UGANDA INSTITUTE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

FINAL YEAR ENGINEERING PROJECT REPORT

PASSANGER MONITORING SYSTEM FOR PUBLIC TRANSPORT

BY

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DEPARTMENT OF ICT AND ENGINEERING

SUPERVISOR:

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A PROJECT PROPOSAL SUBMITTED TO THE DEPARTMENT OF ICT AND ENGINEERING IN PARTIAL FULFILLMENT FOR THE AWARD OF THE DIPLOMA IN ELECTRONICS AND COMMUNICATIONS ENGINEERING OF THE UGANDA INSTITUTE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

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ABSTRACT

The Passenger Monitoring System for Public Transport aims to improve efficiency and security in public transportation by utilizing modern technology for automated fare collection and passenger tracking. The system integrates RFID technology, GSM modules, weight sensors, and a keypad interface to accurately monitor passenger entries and exits, register fares, and provide real-time updates to transport operators. The RFID tags allow for seamless identification of passengers, while the weight sensors help to track occupancy levels. The GSM module ensures communication with central systems for data reporting and alerts. This project is designed to streamline public transportation management, improve accountability, and reduce fare evasion. It focuses on enhancing the overall public transport experience by providing a secure, automated, and user-friendly system.

DECLARATION

This is to certify that the following students of registration numbers below have submitted this proposal. It has been presented in accordance with the guidelines governing the award of a Diploma in Electronics and Communications Engineering of the Uganda Institute of Information and Communications Technology (UICT) under the supervision of Mr. Mutungi Godfrey. We further certify that the work in this proposal is original and has been done by us under the general supervision of our supervisor. The work has not been submitted to any other institution for the award of a degree, diploma, or certificate.

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APPROVAL

This is to certify that this project proposal has been done by the above-mentioned students. The proposal has been presented in accordance with the guidelines governing the award of a Diploma in Electronics and Communications Engineering at the Uganda Institute of Information and Communications Technology (UICT).

Mr. Mutungi Godfrey

Supervisor ………………….. ………………..

Signature Date

ACKNOWLEDGEMENT

We would like to extend our sincere gratitude to the Almighty God for the far he has brought us as far as our academics are concerned with his mighty hand of protection and provision.

Special thanks to our dear families for the endless financial support and courage they have always given us. Great thanks to the team members for their tireless efforts, advice, financial support, and positive critiques, which have led to a smooth and successful completion of this research.

Finally, we would like to thank our institute supervisor, Mr. Mutungi Godfrey for the professional guidance and direction rendered to us to achieve this success.

LIST OF ACRONYMS

RFID - Radio Frequency Identification.

PMS - Passenger Management System.

UICT - Uganda Institute of Information and Communication Technology

PSU – Power Supply Unit.

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CHAPTER ONE: INTRODUCTION

1.1 Introduction

Public transportation systems around the world are vital for moving large numbers of people efficiently. However, managing these systems comes with challenges related to passenger monitoring, fare collection, and safety. A well-designed monitoring system can help public transport operators streamline operations, reduce revenue loss, and improve the overall experience for passengers.

This project, titled **Passenger Monitoring System for Public Transport**, aims to create an automated system that uses RFID technology to track passengers, monitor their boarding and exiting, and register fare payments. The system combines RFID tags, GSM modules, weight sensors, and a keypad interface to provide real-time passenger data, automate fare deductions, and communicate with central servers. By doing so, it offers a solution to many common issues in public transport, such as manual fare collection and limited visibility into passenger flow.

MANUAL SYSTEM VS AUTOMATED SYSTEM.

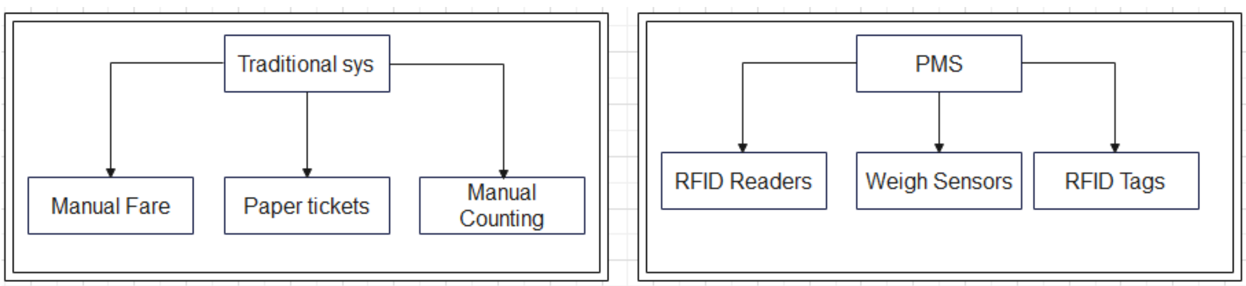


Figure 1: existing Vs PMS

1.2 Background

The transport sector plays a critical role in daily life, particularly in urban areas where public transport is a primary means of commuting. However, ensuring the safety, security, and efficiency of passengers during travel remains a challenge. One of the key problems faced by public transport systems is monitoring the number of passengers boarding and alighting, keeping track of fare payments, and ensuring passengers' security. To address this issue, automation systems have been introduced to optimize fare collection and passenger monitoring.

The **Passenger Monitoring System for Public Transport** is designed to automate fare collection and monitor the number of passengers in real-time. Using RFID technology, this system allows for secure registration, identification of passengers, and fare deduction. In addition, weight sensors on the vehicle's seats detect the presence of passengers, ensuring accurate data on the number of seats occupied. The system also integrates a GSM module to send notifications and alerts to designated contacts, ensuring a robust and efficient transport monitoring system.

This system aims to streamline the processes of boarding and fare management in public transport, making travel safer and more efficient.

1.3 Problem statement

Public transport systems often face challenges in ensuring that all passengers have paid their fares, managing overloading, and maintaining passenger records. Traditional methods of ticketing and monitoring passengers are prone to errors, fraud, and inefficiencies. Manual counting, paper-based tickets, and lack of real-time information are common issues that hinder optimal service delivery. This can lead to revenue losses and safety concerns due to overloading.

