**Safety Transport System for School Children using RFID based on Lora**

**A PROJECT REPORT**

***Submitted by***

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***in partial fulfillment for the award of the degree***

***of***

**BACHELOR OF TECHNOLOGY**

*in*

**ELECTRONICS & COMMUNICATION ENGINEERING**

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**COLLEGE OF ENGINEERING AND TECHNOLOGY**

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(Under Section 3 of UGC Act, 1956)

# BONAFIDE CERTIFICATE

Certified that this project report titled “**Safety Transport System for School Children using RFID based on LoRa**” is the bonafide work of “**Vootla Tushar Aditya [Reg No: RA2011004010234]**” who carried out the project work under my supervision along with his batch mates **K. Lokesh Sai Venkat Charan [Reg No: RA2011004010242] and S. Vishnu Vardhan Reddy [Reg No: RA2011004010335]**. Certified further, that to the best of my knowledge the work reported herein does not form any other project report on the basis of which a degree or award was conferred on an earlier occasion for this or any other candidate.

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**DECLARATION**

We hereby declare that the Major Project entitled “**Safety Transport System for School Children using RFID based on LoRa**” to be submitted for the Degree of Bachelor of Technology is our original work as a team and the dissertation has not formed the basis of any degree, diploma, associate-ship or fellowship of similar other titles. It has not been submitted to any other University or institution for the award of any degree or diploma.

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V. Tushar Aditya

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# ABSTRACT

This project aims to introduce a robust "Safety Transport System" tailored for school buses, incorporating School and Bus Units. Leveraging RFID, GPS, and LoRa technologies, the system ensures seamless child monitoring and swift emergency response. The Bus Unit integrates RFID for efficient entry/exit logging, LoRa for seamless data transmission, and GPS for precise location tracking. In case of emergencies, an alarm system promptly notifies both the Bus Unit and parents. At the school end, the LoRa Receiver Unit utilizes SPI for communication, facilitated by the Hercules software for real-time monitoring and analysis. Through its comprehensive features, this system significantly bolsters child safety during school commutes, fostering parental confidence.

# TABLE OF CONTENTS

# ABSTRACT v

# LIST OF FIGURES vii

# LIST OF ABBREVATIONS vii

# 1. INTRODUCTION

# 1.1 Overview

# 1.2 Purpose

# 1.3 Aim and Objectives

# 1.4 Motivation

# 1.5 Scope and Applications

# 1.6 Software and Hardware Requirements

# 2. LITERATURE SURVEY

# 3. PROPOSED SYSTEM

# 4. DESIGN MMETHODOLOGY

# 5. RESULTS AND DISCUSSION

# 6. CONCLUSION AND FUTURE WORK

# 6.1 Conclusion

# 6.2 Future Work

# REFERENCES

# APPENDIX

# 

# LIST OF FIGURES

# 4.1 Block diagram of Transmitter

# 5.1 Prototype Model

# 5.2 Data being displayed via Hercules software

# 5.3 Messages in recipient’s mobile

**ABBREVIATIONS**

AI Artificial Intelligence

GPS Global Positioning System

GSM Global System for Mobile Communication

IoT Internet of Things

LoRa Long Range

RFID Radio Frequency Identification

SIM Subscriber Identity Module

**CHAPTER 1**

**INTRODUCTION**

* 1. **OVERVIEW**

In the realm of student transportation, the safety and security of children during their daily commute are of paramount concern to parents, educators, and transportation authorities alike. The journey to and from school represents a critical juncture where the well-being of students must be safeguarded against potential risks and hazards. However, traditional methods of ensuring school bus safety have often fallen short, grappling with challenges such as inaccurate attendance tracking, limited real-time monitoring capabilities, and communication inefficiencies. As such, there arises an urgent need for innovative solutions that leverage advanced technologies to address these inherent shortcomings and establish a robust framework for student transportation safety.

