BRAC UNIVERSITY

CSE360: Computer Interfacing

Lab Project Report

Title: Automatic Bus Administrative System with Door Control

by

Group No : 5
Section : 7

Group Members:

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Abstract

The public transportation system of Dhaka, Bangladesh is often described as having operational indiscipline, extreme safety risks, and no administrative accountability. This project outlines the design and execution of a prototype Automatic Bus Administrative System with Door Control that will help alleviate these severe problems with the help of IoT-based automation and data logging. The following methodology is based on an Arduino microcontroller that incorporates modules of Bluetooth (HC-05) to detect stations within a specific area, two IR sensors to count the directions and passengers, a Hall effect sensor to monitor the vehicle speed, and an RFID module to identify the driver. Outputs of the system are controlled by the use of a servo motor to open and close the door, an LCD display to show speed, and buzzers to signal. The prototype thus effectively embodies the main features such as automated door control at specific stops only, real-time passenger loading with overcrowding warning and an alert button, secure data transfer, a passenger-specific emergency alert button, and a solar-powered and temperature-regulated cabin fan. The broader impact of this work is significant, addressing key sustainability pillars: it increases social sustainability by significantly boosting passenger safety and discipline; supports the economic sustainability of fleet operators through operational efficiencies based on the data; and provides urban planners with evidence-based insights to encourage a modal shift to public transit, which in turn, reduces congestion in the city and related emissions. Finally, such a system offers a scalable model that will help to replace the bus service in Dhaka with an updated, responsible, and sustainable system of transportation.

Keywords

Internet of Things (IoT), Embedded Systems, Smart Transportation, Sustainability, Automation

1. Introduction

1.1 Problem and Motivation

Dhaka is a megacity which consists of millions of people who depend on local buses as their primary medium of transportation.. In spite of its decisive role, the bus transportation system is infamously disorganized and is prone to systematic errors, which jeopardize civic order, traffic congestion, passenger safety, and often hurting the economy. A culture of poor operational discipline that is primarily created by a contract-based model in which drivers are encouraged to drive as many people as they can causes hazardous practices (Kabir, 2024). Buses generally stop in the middle of the roads to pick-up passengers, unsafe competitiveness of the buses to pick up more and more passengers which create congestion inside the bus (Hossain, 2023). Sometimes, passengers are forced to cling to the sides of the buses. All these things, in addition to putting Dhaka among the top most traffic prone cities, does an immersive economic cost to the economy which is estimated to be around billions of dollars annually (The World Bank, 2022). Moreover, the high percentage of fatal road accidents are typically reported to involve buses (Passenger Welfare Association, 2025). The authorities and the owners of the fleets can not implement the regulations nor hold the drivers accountable and make qualified decisions about the enhancement of the offered services without the collection of data and administrative control in real-time (Rahman and Islam, 2023). The logic behind this initiative is that there is an urgent need to introduce a technological

infrastructure that can bring discipline, enhance safety, and create a responsible ecosystem of public transport.

1.2 Project Objectives

The main aim of this project is to design a prototype, construct and test an **Automatic Bus Administrative System with Door Control**. The purpose of this system is to eliminate the issues mentioned above using a combined system. The specific objectives are:

- To **automate bus door control** with the help of a location-sensitive system (Bluetooth) to allow door operation only on a specified bus station..
- To implement a **passenger counting mechanism** using two IR sensors, and setting up an alarm system that will activate if the passenger count rises a certain threshold.
- To **monitor and display the bus's real-time speed** to promote adherence to speed limits.
- To provide security to the passengers by introducing **an emergency button**, pressing the emergency button stores the count of the emergency button pressed and will be sent to the admin station.
- To improve driver accountability through an **RFID-based authentication system**.
- To **save all the data for a trip**(passenger counts, stops, emergency events, driver information) and implement a system to deliver this information to the admin station for further analysis.
- To **monitor the internal bus temperature**, and **activating a fan** when it crosses a threshold

1.3 Scope and Relevance to Computer Interfacing

The project is created as a prototype with the purpose of proving the concept. The scope focuses on an embedded system, integrating several hardware units into a self-contained core, based on the Arduino microcontroller and emulates the functionality on a smaller scale. The project can be characterized as a classic and enhanced implementation of the very essence of **Computer Interfacing (CSE 360).** It can show how it can build a brain-like system by offering the possibility to simplify the connection between a computing processor (the microcontroller) and the real world. Its applicability is emphasised by:

- **Interfacing with Sensors (Inputs):** This project gathers data from the environment by using multiple sensors. For example, DHT11 (Temperature Sensor), RFID (for driver authentication), 2xIR sensors (to count passengers), Push Button (for emergency alerts), Hall Effect Sensor (to calculate speed). All these sensors take input from the environment and send the data to the arduino for further processing.
- **Interfacing with Outputs:** After getting the input from the sensors, the arduino processes and sends the data to the output sensors. For output, we have used a servo motor (To open the door), a buzzer (to show that the bus is overcrowded), a fan (which turns on if the temperature crosses a certain threshold) and LCD screens (to show output).
- **Communication Protocols:** We mainly used the bluetooth module HC-05 as our medium for communication. This bluetooth module uses UART communication protocol.

2. Related Work/ Inspiration

2.1 Existing Work

The idea of using technology to enhance people transportation commonly known as Intelligent Transport Systems to refer to (ITS) is not a new area. Our project is also inspired by a number of fields and it tries to tackle a differentiating variety of challenges. The high-technology ITS that is practiced in developed cities such as Singapore and London provides the inspiration. Such systems include GPS-based real-time vehicle tracking systems, high-tech Automated Passenger Counting (APC) systems, 3D camera-based systems, and on-board digital payment systems (such as Oyster or EZ-Link cards). These two examples have effectively shown how data-based management can make routes more efficient, and services better, and provide commuter experience. Those vast systems are the standard of what a completely modernized system of public transports can do and encourage the data-logging and management features of a project and we are motivated by it.