The **Passenger Monitoring System for Public Transport** addresses these challenges by automating passenger identification and fare collection. Using RFID technology and weight sensors, the system ensures that only registered and paid passengers are allowed to board the vehicle, and it keeps real-time data on seat occupancy. This prevents overloading and enhances the overall operational efficiency of public transport systems.

1.4 Main Objective

The main objective of this project is to develop a reliable, automated system that monitors passenger boarding and fare payment in real-time

1.5 Specific Objectives

The specific objectives include:

I. To acquire hands-on experience in using what we have studied in the course to solve real-life problems in our community.
II. To design an RFID-based system that registers passengers, deducts fares automatically, detect seat occupied using weigh sensors and monitor number of passengers on board.
III. To send alerts and notifications through a GSM module to passengers when they make payment for the trip.
IV. To test and validate the system.

1.6 Scope

The **Passenger Monitoring System** will be implemented in small and medium-sized public transport vehicles, such as buses or vans. The system will monitor passenger boarding through RFID tag identification and seat occupancy through weight sensors. It will also manage fare collection and send notifications when passengers board or alight. The system will be designed for ease of use, ensuring minimal disruption to passengers and operators.

The following the tools we used in our system and how they are used.

RFID Reader: The RFID Reader communicates with the Card to collect information about the card by scanning.

GSM module: This module is used in our system to enable alerting of the vehicle owners about what is going on in the bus that is; when there is a payment made.

Microcontroller: The controller in our system manages data storage about the customer travel information that is the start point and the stopover point.

Keypad: The Keypad in our system is used to enter the amount to be paid as the transport fare.

Weigh Sensors: The weigh sensors in our system are used to record weight and communicate to the LED to show that a seat is occupied by the passenger.

Relay: The relay in PMS is used to efficient switching to connect and disconnect power to devices.

Power Unit: The power unit in our PMS is used to supply stable power to all the system components.

Solenoid Lock: This is used to Open and lock the door during entry and exit of the passengers.

Display Unit: The display Unit in PMS displays information.

MIFARE: This is a protocol that is used in our PMS to ensure quick and easy transactions. This reduces queuing time and increases convenience for users.

SPI (Serial Peripheral Interface): This protocol is used in our PMS enable communication over short distance wired system.

I2C: This is a two wire serial communication protocol that uses a serial data line and serial clock line and is used in our PMS to support microcontrollers to enable receiving and sending of commands and data.

Request Button: This is used in our PMS to request to input a command.

UART (Universal Asynchronous receiver / transmitter): This is used in our PMS to take bytes of data and transmits the individual bits in a sequential form.

1.7 Significance

The **Passenger Monitoring System** offers several benefits to public transport operators:

Fare Accuracy: Automated fare deduction reduces errors and minimizes fare evasion.

Real-Time Monitoring: The system provides real-time updates on passenger load, allowing operators to better manage their fleet.

Increased Efficiency: By automating manual processes, the system reduces the workload for staff and improves the overall efficiency of the transport system.

Data-Driven Decisions: The collected data can help operators optimize routes, reduce overcrowding, and improve service quality.

Enhanced Security: With RFID tracking, operators can ensure better passenger safety and prevent unauthorized access to the transport system.

1.8 Justification

Public transportation plays a crucial role in urban mobility, but many systems are outdated, relying on manual fare collection and limited passenger monitoring. This results in inefficiencies, lost revenue, and poor service quality. The proposed **Passenger Monitoring System** offers a solution to these issues by leveraging RFID and other technologies to automate fare collection, track passengers in real-time, and provide accurate data to transport operators. The system is cost-effective, scalable, and easy to implement, making it an ideal solution for improving the efficiency and sustainability of public transport systems.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In modern urban and rural transport systems, passenger monitoring has become essential to ensure security, accurate fare collection, and efficient operation. The challenge lies in monitoring passenger movement effectively while minimizing manual intervention. With the rise of technologies like RFID (Radio Frequency Identification), GSM (Global System for Mobile Communications), microcontrollers, and weight sensors, public transport systems have evolved to offer more streamlined solutions. These systems have the potential to automate processes such as fare registration, passenger tracking, and vehicle management. This chapter reviews the theoretical foundations, existing systems, and technological advances that influence the development of the **Passenger Monitoring System** proposed in this study.

2.2 Theoretical review

The proposed **Passenger Monitoring System for Public Transport** leverages various technologies to automate fare collection, track passenger activity, and ensure vehicle load management. This section provides a detailed theoretical review of the key components and technologies involved, such as **RFID**, **GSM**, **Weight Sensors**, and **Microcontrollers**, which are integrated to create a robust, efficient monitoring system.

2.2.1 RFID Technology

Radio Frequency Identification (RFID) is a wireless communication technology that uses electromagnetic fields to automatically identify and track tags attached to objects. In public transportation systems, RFID tags are issued to passengers, typically in the form of cards. When passengers board or alight from a vehicle, the RFID reader scans their card, logging essential data such as the time of entry or exit, location, and fare information.

RFID consists of two main components:

1. **RFID Tags**: These are small devices embedded with a microchip and an antenna, storing information about the passenger or a unique identifier.

Figure 2: RFID Tag

2. **RFID Readers**: These devices emit radio waves to detect and read the information stored on the RFID tags when they come into proximity.

Figure 3: RFID Reader

The RFID reader installed in the vehicle is connected to the microcontroller, which processes the data and ensures that the fare is deducted accordingly. This real-time processing helps in keeping accurate records of passenger movements and ensures that the system is easy to use and reliable.

According to Siva Aditya Putrevu and Sri Kumar Chaladi, RFID technology is extremely useful in public transport systems due to its **accuracy, speed, and ability to handle multiple transactions** at once. Their research demonstrates how RFID systems can streamline public transport processes and enhance operational efficiency.

2.2.2 GSM Technology

Global System for Mobile Communications (GSM) technology is widely used for communication in mobile devices and embedded systems. In this project, GSM modules provide a reliable method for transmitting data between the public transport vehicle and a central monitoring station. This includes information such as the vehicle's current location, the number of passengers onboard, and fare transactions.

The **GSM module** in the system operates by connecting to cellular networks, transmitting data collected from the RFID system and weight sensors. The real-time data helps the transport authority or the operator to:

- Monitor the number of passengers onboard.
- Track vehicle location for efficient route management.
- Detect abnormalities like overloading or route deviations.

