al. have focused on IoT based smart public transport bus. Every bus has an Arduino Nano-based system that uses the Global Positioning System (GPS) to determine latitude and longitude, the Global Mobile Communication System (GSM) to provide wireless internet access, and infrared sensors at the entry and departure doors to count passengers. Arduino continuously retrieves GPS coordinates while the ignition is on and sends the information, along with the number of passengers, to a webpage. The Infrared sensor (IR) sensors monitor passenger enters and exits when the ignition is off, updating the count appropriately. The website shows the bus number, route, and timings that are manually supplied by the authorities. At every bus stop, QR codes provide the public with access to transit information, enabling users to scan and see the webpage's details.

Internet commands establish connectivity between the GSM module and the webpage, enabling data transmission. With a user-friendly interface via QR codes, the proposed solution improves public access to real- time bus information and passenger counts. Individual program units are created as part of the system design in order to read GPS data, establish GSM connectivity, and send data to the webpage. These program units are then connected to provide the entire system with functionality.[2]

Jeyakkannan Nagavel et al. made the use of wireless sensor networks in an internet of things-based smart bus system. The project uses an Arduino Uno controller and an ATmega328 microprocessor to incorporate an alcohol sensor, Global Positioning System (GPS), the Global Mobile Communication System (GSM), and Radio Frequency Identification (RFID). The technology uses the alcohol sensor to detect the presence of alcohol before allowing the bus to start in the morning mode. A warning message is issued to the authorities and the bus cannot start if alcohol is found. The relay is then severed. Only after passing an alcohol test may another driver start the bus. The position of the bus is shown on the Liquid Crystal Display (LCD) and is communicated to parents via GSM via the system. Students RFID cards are scanned for admission at each stop, and after the RFID module has confirmed the code, the door is opened for them. Similar alcohol checks take place in the evening mode, and students board the bus using their RFID cards. Higher data speeds are possible with the Global Packet Radio Service (GPRS) enabled GSM module and the project’s goal is to improve communication and safety in school bus transportation.[3]

J Shah et al. proposed a comprehensive system that integrates Radio Frequency Identification (RFID) technology for automated ticketing and passenger tracking, eliminating paper tickets and reducing waiting times. The system also utilizes the Global Positioning System (GPS), and the Global mobile communication System (GSM) for real-time bus tracking, enhancing overall efficiency and passenger experience. Additionally, the paper discusses future enhancements, including machine learning models for predictive analysis and blockchain technology for secure data storage. Overall, the proposed smart bus system offers a promising approach to address the inefficiencies of traditional bus systems and create a more sustainable and convenient public transportation infrastructure.[4]

Priyanka Godge et al. proposed a Smart Bus Management and Tracking System automation processpresents a paradigm shift, enabling remote monitoring and control that the proposed framework comprises two sections: Admin login and Station master login. The admin module allows for adding bus details, station master details and viewing bus details. The Station master module enables the viewing of bus information at a specific bus stop. The workflow involves authentication for both station masters and admins at the application start. Admin operations include adding buses and station masters, as well as viewing bus and stationmaster details. In the Station master module, information such as bus type, bus number, arrival/departure times, current bus location and stops between the source and destination are accessible. When a bus arrives at a station, its Radio Frequency Identification (RFID) tag is scanned by the RFID reader which in conjunction with Global Positioning System (GPS), tracks the bus's location. This data is then communicated to the server, updating the database entries. The RFID system functions as a reader that can retrieve unique IDs and other information from tags, with passive RFID systems utilizing transmitted signals for tag activation and data reflection back to the reader.[5]

Kumbhar V B et al. proposed a system integrates various technologies including Global Positioning System (GPS), Radio Frequency Identification (RFID), and Infrared (IR) modules to track buses in real-time, monitor seat occupancy, and implement a new ticketing scheme .The motivation behind the project stems from the significant reliance on buses for public transportation in India and the associated challenges faced by passengers due to the lack of timely information about bus schedules and seat availability. Existing systems either suffer from high costs or lack integration of all necessary functionalities into a single unit. Thus, the paper aims to address these limitations by providing an affordable, comprehensive solution.[6]