2.2 Project Differentiation and Novelty

There are three key aspects in which our **Automatic Bus Administrative System** differs with the existing systems:

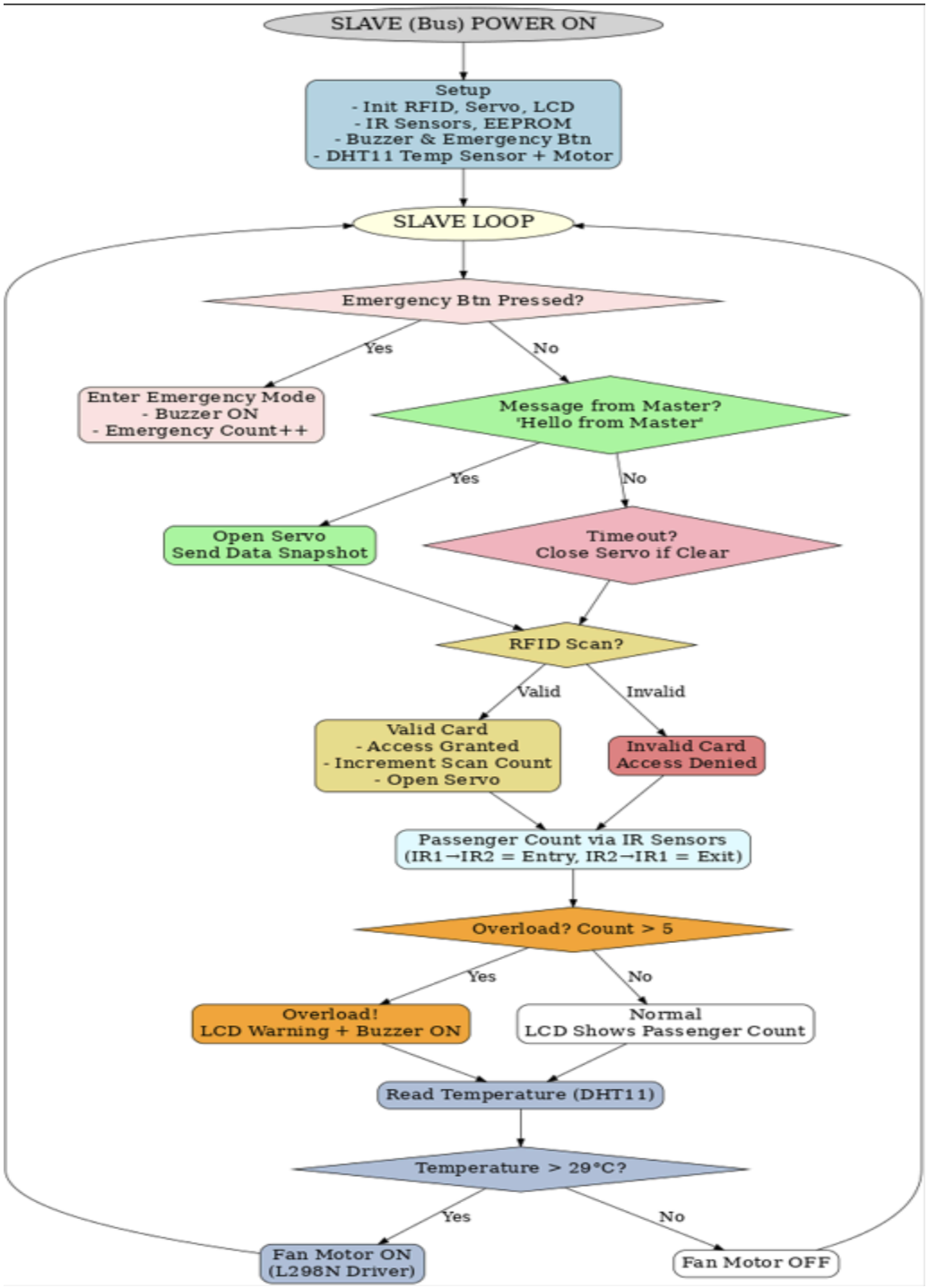
Context-Specific Design
Our design is very specific to solve the existing problem of Dhaka city transportation system.

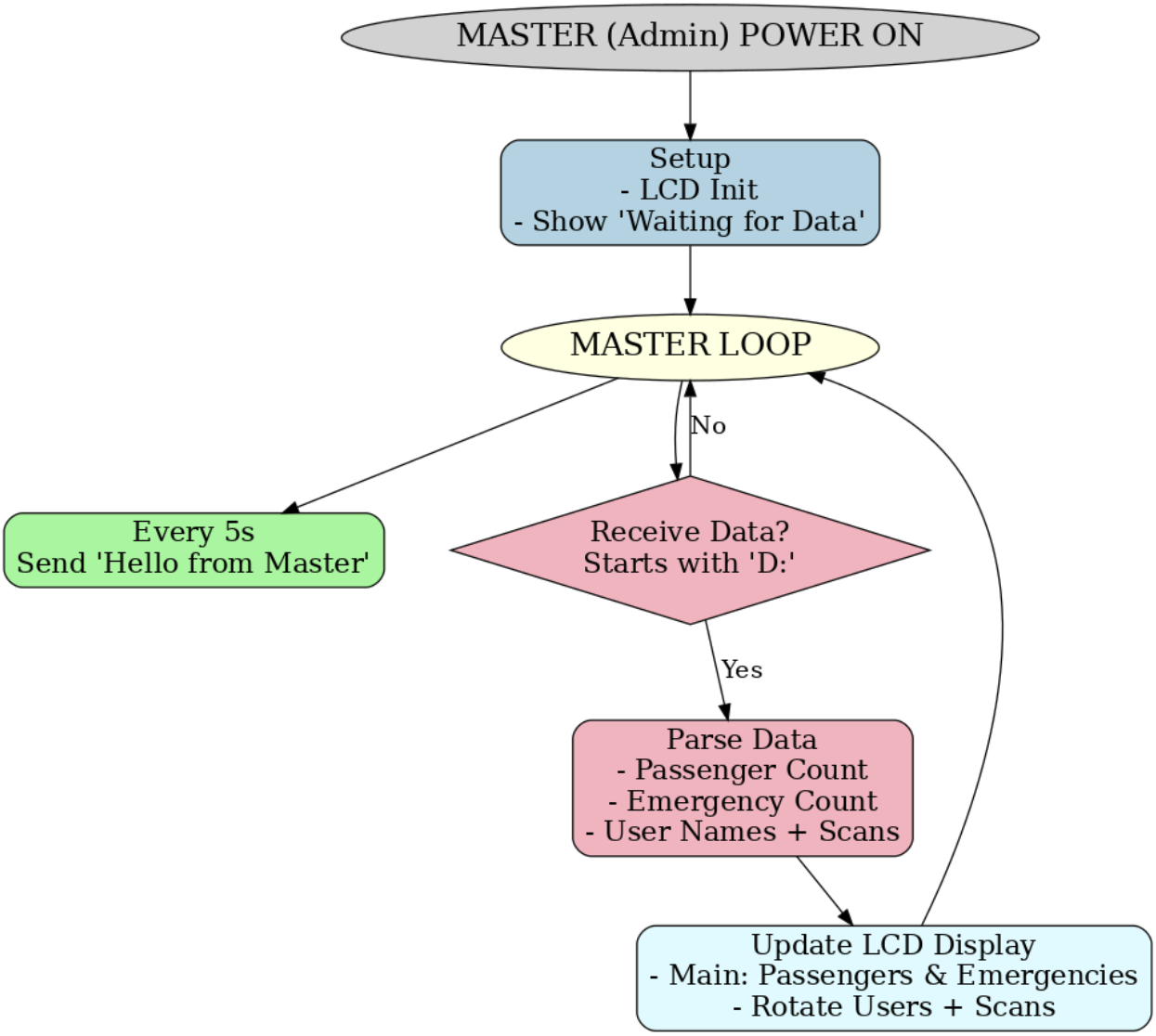
Holistic Integration
Our project includes many small parts to create a holistic solution. For example, driver responsibility in RFID, driver discipline in automated doors, passenger safety in crowd notifications, safety IR, and emergency button, administrators to view logs all are implemented in one system. It does not provide a part supply solution but rather a comprehensive solution.