By using GSM modules, the system ensures **constant communication** between the vehicle and the central server, allowing operators to make real-time decisions. This technology provides high coverage, reliability, and relatively low-cost communication, making it ideal for public transport applications.

Here is a GSM that we used in designing ours system prototype.

Figure 4: GSM module

2.2.3 Weigh Sensors

Weight sensors play a crucial role in monitoring the load inside a vehicle. These sensors measure the overall weight of passengers in the vehicle and compare it to the vehicle's capacity. This feature is vital in preventing overloading, which can compromise passenger safety and vehicle performance.

Key functions of weight sensors in the system:

1. **Load Measurement**: The sensors detect the combined weight of passengers when they board or alight from the vehicle.
2. **Data Communication**: The weight data is sent to the microcontroller, which compares it against predefined safety limits.
3. **Alarm Trigger**: If the load exceeds the vehicle's capacity, an alarm is triggered to alert the driver or operator.

The weight sensor data is continuously monitored and transmitted via the GSM module to the central server for remote analysis. This ensures **passenger safety** and reduces the risk of vehicle overloading, contributing to improved vehicle efficiency and a safer transport system.

Here is the photo of weigh sensors that we used.

Figure 5: Weigh Sensor

2.2.3 Microcontrollers.

The **microcontroller** is the central processing unit of the entire system. It coordinates all operations, including:

- **Processing RFID data**: When a passenger swipes their RFID card, the microcontroller verifies the card information, calculates the fare, and updates the central database.
- **Managing weight sensor input**: The microcontroller receives data from the weight sensors, determining the number of passengers onboard and checking if the load is within safe limits.
- **Handling GSM communication**: The microcontroller ensures that the GSM module transmits all relevant data, such as vehicle location and passenger count, to the central monitoring station in real time.

Some of the key features of microcontrollers in passenger monitoring systems include:

1. **Low Power Consumption**: Microcontrollers are optimized for energy efficiency, ensuring that the system remains operational for extended periods, even in low-power environments.
2. **Real-time Data Processing**: The microcontroller processes inputs from all system components instantly, ensuring that fare collection, load management, and communication happen in real time.
3. **System Integration**: The microcontroller serves as the brain of the system, integrating all components (RFID, weight sensors, GSM modules, and keypads) and ensuring seamless operation.

Here is a microcontroller that we used in our system.

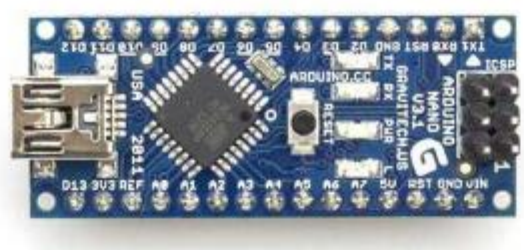


Figure 6: Microcontroller

2.3 Existing systems

2.3.1 RFID Passenger Monitoring Systems

In recent years, various cities have implemented **RFID-based systems** to automate passenger monitoring and fare collection. These systems typically use contactless RFID cards, which passengers scan when entering and exiting the vehicle. The RFID reader records the time and location of the scan, and the system deducts the appropriate fare from the passenger’s balance. While RFID systems are highly efficient in managing fare transactions, some existing systems have limited integration with real-time tracking and vehicle load monitoring.

Limitations:

- Lack of real-time communication to a central server.

- Inability to track vehicle location or monitor passenger load in real-time.

2.3.2 GSM-enabled Vehicle Tracking System.

Many public transport systems employ **GSM modules** for real-time vehicle tracking. These systems provide operators with live updates on vehicle location, estimated arrival times, and route deviations. However, these systems often focus solely on vehicle tracking and do not integrate passenger monitoring features such as load management or fare collection.

Limitations:

- Limited integration with RFID systems.
- Does not monitor passenger load or automate fare collection.

2.4 Comparative Review

Feature	Existing Systems	Our System
Passenger Tracking	Manual based	Automated RFID-based system
Fare Collection	Manual based	Automatic fare deduction via RFID
Passenger Monitoring	Limited monitoring	Real-time passenger monitoring via GSM communication
Load Monitoring	No load monitoring	Weight sensors integrated to monitor vehicle overload
Flexibility	Not flexible	Scalable and automated system

Cost	Low	moderate
User experience	Simple	User friendly

Table 1: Comparative evaluation

In addition to the above, our proposed project has the following advantages;

The **Passenger Monitoring System** proposed in this study offers several advantages over existing solutions:

- **Comprehensive Monitoring**: The integration of RFID, GSM, and weight sensors provides a complete solution for passenger tracking, fare collection, and vehicle load management.
- **Cost-Effective**: The use of affordable components makes the system economically viable for widespread adoption.
- **Real-Time Updates**: By using GSM modules, the system ensures that passenger data, vehicle location, and load information are communicated to a central server in real-time.
- **Improved Safety**: Weight sensors help prevent overloading, ensuring that vehicles operate within their safe carrying capacity.
- **Automation**: The system automates fare collection and passenger tracking, reducing the need for manual intervention and increasing efficiency.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

The project specifications above are clear and defined, and so we built a system capable of performing these actions. In this chapter, we covered what tools and methods used to reach our objectives. We have also included the techniques we employed and the tools that we used to develop a passenger monitoring system.

3.2 System Study

These are the techniques and the methods which were used in the process of gathering raw facts in a given research for analysis. These were applied to study the acquisition and provision of information in our system in order to accomplish the specific objectives.

3.2.1 Group Discussions

We had several meetings as group members where we would meet physically and at times online via zoom meetings, through this we were able to share different ideas on how best we can come up with our system that is cost effective in terms of implementation yet fulfilling our objectives.

PHOTOS OF US IN A DISCUSSION WORKING ON THE PROJECT.

Figure 7: Group Discussion

3.2.2 Consultation

We made several consultations from our project supervisor and other lecturers to get some technical support from them. We also consulted several people where we bought components from, and great advice was given to us on how best we would design our system.

3.2.3 Documentaries and videos

Most of the different systems that were written in our literature review had videos, tutorials, and documentaries, and this were of great importance in helping us have a broader idea on those systems.