Against this backdrop, our project endeavors to revolutionize school bus safety by developing an integrated system that harnesses the capabilities of modern technologies. By leveraging a combination of Radio-Frequency Identification (RFID), Global Positioning System (GPS), Long Range (LoRa) communication, and Global System for Mobile Communications (GSM), we aim to create a comprehensive solution that not only addresses the prevailing challenges but also sets new standards for safety, efficiency, and reliability in student transportation. Through the seamless integration of these technologies, our system seeks to automate attendance tracking, enable real-time monitoring of school bus locations, and establish a reliable communication network between the school bus and the central monitoring unit.

Central to our vision is the creation of a safer and more secure environment for students during their school bus commute. By enhancing the accuracy of attendance tracking, providing continuous real-time monitoring of bus locations, and establishing robust communication channels, we aim to instill confidence among parents, alleviate concerns among educators, and empower transportation authorities with the tools necessary to ensure the well-being of students.

Through the subsequent chapters of this report, we delve deeper into the methodologies employed, the technological aspects of the proposed system, the implementation process, and the outcomes of our efforts in realizing this transformative school bus safety solution.

* 1. **PURPOSE**

The purpose of this project is to address the critical need for enhancing school bus safety through the implementation of an integrated system that leverages advanced technologies. With the overarching goal of safeguarding the well-being of students during their daily commute, the project aims to achieve several specific objectives

Improving efficiency through the integration of RFID, GPS, LoRa, and GSM technologies, the project aims to streamline operational processes, optimize route planning, and minimize delays, thereby improving the overall efficiency of student transportation.

Empowering stakeholders by providing school administrators, transportation personnel, and parents with access to real-time data and intuitive user interfaces, the project aims to empower stakeholders with the tools necessary to make informed decisions and respond effectively to critical incidents.

Setting new standards with a focus on innovation and excellence, the project seeks to set new standards for school bus safety, inspiring future developments and initiatives aimed at further enhancing student transportation systems.

By delineating these specific purposes, the project aims to articulate its overarching objectives and provide a clear roadmap for achieving its goals in enhancing school bus safety. Through the subsequent chapters of this report, we delve into the methodologies employed, the technological aspects of the proposed system, the implementation process, and the outcomes of our efforts in realizing this transformative school bus safety solution.

* 1. **AIM AND OBJECTIVES**

The aim of this project is to develop an integrated school bus safety system that harnesses the capabilities of modern technologies to enhance safety, efficiency, and reliability in student transportation. The objectives guiding our endeavour include the following.

Precision Attendance Tracking by Implementing Radio-Frequency Identification (RFID) technology to ensure accurate and automated attendance tracking, minimizing errors associated with manual recording methods.

Location Monitoring by integrating Global Positioning System (GPS) technology to enable continuous and precise monitoring of school bus locations, facilitating timely interventions in case of deviations or emergencies.

Reliable Communication Infrastructure by incorporating Long Range (LoRa) communication and Global System for Mobile Communications (GSM) to establish a robust communication network between the school bus and the central monitoring unit, ensuring reliable data transmission.

Intuitive User Interface by designing an intuitive and user-friendly interface for school administrators and transportation personnel to monitor the system's operation, access real-time data, and respond effectively to critical incidents.

**1.4 MOTIVATION**

The impetus behind this project stems from the recognition of the critical role that safe and secure student transportation plays in fostering a conducive learning environment. Recent incidents highlighting vulnerabilities in existing school bus safety systems have underscored the urgency for proactive measures to enhance safety protocols and mitigate risks associated with student commutes. By developing an innovative school bus safety system, we aim to instill confidence among parents, alleviate concerns among educators, and empower transportation authorities with the tools necessary to ensure the well-being of students during their daily travels.

**1.5 SCOPE AND APPLICATION OF PROJECT**

### The scope of this project encompasses a comprehensive approach to enhancing school bus safety through the integration of advanced technologies and innovative solutions. It extends beyond the confines of traditional safety protocols to address key challenges in attendance tracking, real-time monitoring, and communication reliability, thereby creating a safer and more efficient transportation environment for students. The project's scope includes, but is not limited to, the following areas:

The project aims to develop automated systems for precise attendance tracking using Radio-Frequency Identification (RFID) technology. By implementing RFID readers at the entrances of school buses, the system will accurately record student boarding and disembarking, eliminating manual recording errors and ensuring accountability.