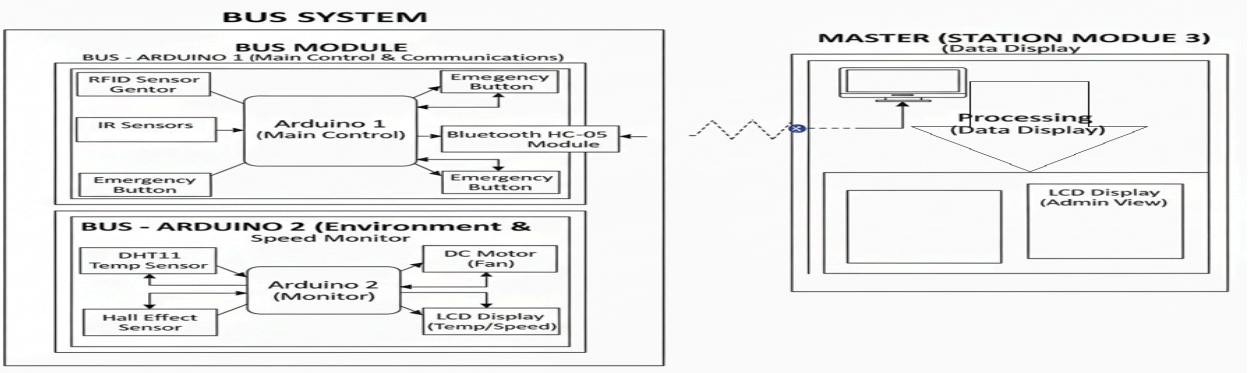
Solving New Issues through Application
We are not creating new hardware, rather we are using inexpensive hardware devices to solve a major social and economic problem in Dhaka City.

3. Technical Approach

3.1 System Architecture




MASTER (Admin) POWER ON
Setup
- LCD Init
- Show 'Waiting for Data'
MASTER LOOP
No
Every 5s
Send 'Hello from Master'
Receive Data?
Starts with 'D:'
Yes
Parse Data
- Passenger Count
- Emergency Count
- User Names + Scans
Update LCD Display
- Main: Passengers & Emergencies
- Rotate Users + Scans


BUS SYSTEM
BUS MODULE
BUS - ARDUINO 1 (Main Control & Communications)
RFID Sensor Gentor
IR Sensors
Emergency Button
Arduino 1 (Main Control)
Emegency Button
Bluetooth HC-05 Module
Emergency Button
BUS - ARDUINO 2 (Environment & Speed Monitor
DHT11 Temp Sensor
Hall Effect Sensor
Arduino 2 (Monitor)
DC Motor (Fan)
LCD Display (Temp/Speed)
MASTER (STATION MODUE 3)
(Data Display
Processing (Data Display)
LCD Display (Admin View)

3.2 Component Used and Cost Breakdown

Name	Price (৳)	Quantity	Subtotal (৳)
Solar Panel 5V 250mA	450.03	1	450.03
Neodymium Magnet D3*3mm	10.03	2	20.06
Bluetooth Module HC05 Master Slave Support	380.06	1	380.06
I2C LCD Display 16x2	295.05	1	295.05
TP4056 Lithium Battery Charging Module	45.08	1	45.08
Male to Male Type Jumper Wire	2.65	20	53.00
Female to Female Type Jumper Wire	2.75	20	55.00
DC Motor 6V	60.08	1	60.08
IRF540 N Channel MOSFET	50.08	1	50.08
Arduino Uno R3 SMD	485.04	2	485.04
Arduino Nano	395.05	1	395.05
Push Button 4 pin Small	2.21	10	22.10
22uF 400V Capacitor	38.05	1	38.05
Diode 1N4007	1.68	5	8.40
Hall Effect Sensor Module Unipolar	80.05	1	80.05
Battery Holder 4 x AAA	60.04	1	60.04

Solar Panel 5V 250mA	450.03	1	450.03
Neodymium Magnet D3*3mm	10.03	2	20.06
Bluetooth Module HC05 Master Slave Support	380.06	1	380.06

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IRF540 N Channel MOSFET	50.08	1	50.08
Arduino Uno R3 SMD	485.04	1	485.04
Arduino Nano	395.05	1	395.05
Push Button 4 pin Small	2.21	10	22.10
22uF 400V Capacitor	38.05	1	38.05
Diode 1N4007	1.68	5	8.40
Hall Effect Sensor Module Unipolar	80.05	1	80.05
Battery Holder 4 x AAA	60.04	1	60.04
HC-05 Bluetooth Module (Refurbished)	640.00	1	640.00
Arduino Uno R3 With Cable	750.00	1	750.00
Robot Wheel for BO Motors RC Car	260.00	1	260.00
20x4 2004 LCD Display Module with IIC/I2C/TWI	440.00	1	440.00
Half Size Self Adhesive Breadboard White	225.00	1	225.00
FC-51 Infrared Obstacle Avoidance IR Sensor	135.00	1	135.00
TowerPro MG996R Servo Motor (Metal, 180°)	440.00	1	440.00
Male-Female Jumper Wires (20cm)	180.00	1	180.00
Female-Female Jumper Wires (1 Pcs)	60.00	1	60.00
Male-Male Jumper Wires (20cm)	60.00	1	60.00
DHT11 Temperature & Humidity Sensor	120.00	1	120.00
Buzzer Sensor 5V - 70dB	20.00	1	20.00

DC 3-Pin Mini Push Button Switch	20.00	1	20.00
Micro SD Card Adapter v1.1 Module	50.00	1	50.00
RFID-RC522 RF IC Card Sensor Module	175.00	1	175.00
MFRC522 RFID Module	190.04	1	190.04
L298N Motor Driver Red	180.07	1	180.07
1K Ohm 1/4W Resistor Pack (20 pcs)	16.78	1	16.78
2K Ohm 1/4W Resistor Pack (20 pcs)	10.50	1	10.50
100K Ohm 1/4W Resistor Pack (20 pcs)	15.05	1	15.05
Bluetooth Module HC05 Master Slave (extra)	380.06	1	380.06