3.2.4 Document Review

This involved searching related literatures on the research topic that we were undertaking, and this guided us on what we did to make improvements on existing systems. It was a very key aspect of system study. During literature review we reviewed some of the documents coming from newspaper articles, journals, books, and this gave us a lot of information on these kinds of system.

3.3 System Design

3.3.1 Tools and Materials Used

We ought to use the following tools to help us come up with our desired prototype

- RFID reader

  The RFID Reader communicates with the Card to collect information about the card by scanning.
- GSM module

  This module is used in our system to enable alerting of the vehicle owners about what is going on in the bus that is; when there is a payment made.
- Microcontroller.

  The controller in our system manages data storage about the customer travel information that is the start point and the stopover point.
- Keypad.

  The Keypad in our system is used to enter the amount to be paid as the transport fare.
- Weigh Sensors

  The weigh sensors in our system are used to record weight and communicate to the LED to show that a seat is occupied by the passenger.
- Relay.

The relay in PMS is used to efficient switching to connect and disconnect power to devices.

- ❖ Power Unit

  The power unit in our PMS is used to supply stable power to all the system components.

- ❖ Solenoid Lock.

  This is used to Open and lock the door during entry and exit of the passengers.

- ❖ Display Unit.

  The display Unit in PMS displays information.

- ❖ Mifare

  This is a protocol that is used in our PMS to ensure quick and easy transactions. This reduces queuing time and increases convenience for users.

- ❖ SPI (Serial Peripheral Interface)

  This protocol is used in our PMS enable communication over short distance wired system.

- ❖ I2C

  This is a two wire serial communication protocol that uses a serial data line and serial clock line and is used in our PMS to support microcontrollers to enable receiving and sending of commands and data.

- ❖ Request button

  This is used in our PMS to request to input a command.

- ❖ UART (Universal Asynchronous Receiver / Transmitter)

  This is used in our PMS to take bytes of data and transmits the individual bits in a sequential form.

CHAPTER FOUR: SYSTEM CONSTRUCTION

In this chapter, we shall explain how we came up with the prototype and how all the connections were made. We first made connections on the breadboard to test the connections and then later we transferred it on the surfboard for the final prototype.

4.1 SYSTEM BLOCK DIAGRAMS

We had two circuits block diagrams, one for the loading station and another one for the vehicle.

4.1.1 BLOCK DIAGRAM FOR LOADING A STATION

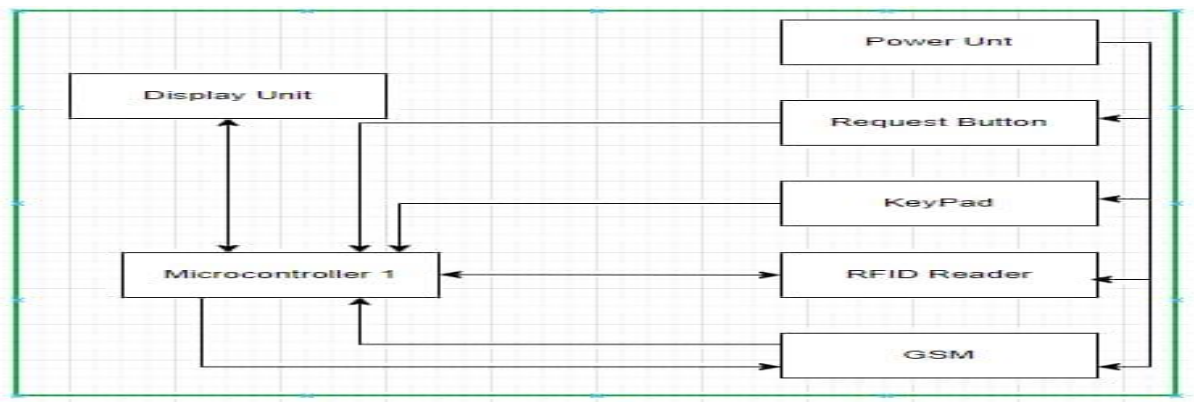


Figure 8: Block diagram of Loading Station

4.1.2 BLOCK DIAGRAM FOR VEHICLE

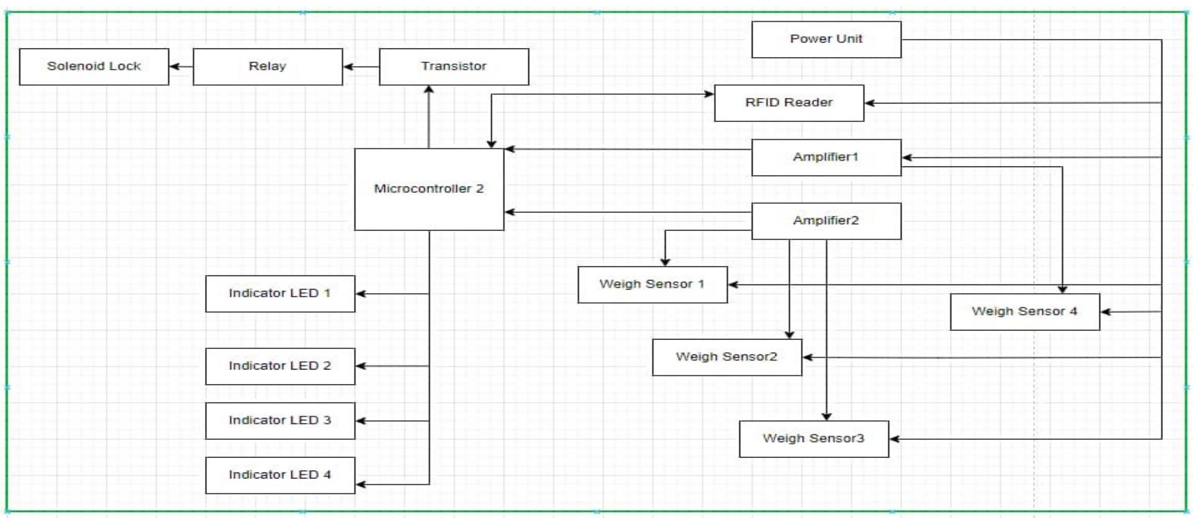


Figure 9: Block diagram of Vehicle

4.2 SYSTEM CIRCUIT DIAGRAM

We had two circuits in our passenger monitoring system prototype.