Surendranath.H et al. introduced a smart bus tracking system. For real-time bus tracking, the suggested solution makes use of an Arduino Mega 2560 microcontroller interfaced with a Liquid crystal display (LCD), Wi-Fi module, Global Positioning System (GPS), and infrared sensors. The GPS module uses satellite communication to get coordinates, which Arduino subsequently sends to a database. An LCD displays the GPS data that has been retrieved and uploaded to Firebase. Additionally, the number of students getting on and off the bus is detected by the system. The LCD and Firebase are notified of the bus's current location remotely using push button switches. Students can track bus information using GPS coordinates and a smart phone app. The Bus Stop Module shows the current bus status by retrieving data from the database. The system architecture involves Arduino Uno and Arduino Mega 2560, powered through USB or a power supply. The Mega 2560 offers 54 digital I/O pins, 16 analog inputs, and 4 UARTs for complex projects. The LCD module provides a user interface, while the Wi- Fi module enables connectivity to networks. GPS offers global position information, and IR sensors cater to sensing and remote controls in the infrared spectrum. The project aims to enhance bus tracking efficiency and student awareness at respective stops.[7]

Sudhir Divekar et al. introduced an innovative Smart Bus System. The project involves two sections: a transmitter placed in a bus and a receiver system at a bus stand. The transmitter comprises a Peripheral Interface Controller (PIC) microcontroller, Global Positioning System (GPS) module, the Global mobile communication System (GSM) modem, voice recording/playback unit, Radio Frequency (RF) transmitter, door switch, relay unit, and a Liquid crystal display (LCD) . The GPS module receives signals from satellites to determine bus locations based on latitude, longitude, and altitude. The microcontroller stores andcompares these coordinates, displaying the location name on the LCD and announcing the stop name via a speaker IC when a

match occurs. The microcontroller also checks door status, preventing bus departure if the door is open to avoid accidents. Information about the bus, including bus number, route, and vacant passenger seats, is transmitted via RF transmitter to the bus stand as the bus approaches. The receiver system at the bus stand detects this information, displays details on a display, and makes automatic announcements. The system utilizes GPS technology and microcontrollers for an efficient bus location announcement system.[8].

Karthikeyan G et al. proposed a system involves a Global Positioning System (GPS) module fixed inside each bus, continuously fetching latitude and longitude data, processed by NodeMCU, and sent to a cloud server connected to Google Maps for real-time bus tracking. Users can monitor the bus's location through the mobile application. The system also includes monitoring bus stand entries, activating a timer upon entry, and triggering a buzzer if the bus exceeds the designated time. Violations trigger notifications and details sent to the bus stand in-charge, who may impose penalties. Monthly reports, including rule violations and fines, are forwarded to the bus owner. An emergency OFF switch is available for the bus stand in-charge to shut down the system in emergencies. The GPS data is sent to the cloud server, checked against bus stand locations, and triggers alerts and notifications as needed. The entire process updates in real-time on the mobile application, providing a comprehensive solution for bus monitoring, compliance, and accountability.[9]

M. Malleswari et al. have introduced a Radio Frequency Identification (RFID) Based College Bus Management System. The proposed system comprises two modules: the in-bus module and the base station module. The in-bus module is fixed in buses to track passengers' entry and exit. Passengers swipe identity cards, and the RFID reader sends the tag number to the microcontroller. The microcontroller checks if the person belongs to the bus, and if so, it sends the tag number, along with Global Positioning System (GPS) location and time, to the base station module via a the Global Mobile Communication System (GSM) modem. In case of an unauthorized person, an error is displayed on the in-bus module's Liquid crystal display (LCD). The base station module, equipped with a GSM receiver, microcontroller, and computer, receives the information, searches for the tag number-related data, and stores it for further use. The system aims to efficiently track passenger movement and provide real-time data to the base station for monitoring and record-keeping.[10]

Walke A et al. has presented a smart bus system designed to address challenges faced by traditional bus systems, such as traffic congestion, delays, and irregular dispatching times. The system utilizes various technologies, including Global Positioning System (GPS), IoT and Android applications, to track bus locations in real-time, predict arrival times, and provide information about seat availability and bus crowding to passengers. By enabling passengers to plan their travel efficiently and consider alternative transport options, if necessary, the system aims to improve passenger satisfaction and reduce reliance on private vehicles, thereby contributing to reduced traffic congestion and pollution.[11]

Sridevi et al. proposed a system leverages IoT devices and sensors to provide real-time tracking and management of buses, enhancing operational efficiency and passenger experience. This approach likely integrates Global Positioning System (GPS) for location tracking, Radio Frequency Identification (RFID) for passenger identification, and communication technologies for data transmission. The study may discuss the architecture of the IoT-based system, data integration challenges, and the potential benefits in terms of route optimization, fleet management, and passenger information services.[12]