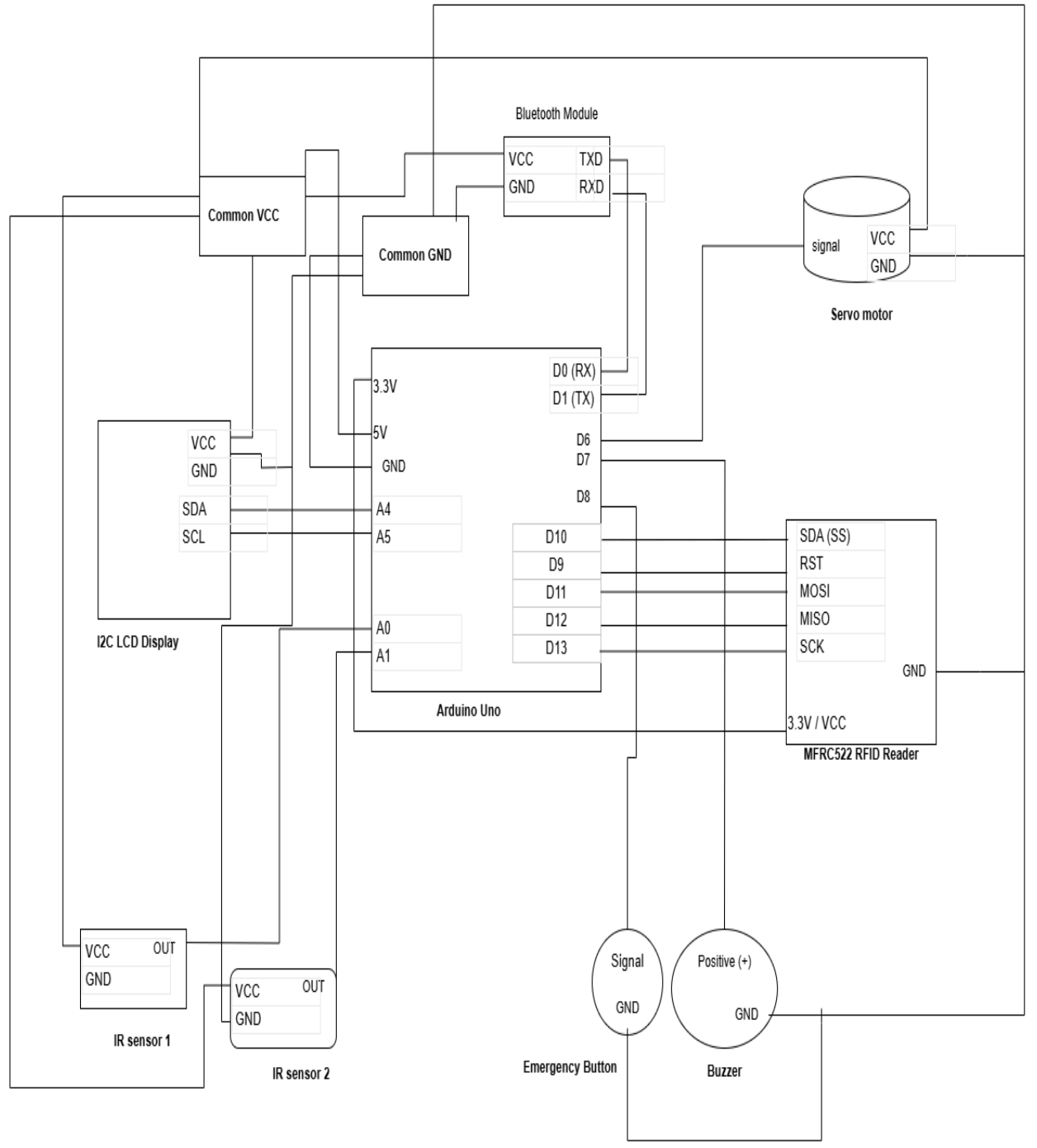
Total : 7,479.80 Taka (Only)

3.3 Communication Protocol

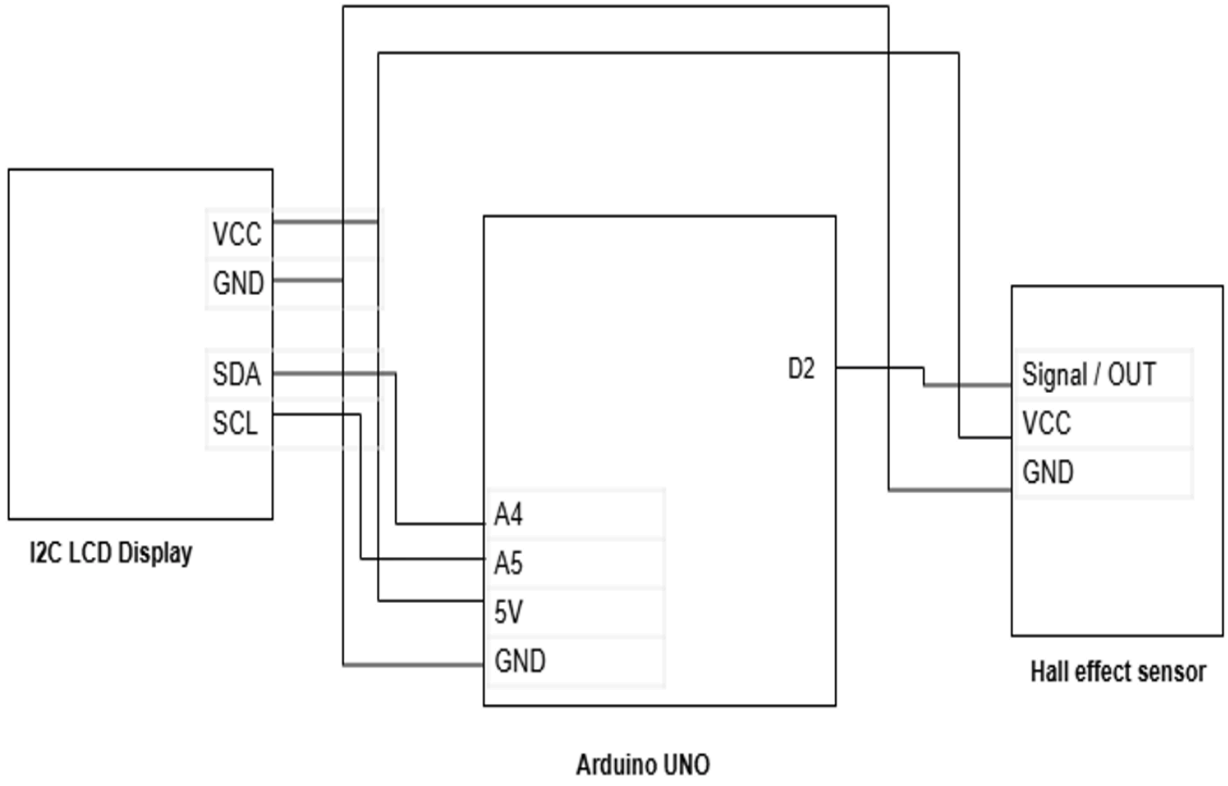
We used UART (Universal Asynchronous Receiver-Transmitter) as the primary communication protocol in our project. This protocol is used to establish a communication between the station (master) and the slave (bus). The TX/RX pins are used by both master and slave in this system. Upon connecting via bluetooth (HC-05), the master sends a "Hello from Master" request to the slave (bus), and the slave responds with formatted data. We used this simple communication protocol to ensure cost-effectiveness and also to maintain wireless communication. Moreover, The sensor MFRC522 RFID Reader uses SPI (Serial Peripheral Interface) communication protocol to transmit data quickly to the arduino. Also, the I2C LCD display used the I2C protocol for the display. It uses a simple two wire (SDA connected to D13 and SCL connected to A4) system and effectively shows the data on the display.