CIRCUIT DIAGRAM FOR LOADING STATION

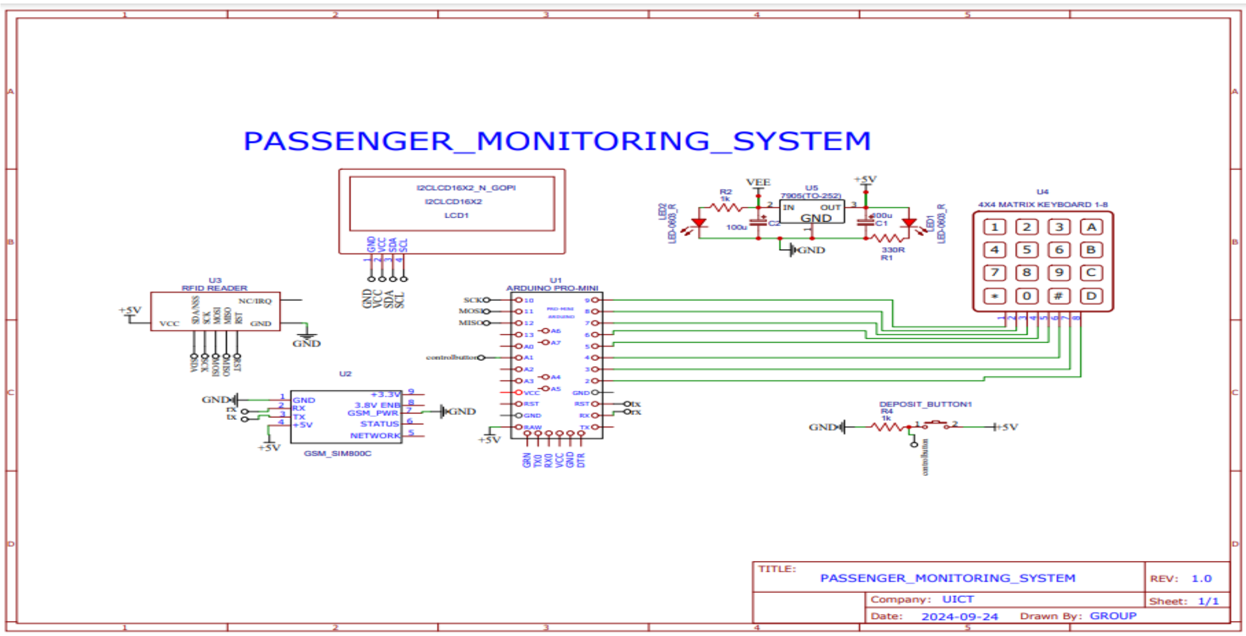


Figure 10: Circuit diagram of loading a station

CIRCUIT DIAGRAM FOR VEHICLE

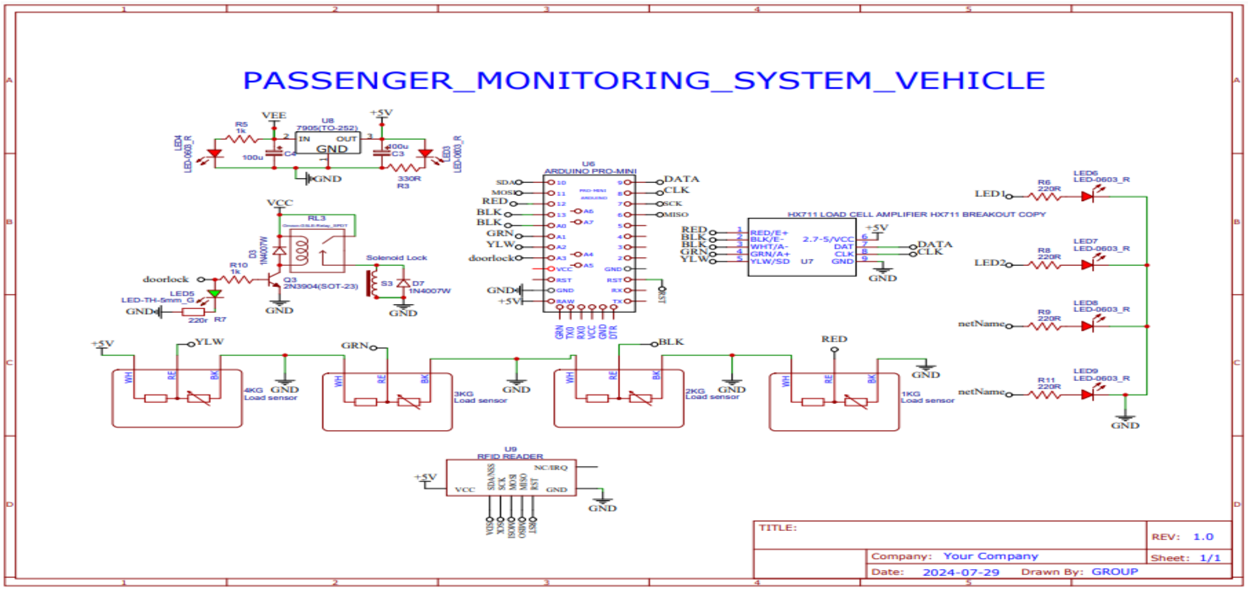


Figure 11: Circuit Diagram of vehicle

BELOW ARE THE CONNECTIONS:

Weigh sensors use the whinstone bridge to detect presence of a passenger on a seat using based on compression and tension.

LED diodes communicate with weigh sensors such that when a seat is occupied, they are able to light up to show presence of a passenger on a seat.

Voltage Regulator steps down the voltage to 5V for supplying the microcontroller and other components like the RFID reader.

4.3 SYSTEM FLOW CHARTS

SYSTEM FLOW FOR LOADING STATION.