Hu et al. focused on the design and implementation of a bus monitoring system based on Global Positioning System (GPS) for the Beijing Olympics. The study likely presents a case study of a bus monitoring system deployed for a specific event, highlighting the design considerations, implementation challenges, and outcomes of the system. It may discuss the use of GPS technology for real-time tracking of buses, data communication protocols, and the integration with event management systems. The study may also address the impact of the monitoring system on event logistics, transportation efficiency, and passenger safety during the Beijing Olympics.[13]

Kamble et al. proposed a bus tracking and monitoring using Radio Frequency Identification (RFID) technology. RFID is utilized for real-time tracking and monitoring of buses. The system integrates RFID readers with Global Mobile Communication System (GSM) communication, enabling the transmission of bus location data to a central database as the bus approaches tagged bus stops. This approach aims to enhance the efficiency of bus operations by reducing un-utilization periods and waiting times, ultimately benefiting both administrators and passengers. The study likely delves into the technical aspects of RFID implementation, data transmission protocols, and the impact of real-time tracking on bus scheduling and service reliability.[14]

Tarapiah et al. offers passengers the ability to track buses in real-time through a web-based interface, providing information on bus locations and estimated arrival times. This approach enhances passenger convenience and service transparency, enabling commuters to make informed decisions about their travel plans. The study likely discusses the design and implementation of the web-based tracking system, including aspects such as data collection, processing, and visualization. It may also address usability considerations and the potential impact of the system on passenger satisfaction and public transport usage.[15]

III. PROPOSED SYSTEM ARCHITECTURE

The Smart ticket collecting system is designed to transform how bus tickets are handled using RFID technology. It simplifies paying for tickets and makes the whole process smoother for passengers. With RFID cards, tickets can be quickly checked and it keeps track of available seats in real-time. Passengers can easily see the latest schedules and know if there are empty seats before they board. This system provides constant updates at bus stops, making it easier for passengers to plan their journeys. By using ZigBee technology, buses and bus stops can communicate wirelessly, making the whole service even more efficient.

3.1 BUS MODULE

The fig.3.1 depicts the block diagram of bus module in which the central module is the Arduino UNO, acting as the brain to the entire operation. The system starts with a power supply which provides electrical power to all components in the system. As passengers board, IR sensors positioned at the entry and exit points detect their movements. A set of switches controls the power state of the bus, allowing for smooth activation or deactivation.

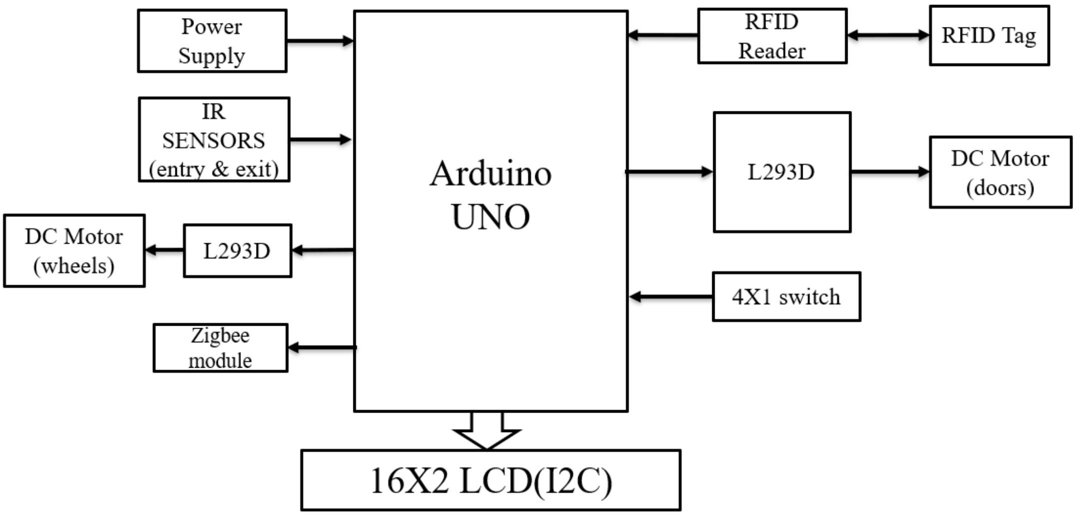

Fig.3.1.Block Diagram of Bus Module

The L293D IC drives the DC motor responsible for the bus's motion. Meanwhile, Zigbee modules facilitate wireless communication. RFID reader and cards contribute to passenger identification and tracking, enhancing security and management efficiency. To provide real-time information and instructions, a 16x2 LCD is integrated into the system.