3.4 Circuit/Schematic

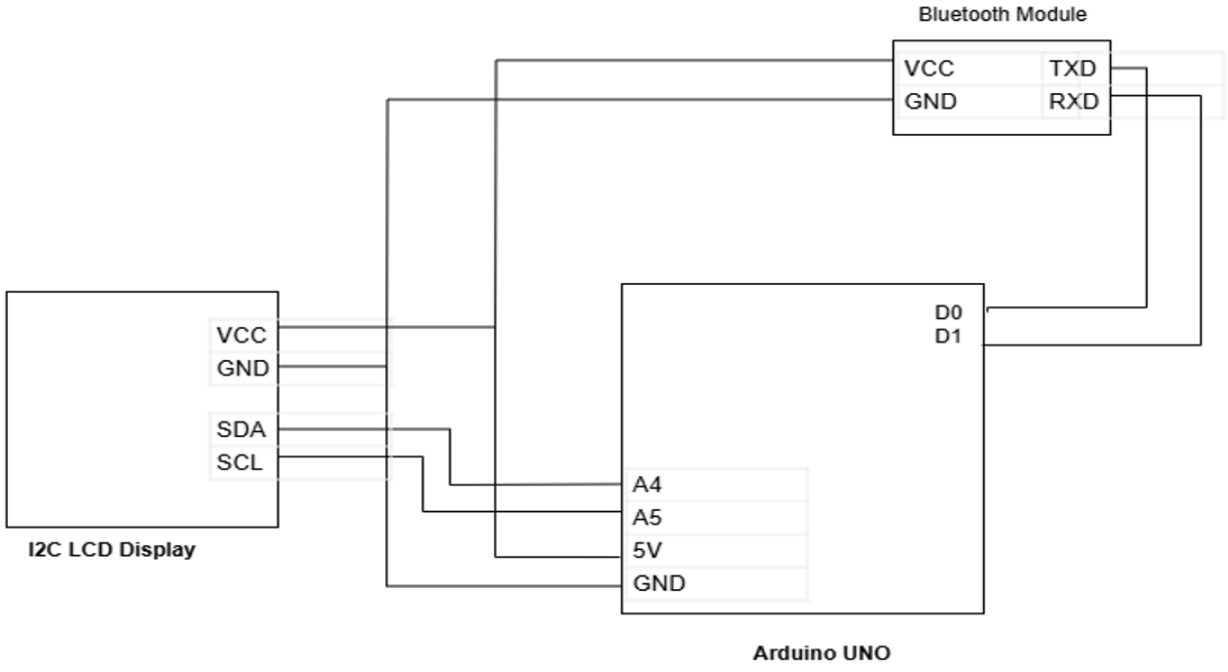
Bus slave diagram



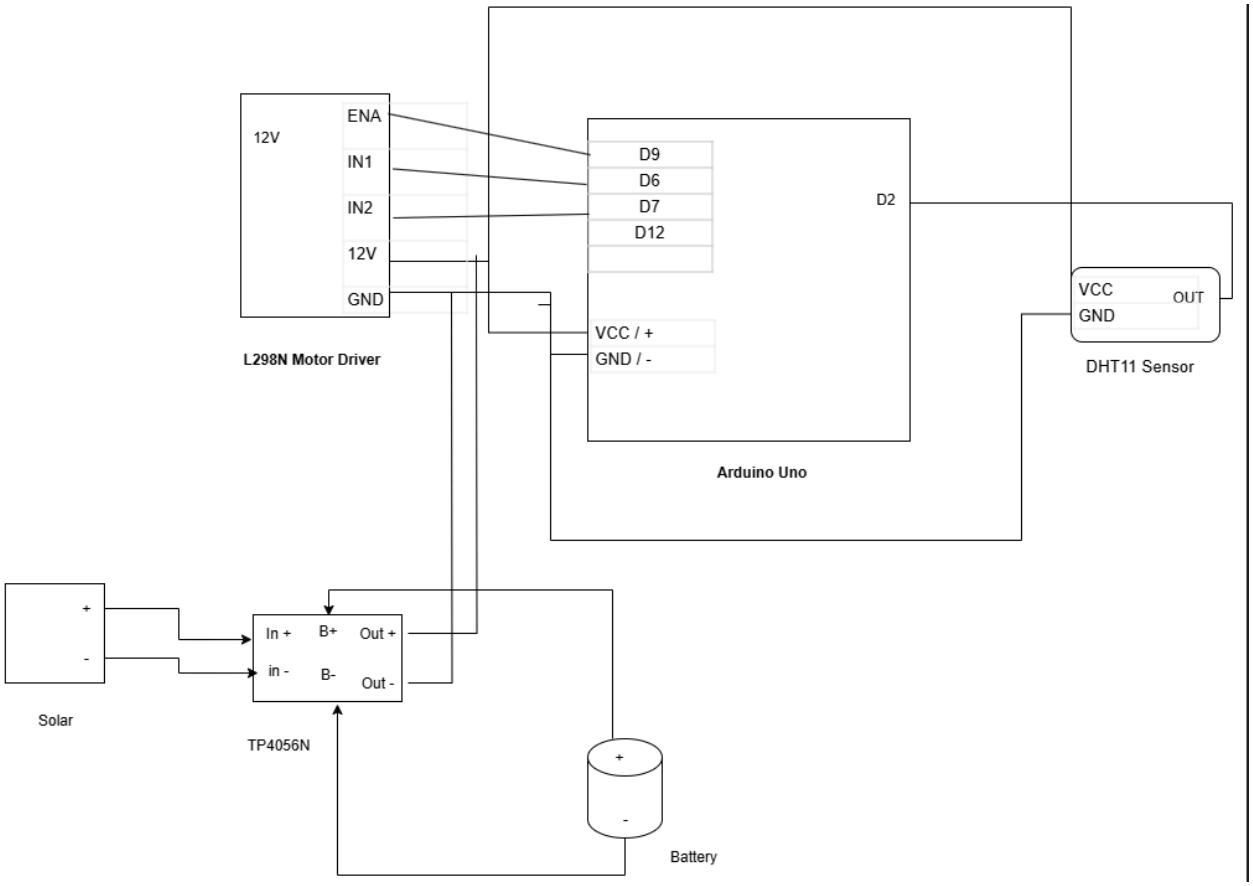
Speed Meter and Temperature Diagram



Station Master Diagram



DHT11, Motor with solar



3.5 Implementation

First, the bus's power goes on. It initializes its EPROM, and gets the predefined RFID information. If any emergency button is pressed, it increments the count of the number of emergency buttons pressed. If any person enters the bus (activating the first IR sensor first, then the second one) then it increases the passengers count by 1. If any passenger gets out of the bus (activating the second IR sensor first, then the first one) then it decreases the passenger count by 1. If the overall passenger count exceeds a certain threshold, then the buzzer makes a sound and shows in the LCD that the maximum number of passengers have been reached. If a driver (whose information is present in the EPROM) scans the RFID, then it shows that the access has been granted in the LCD and stores the information about the Driver and increments how many times he has scanned the RFID card. Also, the servo motor rotates and the door opens. Then after some predefined time, the door automatically closes by rotating the servo motor again. If any passenger is blocking the IR sensors, it also shows in the LCD that IR sensors are blocked. There is also a temperature sensor inside the bus which is connected to a separate arduino. If the temperature rises over a certain threshold, then the arduino rotates a motor with the help of a driver circuit, which turns on a fan. There is also a magnet connected to the wheel of the bus, which calculates the speed of the bus with the help of a hall effect sensor. This speed information and the temperature information are shown in a separate LCD device. On the other hand, the station is also continuously searching for the bus using a bluetooth module (HC-05). If the station gets connected to the bus, it sends a message "Hello From Master". After receiving this message, the bus automatically opens the door by rotating the servo motor.

The bus sends all its recorded data (Passenger count, driver information and number of emergency buttons pressed) to the station. After some predefined time, the door automatically closes.

3.6 Challenges