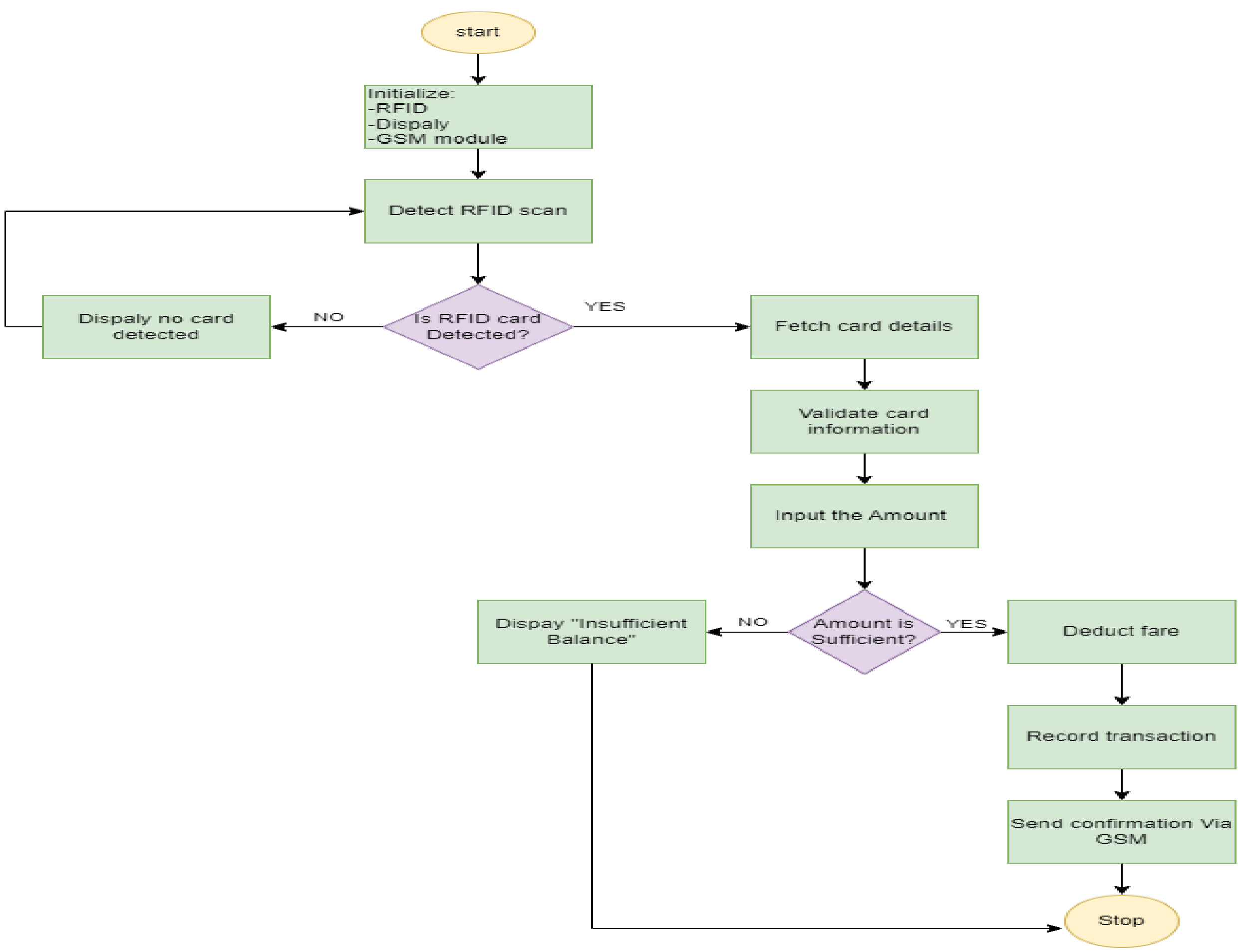


Figure 12: System flow for loading station

SYSTEM FLOW FOR VEHICLE

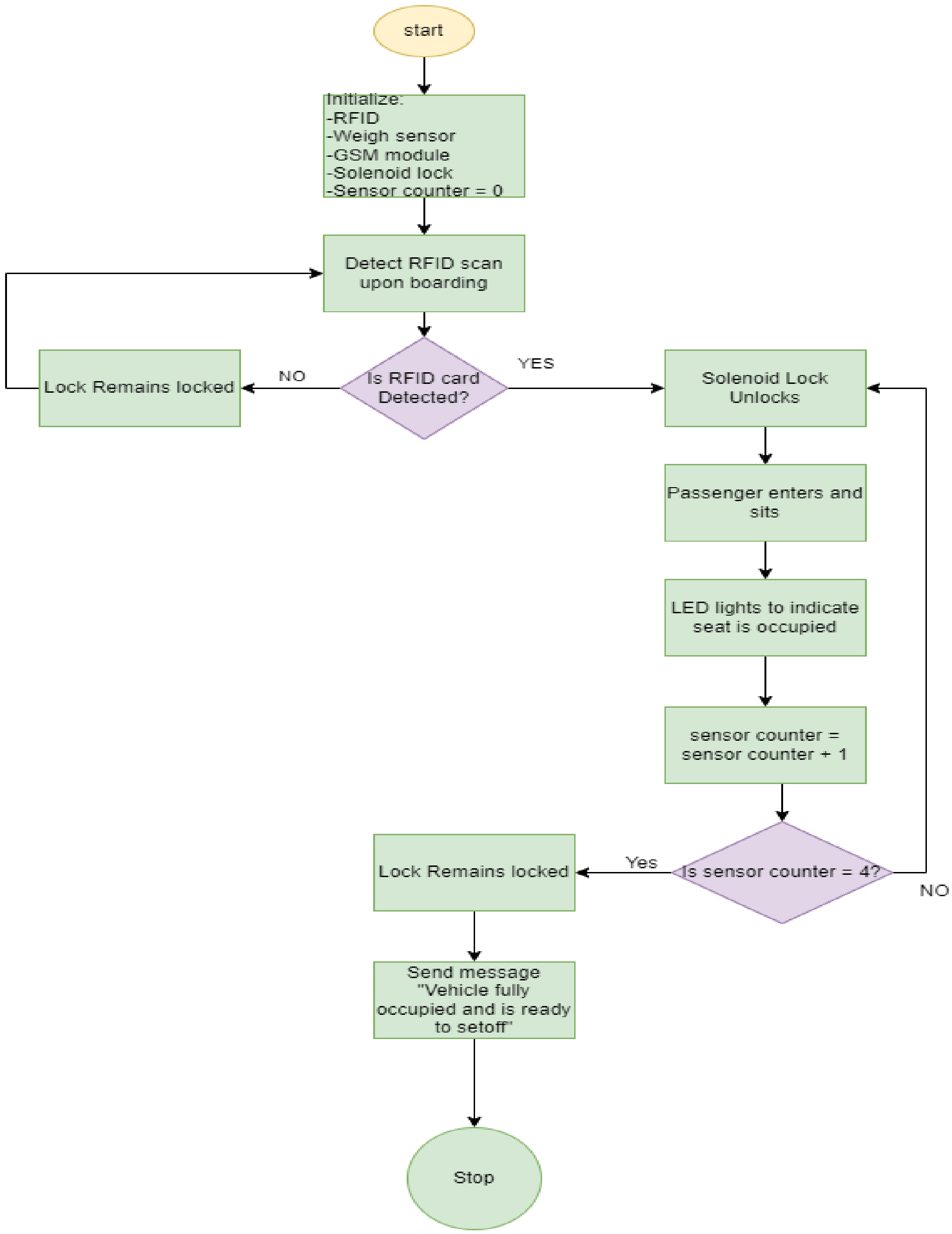


Figure 13: System flow for Vehicle

CHAPTER FIVE: SYSTEM TESTING AND VALIDATION

This chapter explains how we implemented and tested our project to the final stage. We carried out component testing, block testing and final testing to ensure that our project works as required

5.1 COMPONENT TESTING

Component testing ensures that all individual components of the Passenger Monitoring System work as expected before they are integrated into the overall system. The following components were tested individually:

RFID Reader and Tags: RFID tags were scanned by the reader to ensure accurate identification of passengers. Tests were conducted to check the reading range, response time, and data transmission to the microcontroller. Each test confirmed the correct identification of passengers as they entered or exited the vehicle.

GSM Module: The GSM module was tested to ensure that it could transmit data to the central system. Multiple test messages were sent, including fare information and occupancy updates, to validate that the module functioned correctly and was able to maintain a stable connection.

Weight Sensor: The weight sensor was calibrated and tested by placing various known weights to simulate different passenger loads. It was tested to confirm that it could accurately detect changes in occupancy and notify the system in real time.

Keypad Interface: The keypad was tested for manual input of commands and passenger data. All keys were checked for functionality, response time, and error detection.

Microcontroller: The microcontroller was tested to ensure that it received, processed, and transmitted data correctly from all connected components.

5.2 BLOCK TESTING

Once all individual components were tested, block testing was performed to verify that each subsystem works as expected when components are combined.

We had two subsystems that is the load station and the vehicle:

We integrated components together to form the module for loading station where by the keypad, microcontroller, GSM were all integrated and tested to ensure that a passengers can register their information and also load a fare on their RFID cards.