3.2 BUS STOP MODULE

The fig 3.2 depicts the block diagram of bus stop module, in which the focal point is once again the Arduino UNO, establishing a wireless connection with the inside bus module through Zigbee modules. For visual communication, a 16x2 LCD display at the bus stop conveys real-time bus schedules, announcements any other information.

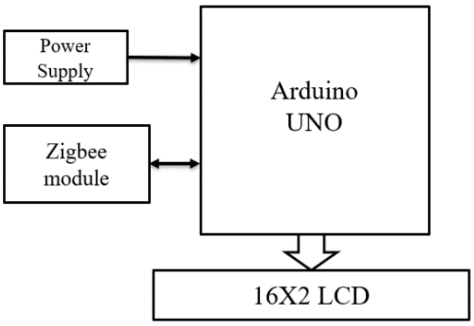

Fig3.2. Block Diagram of Bus stop module

At the bus stop module,
1. **Arduino Uno**: Receives and processes data from other components.
2. **Zigbee Module**: Facilitates data exchange between the bus stop module and the bus module.
3**. 16X2 LCD**: Displays relevant information to passengers waiting at the bus stop.

3.3 COMMUNICATION BETWEEN THE BUS MODULE & BUS STOP MODULE:

1. The Zigbee module in both the bus module and the bus stop module enables wireless communication between them.
2. The Arduino Uno in the bus module can send data, such as the current seat availability and bus route, to the Arduino Uno in the bus stop module via the Zigbee module.
3. The Arduino Uno in the bus stop module can then display this information on the Liquid crystal display (LCD) screen for passengers waiting at the bus stop.

3.4 FLOW CHART OF THE PROPOSED MODEL

The fig 3.4.depicts the flowchart for the smart bus management system consists of several components working together to provide an efficient and convenient fare collection solution.