We have faced multiple challenges in this project. The first challenge was to set up the RFID. There were no viable instructions available to set up the MFRC522 RFID. However, from a youtube video we have learned how to set up the RFID. The second challenge was to connect the master and slave device via bluetooth. This bluetooth module (HC-05) requires specific setup commands, which we were unaware of. Moreover, some of the components had faulty pins which required changing our whole circuits again.

4. Sustainability & Impact

4.1 Sustainability

Our project Automatic Bus Administrative System with Door Control focuses on sustainability. It encourages using public transports, which reduces the usage of private vehicles, which results in less greenhouse gas emissions. This system uses low-power components, ensuring energy efficiency. Moreover, the usage of solar panels to recharge batteries which are used to activate fans is a direct result of using renewable energy. This implementation reduces the load of the bus's primary energy source. Furthermore, the usage of modular components ensures that the individual components can be replaced very easily.

4.2 Impact

This project's potential overall impact is very significant. First, it ensures that the buses are bound to take passengers from the stations only, which ensures that the buses do not stop except their pre-defined stations. This feature helps to reduce traffic congestion and passenger safety. Also, our project implements Passenger Emergency Button, which ensures passengers security. Moreover, drivers are monitored using the RFID system, so that they are accountable for the emergency stops. Furthermore, ensuring data driven management, our project ensures overall accountability. These implementations will encourage people to use public transport more, which will lead to reduced usage of private vehicles, which will benefit the entire community.

4.3 Future Work

Future work should be focused on precision and connectivity. Instead of using Bluetooth, GPS could be used to track specific locations and monitor the buses in real time. Along with passenger count, AI powered cameras can be installed to log critical data about the passengers for security purposes. For scalability, instead of sending all data at once, GSM/4G modules could be integrated to transmit data in real time.

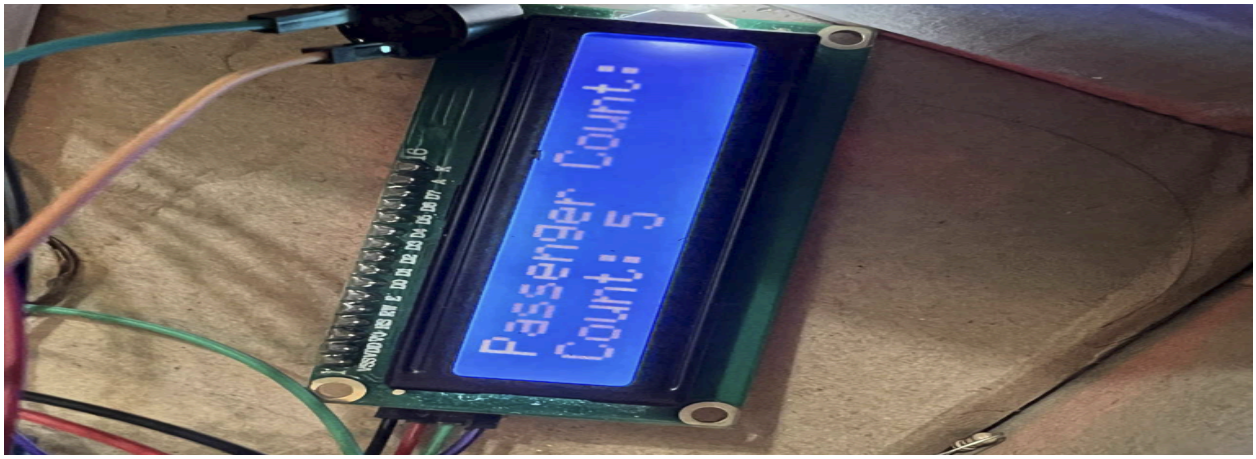
4.4 Limitations

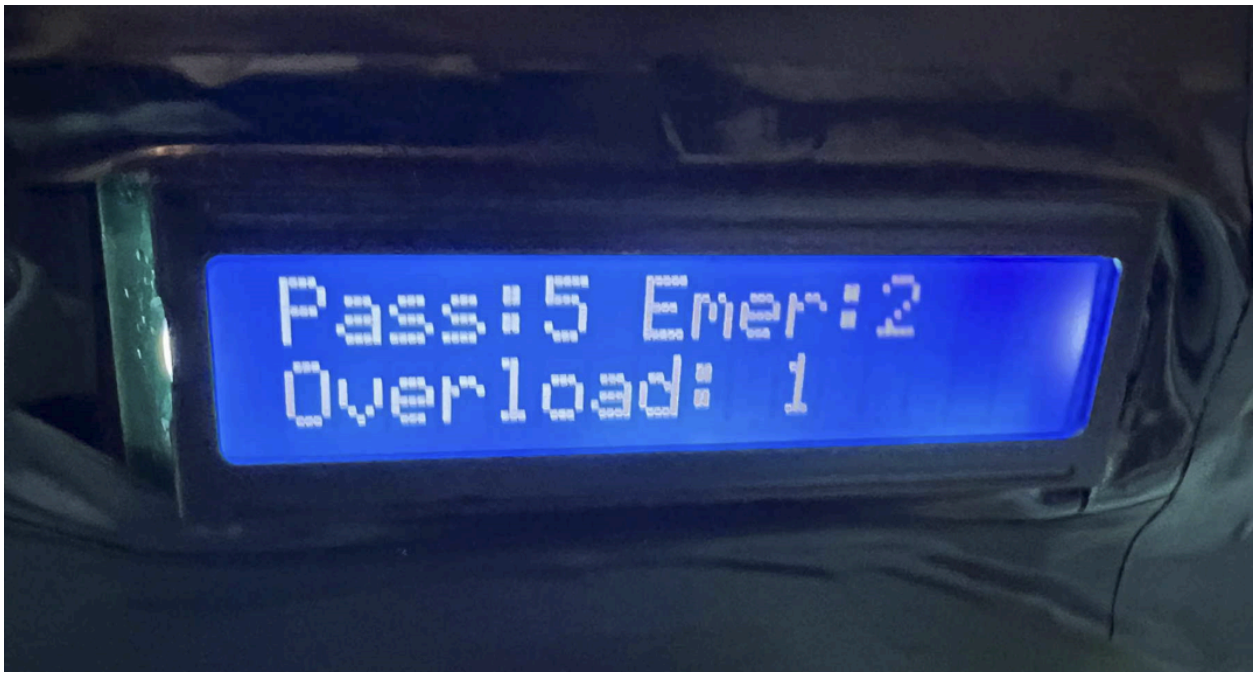
Even though the prototype is effective, the system possesses certain limits. Bluetooth (HC-05) module has a very short range and loses track among the interference, so that it may be difficult to detect stations