Also we formed the second module at the vehicle whereby we tested and with cards that did not have fare loaded and the solenoid lock could not open, instead could send a message “Insufficient balance!”. When the card had a Fare loaded, a deduction could be done and the solenoid lock unlocks immediately after fare deduction.

We placed various weights on the Weigh sensors and the LED lights could light indicating presence of a passenger on a seat.

5.3 FINAL PROTOTYPE TESTING

The final prototype testing involved the full system operating under simulated real-world conditions to assess its overall functionality and performance:

Boarding and Alighting:

A complete prototype test was performed by placing different weights on the seats where weigh sensors were placed to ensure the LED lights.

Reliability and Error Handling:

The system was monitored for potential errors, such as multiple passengers using the same RFID card or faulty sensor readings. The system could handle the situation and therefore had minimal errors.

Power and Connectivity Testing:

The system’s power efficiency and GSM module connectivity were assessed under various conditions, including poor signal areas. The system performed well, with minimal power consumption and reliable data transmission, even in low-signal areas.

CHAPTER SIX: DICUSSION, CONCLUSION, RECOMMENDATIONS

6.1: DISCUSSION.

In our discussion, some of the challenges that we faced include:

Getting tools that are compatible was an issue. Some tools could not function properly when connected on our prototype

Cost constraints that is raising funds for the project in time.

System short circuiting which hindered us from completing the project in time. Difficulties in meeting as a team as when we finished exams people moved to places far away from campus.

6.2: CONCLUSION

Our Passenger monitoring system successfully demonstrates automated fare registration using RFID and real time updates via GSM by sending alerts once customers make payment for the trip, plus calling to ensure that the alert is seen by the passenger.

The system also restricts the extra passenger from entering the vehicle once the seats are fully occupied.

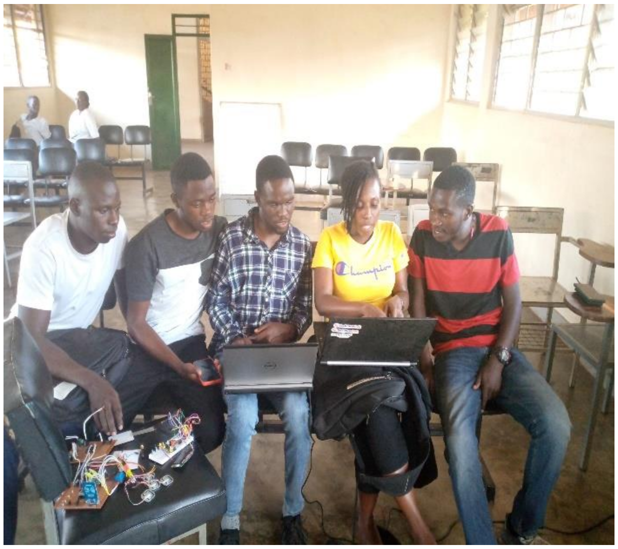
We thank the supervisor, the lectures whom we could meet during early presentations they contributed much to the successful completion of the project design by giving us guidance.