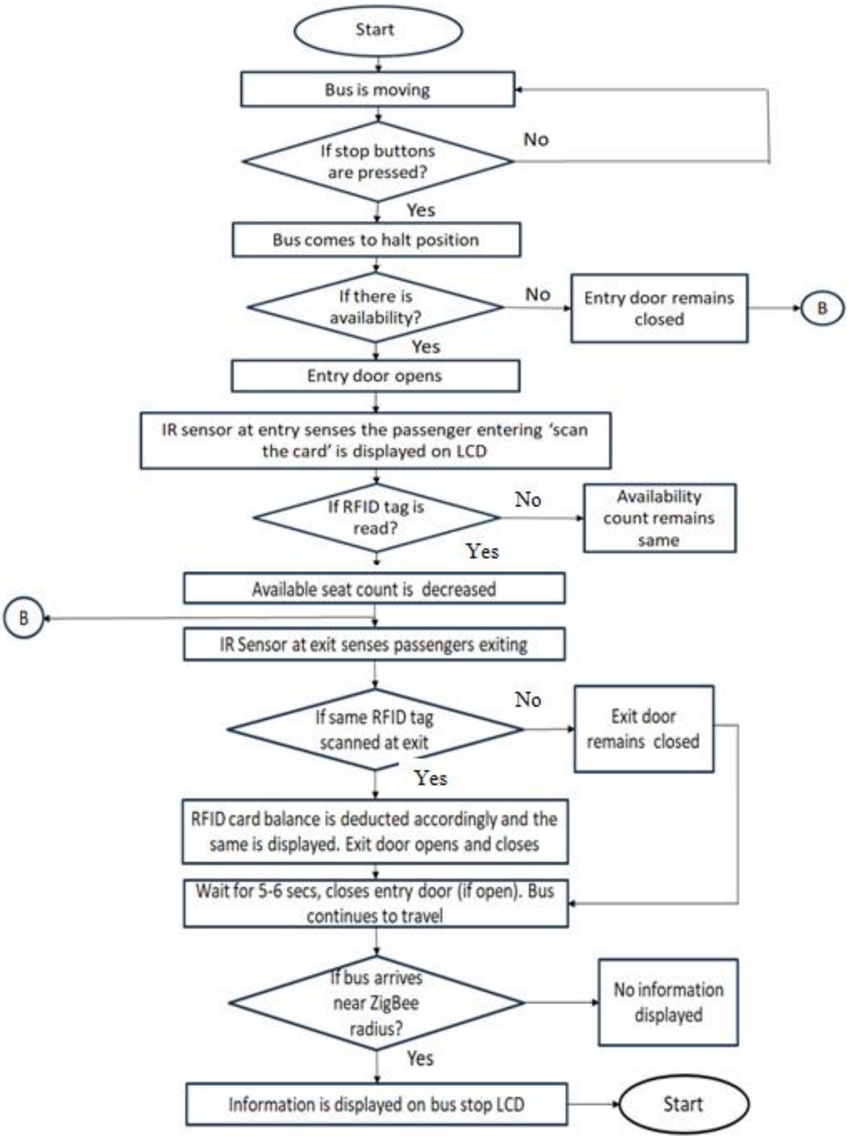

Fig.3.4. Flow chart of integrated bus system.

Here's a description of the flowchart working:

1. Upon receiving power supply, the bus initiates movement.
2. If the stop button is pressed, the bus halts, otherwise, it continues moving.
3. When the bus comes to a stop, it checks for seat availability.
4. If seats are available, the entry door opens, otherwise, it remains closed.
5. Upon entry door opening, sensors detect passengers entering, and a "scan the card" message displays on the bus's LCD.
6. RFID readers and IR sensors near the entry and exit doors facilitate ticketing and passenger tracking.
7. If the RFID reader reads the passenger's card, a "passenger entry" message with a seat count decrement appears on the LCD.
8. If the IR sensor detects motion for passenger exit, the RFID reader checks if the same card scanned at entry is presented at exit
9. If the card matches, the exit door opens, the RFID card balance decreases, and the LCD displays the deduction and the seat count increases by one for each passenger exit.
10. If the card doesn't match, the exit door remains closed.
11. After a 5-6 second wait, the entry door (if open) closes, and the bus resumes movement.
12. When the bus nears a Zigbee radius, seat count and route information will be display on the LCD at the bus station module.
13. Otherwise, no information is displayed, and the whole process repeats.

IV. METHODOLOGY

The passenger entries and departures are facilitated by placing IR sensors near the bus doors. These sensors detect the presence of passengers and trigger occupancy increments or decrements accordingly. The RFID scanners installed near the entry & exit door verifies the validity of the card ensuring that only authorized passengers are granted access. The exit door remains locked until the same RFID card scanned during entry is presented for exit and corresponding fair amount is deducted. The system leverages ZigBee technology to provide real-time updates at the LCD screen of the bus stop. Information's such as the bus's current occupancy status and route details are displayed, keeping waiting passengers informed and reducing uncertainty.

The above can be concise in the following steps:

1. Passengers entering and departing when the stop button is pressed.
2. IR sensors are placed near the doors to increment and decrement the occupancies; entry door is opens only if there is occupancy.
3. RFID scanner placed near the entry door takes the entry count of passengers and the scanner at the exit door deducts the amount from the card.
4. Exit door opens only when the same RFID card scanned at the entry is scanned during exit.
5. Information is updated at the LCD screen of bus stop if the bus is within the ZigBee range.

V. CONCLUSION

The Smart Bus Management System presents a transformative solution for enhancing the efficiency, reliability, and convenience of public transportation. By seamlessly integrating technologies such as IR sensors, RFID scanners, and ZigBee communication, this system streamlines passenger boarding, fare collection, and real-time information dissemination. Through precise implementation of IR sensors, the system optimizes passenger entry and exit processes, reducing delays and improving overall operational efficiency. RFID scanners facilitate automated fare collection and accurate passenger tracking, leading to enhanced revenue management and decreased instances of fare evasion. Furthermore, the integration of ZigBee communication enables seamless data exchange between buses and bus stops, empowering passengers with real-time information and improving their overall experience. The Smart Bus Management System represents a significant step forward in the evolution of public transportation, offering a comprehensive solution to meet the growing demands of urban mobility.

VI. FUTURE SCOPE

1. Future iterations could incorporate additional features aimed at further improving the passenger experience. This might include interactive displays providing real-time route information, entertainment options, or even personalized recommendations based on passenger preferences.

2. Utilizing data collected from RFID scans, seat counts, and passenger boarding patterns, advanced analytics can be applied to optimize bus routes, schedules, and capacity management.

3. Developing companion mobile applications could allow passengers to access real-time information, receive alerts on bus arrivals, and even reserve seats in advance.

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