reliably. The IR sensor based passenger counter can provide incorrect counts whenever a large number of people are facing the sensor or when a person remains inside the entrance. The system also is not linked to the cloud in the real time. That is, data can only be accessed after the bus arrives at an admin station, thus, we are not able to track emergencies or vehicle status in real-time.

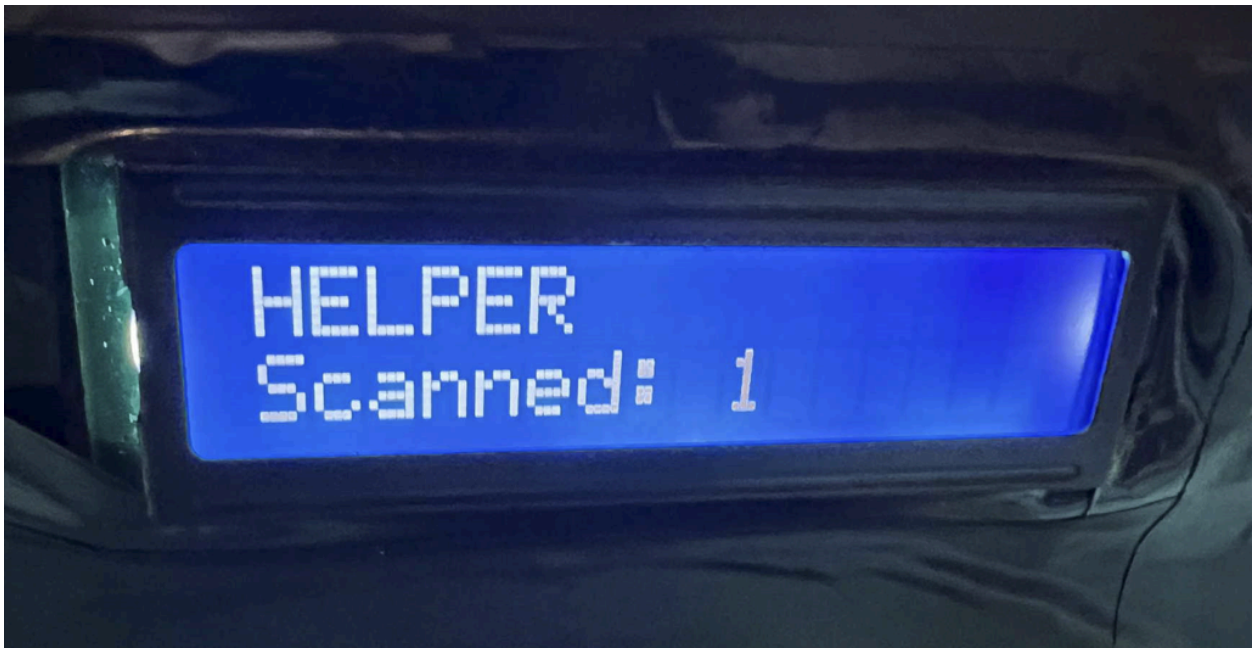
5. Results & Discussion

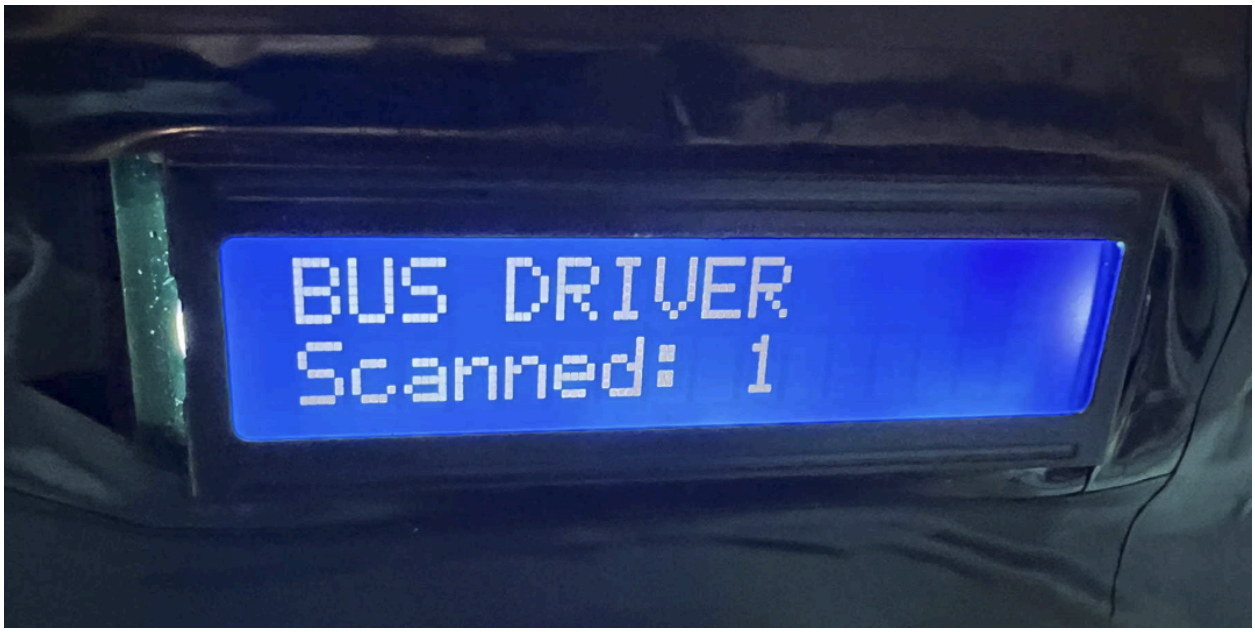

Gate blocked!
Please move away


Passenger Count: 5


Pass:5 Emer:2
Overload: 1


STATION MASTER
Scanned: 0


HELPER
Scanned: 1


BUS DRIVER
Scanned: 1

```
System Ready: Bus System Operational.
EEPROM already initialized. Loading cards...
Loaded Card 1: UID= F3 97 17 2D, Name=BUS DRIVER
Loaded Card 2: UID= 19 78 97 3F, Name=HELPER
Loaded Card 3: UID= 11 22 33 44, Name=STATION MASTER
Total cards loaded: 3
Scanned Card UID: 19 78 97 3F
Access Granted! Welcome, HELPER
Activating servo...
Servo closed successfully.
Scanned Card UID: F3 97 17 2D
Access Granted! Welcome, BUS DRIVER
Activating servo...
Servo closed successfully.
```

```
Entry -> Count: 3
Exit  -> Count: 2
Entry -> Count: 3
Entry -> Count: 4
Exit  -> Count: 3
Entry -> Count: 4
Exit  -> Count: 3
Entry -> Count: 4
Exit  -> Count: 3
Entry -> Count: 4
Entry -> Count: 5
Overload detected, buzzer ON.
Entry -> Count: 6
Overload buzzer timed out, turning OFF.
Entry -> Count: 7
Exit  -> Count: 6
Entry -> Count: 7
Exit  -> Count: 6
Entry -> Count: 7
Entry -> Count: 8
Entry -> Count: 9
Exit  -> Count: 8
Exit  -> Count: 7
Exit  -> Count: 6
Passenger count normal. Overload state reset.
Exit  -> Count: 5
Emergency button pressed! Buzzer and LCD activated.
Emergency button pressed! Buzzer and LCD activated.
Emergency alert timed out.
Scanned Card UID: F3 97 17 2D
Access Granted! Welcome, BUS DRIVER
Activating servo...
Servo closed successfully.
Scanned Card UID: 19 78 97 3F
Access Granted! Welcome, HELPER
Activating servo...
Servo closed successfully.
Received via Bluetooth: Hello from Master
D:5,2,1,BUS DRIVER,1,HELPER,1,STATION MASTER,0
Sent to Admin: D:5,2,1,BUS DRIVER,1,HELPER,1,STATION MASTER,0
```

```
System Initialized. Motor is OFF.
Temperature: 32.80 °C
ThresSystem Initialized. Motor is OFF.
Temperature: 32.30 °C
Threshold exceeded. Motor ON.
Fan is currently on
Fan is currently on
Fan is currently on
Fan is currently on
Fan is currently on
Fan is currently on
Temperature: 31.80 °C
Temperature is normal. Motor OFF.
Temperature: 31.80 °C
Temperature is normal. Motor OFF.
Temperature: 31.80 °C
Temperature is normal. Motor OFF.
Temperature: 31.80 °C
Temperature is normal. Motor OFF.
Temperature: 31.80 °C
Temperature is normal. Motor OFF.
Temperature: 31.80 °C
Temperature is normal. Motor OFF.
Temperature: 31.40 °C
Temperature is normal. Motor OFF.
Temperature: 31.30 °C
Temperature is normal. Motor OFF.
Temperature: 31.30 °C
Temperature is normal. Motor OFF.
Temperature: 31.30 °C
Temperature is normal. Motor OFF.
Temperature: 31.30 °C
Temperature is normal. Motor OFF.
Temperature: 31.30 °C
```

Discussion :