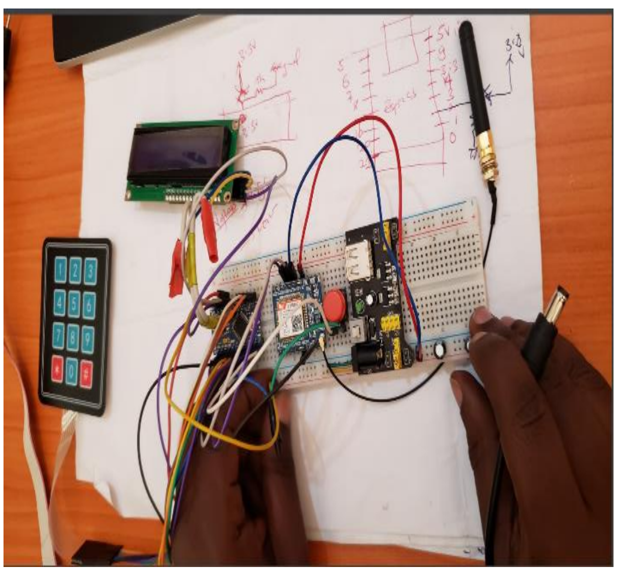
6.3: RECOMMENDATIONS

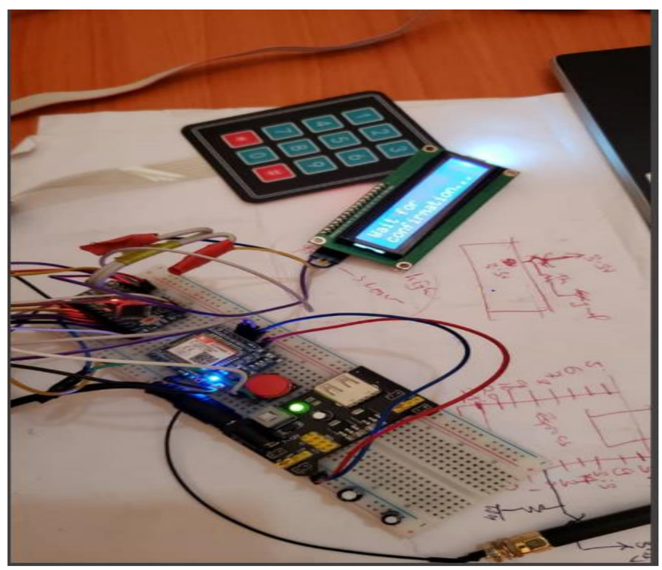
Based on the research we made, we came up with the following recommendations to improve on our research.

- We recommend a mobile app for passengers to check fare status and travel history.
- We recommend future improvements for the system to cater for different stopovers since or system only works on the

PICTURES SHOWING PROJECT ACTIVITIES







References

- Smith, A. (2022). *The Role of RFID in Modernizing Public Transport*. Technology Today, 19(4), 134-142.
- Harper, M. (2021). *Challenges in Implementing Advanced Fare Collection Systems*. Journal of Transportation Security, 15(3), 45-58.
- Kato, P. (2021). *Public Transport Challenges in Uganda*. Ugandan Transport Review, 7(1), 30-44.
- IEEE. (2021). *Advancements in RFID Technology for Public Transport*. IEEE Transactions on Industrial Electronics, 68(4), 1097-1105.
- *Davis, M., & Chen, L. (2023). Integrating RFID and IoT for Smart Transportation Systems. *Journal of Urban Technology, 30(4), 67-85.*
- *Johnson, T., & Lee, K. (2024). The Future of Cashless Payments: Trends and Technologies. Journal of Payment Systems, 10(1), 45-61.*
- *Sharma, S., & Kumar, V. (2022). Innovations in Weigh Sensor Technologies for Transportation Applications. *Sensors and Actuators A: Physical, 332, 113264.*
- Johnson, R., & Lee, C. (2023). *Optimizing Fare Collection with RFID Technology*. Transportation Research Journal, 21(2), 89-102.
- *Green, T., & Moore, C. (2023). Implementation and Testing of Advanced Passenger Monitoring Systems. *Journal of Transportation Engineering, 149(7), 05023014.*
- World Bank. (2020). *Public Transport and Economic Development*. World Bank
- UNDP (United Nations Development Programme). (2020). *Technological Barriers in Developing Countries: A Focus on Public Transport*. UNDP Report.
- Nguyen, L. (2022). *Case Studies in RFID-Based Transit Systems*. Asian Transport Studies, 10(3), 22-36.
- *Li, H., & Zhang, X. (2024). Recent Innovations in Urban Transportation Technology: A Comprehensive Survey. *Urban Transport Journal, 17(1), 22-39.*
- *Singh, R., & Patel, R. (2023). Comparative Analysis of Passenger Monitoring Systems in Public Transport. *Transport Reviews, 43(2), 250-265*
- *Davis, M., & Chen, L. (2023). Integrating RFID and IoT for Smart Transportation Systems. *Journal of Urban Technology, 30(4), 67-85.*

Appendices

Appendix 1. Project Budget

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE(UGX)	ACTUAL PRICE(UGX)
MICROCONTROLLER	ESP32	1	120,000	120,000
MICROCONTROLLER	ARDUINO	1	80,000	80,0000
RFID	TAG	1	15,000	15,000
RFID	READER	2	25,000	50,000
WEIGH SENSOR	50KG	5	25,000	125,000
BATTERY	12V dc	1	45,000	45,000
DC TO DC CONVERTER	12V dc	1	35,000	35,000
DISPLAY UNIT	5V (20*4)	1	40,000	40,000
4*4 KEYPAD	MATRIX KEYPAD	1	25,000	25,000
INDICATOR LED'S	3MM LED'S RGB	4	1,000	4,000
CABBLING	1MM/5 METERS	1	1,200	1,200
CAPACITORS	ELECTROLYTIC	2	4,000	8,000
VERO BOARD	7*8 CMM	2	6,500	13,000
SOLDERING IRON		1	18,000	18,000
SOLDER WIRE	1.2mm	1	5,000	5,000
PUSH BUTTONS	5mm	5	3,000	15,000
MALE HEADER PINS	40PIN	1	3,000	3,000
FEMALE HEADER PINS	40PIN	1	3,000	3,000
OTHERS			80,000	80,000
TRANSPORT			50,000	50,000
TOTAL COST				735,200

Table 2: Project budget

END