From the pictures, we can see that the project is working with its full potential. When the passenger count gets higher than the predefined number (in here, it's 5), it shows "OverLoad Detected". If the emergency button is pressed, it shows that the emergency button has been pressed and tracks the count of emergency buttons pressed in a variable. When a driver/helper scans their RFID, the system first checks the RFID with its EEP ROM. If it finds a match, then it shows "ACCESS GRANTED" else it shows "ACCESS DENIED". Moreover, it also activates the servo motor, which opens the door. After a predefined time, the servo motor automatically rotates in the opposite direction, closing the door. Finally, when the slave (bus) connects with the master (admin station), it sends all these data (for example, D : 5 (passenger count), 2 (Number of emergency button pressed), 1 (if the bus was overloaded), BUS DRIVER, 1, HELPER, 1, STATION MASTER, 0 (people and if they used the RFID scan how many). All this data is received by the master, and it shows the data in its LCD (given in the pictures). Moreover, the servo motor is only turned on when it crosses a threshold temperature (for this example, it's 32.80 degrees).

6. Conclusion

We have successfully implemented a smart bus administration system with automatic door control where the door of the bus will only open if the bus reaches a station.The doors can be manually opened by the driver by scanning the RFID card of the driver, however, this action will be sent to the admin station. The bus can't be overcrowded as if the number of passengers exceeds the predefined threshold, then it will trigger an alarm. Moreover, we have implemented an automatic fan system with turns on when the temperature rises more than a predetermined threshold. A solar system charges the batteries that are required to turn on the fan. With this prototype project, we are hopeful that the government will take necessary steps to implement this type of system in practical life. Our project will encourage people to use public transports, which reduces the usage of private vehicles, which results in less greenhouse gas emissions.

7. Contribution

Name	Role(s) / Responsibilities	Specific Contributions

MD. Abu Tarabin Surzo	Hardware design, Circuit building, Software Design	● Circuit for solar panel ● Code for solar panel ● Circuit for DC Motor logic ● Code for DC motor logic ● Circuit for bluetooth module ● Code for bluetooth module ● Circuit for Servo motor ● Code for Servo motor ● Integrating all code for slave ● Code for storing information in the EEP ROM
SM Azmain Faysal	Hardware design, Circuit building,Software Design	● Circuit for IR Sensor ● Code for IR sensor ● Code for IR overload Logic ● Circuit for hall effect sensor ● Code for hall effect sensor ● Code for speed calculation ● Showing the data to the LCD ● Code for motor logic ● Code for RFID integration in the EEP ROM ● Circuit for Solar ● Code for Solar
Aumio Rahman	Hardware design, Circuit building, Software Design	● Circuit for master ● Code for master ● Code for transferring data from slave to master ● Code for showing data to the master ● Circuit for LCD integration for the master ● Code for slave for successful data transfer ● Circuit for Solar ● Code for sending data without saving in the EEP ROM ● Circuit for slave to integrate all
MD. Raiyan Uddin	Hardware design, Circuit building,Software Design	● Circuit for RFID Scan ● Code for RFID scan ● Code for RFID storage ● Circuit for DHT11 sensor ● Code for DHT11 sensor ● Circuit for Hall effect ● Code for Hall effect ● Code to show data to the LCD ● Code for implementing speed, temperature and motor

		● Circuit for Solar ● Code for Solar
Ferdous Ahmed Auvi	Hardware design, Circuit building,Software Design	● Circuit for emergency button ● Code for emergency button ● Code for emergency count ● Code for showing data to the slave ● Circuit for Hall effect ● Circuit for motor logic ● Code for motor logic ● Circuit for DHT11 sensor ● Code for DHT1 ● Code for speed to the LCD ● Circuit for Solar ● Code for Solar

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