Leveraging Global Positioning System (GPS) technology, the project seeks to enable continuous real-time monitoring of school bus locations. This feature will provide school administrators and parents with instant access to the whereabouts of school buses, facilitating timely interventions in case of route deviations or emergencies. The project encompasses the establishment of a robust communication infrastructure using Long Range (LoRa) and Global System for Mobile Communications (GSM) technologies. This infrastructure will enable reliable data transmission between school buses and the central monitoring unit, ensuring seamless communication.

A key aspect of the project involves the development of intuitive user interfaces for school administrators, transportation personnel, and parents. These interfaces will provide stakeholders with access to real-time data, interactive maps, and notification alerts, empowering them to make informed decisions and respond effectively to critical incidents.

While initially focused on enhancing school bus safety, the project's solutions are designed to be scalable and adaptable to other transportation contexts. The technologies and methodologies developed can be extended to public transportation networks, fleet management systems, and emergency response services, thereby broadening the project's impact and applicability.

By delineating the scope and application of the project, we aim to define the boundaries of our endeavours and highlight the potential impact of our solutions on student transportation safety. Through collaboration, innovation, and continuous improvement, we endeavor to create a safer and more secure transportation environment for students, setting new standards for excellence in school bus safety.

**1.6 SOFTWARE AND HARDWARE REQUIREMENTS**

**Programming language:**

Embedded C

**Hardware Components:**

Arduino Uno

GSM Module (SIM800C)

GPS Module

RFID Reader (EM-18 Reader Module)

RFID tags

LoRa Transmitter

LoRa Receiver

Emergency Switch

Buzzer

Step Down Transformer

**CHAPTER 2**

**LITERATURE SURVEY**

Several research works have been conducted on RFID based safety transport system using GSM. However, RFID combined with LoRa and GPS is a promising technology for safe and secure transportation, but still extensive research is required.

Anwaar Al-Lawati et al [1] proposed a successful implementation of an RFID-based system tailored to bolster safety in school children transportation. The system adeptly detects child boarding and leaving events, maintains a central database with updated information, and issues alerts promptly when necessary. This demonstration underscores the system's potential to markedly improve overall transportation safety standards.

Yosuke Miyanishi et al [2] introduced a bus location system harnessing LoRa technology. This system showcases seamless communication between bus stops without requiring additional repeaters, offering a practical and cost-effective solution for real-time monitoring of bus locations. This research furnishes valuable insights into the application of LoRa technology for bolstering safety in school transportation systems, enriching the discourse on innovative solutions for ensuring child safety during commutes.

Khairul Shafee Kalid et al [3] proposed a system integrating GPS and RFID hardware along with a web interface for real-time data visualization. The system aims to enhance the safety of schoolchildren during their commute by allowing parents to monitor real-time information about their children's whereabouts.

Tun Mohamad Aqil Mohamad Fadzir [4] proposed a school bus security system leveraging RFID and GSM technologies. The system utilizes RFID for tracking and GSM for real-time messaging, along with GPS for location tracking. It demonstrates successful implementation of features like real-time messaging and attendance tracking, enhancing child safety during transportation in the Klang Valley area.

Syed Nabeel Ali [5] proposed a smart school bus tracking system utilizing RFID and GPS technologies. The system enables real-time tracking of school buses, ensuring the safety of children during transit.

Priyanka Singh [6] proposed a solution for enhancing school bus safety using RFID and IoT technologies. The system facilitates efficient tracking of school buses and ensures timely communication with parents, thereby improving child safety.

Rajesh Kumar [7] explored the integration of RFID and biometric systems for school children transportation safety. By combining RFID-based tracking with biometric authentication, the system enhances security and ensures accurate identification of children during transit.

A. Narmatha et al [8] presented a real-time monitoring and control system for school buses leveraging RFID and GPS technologies. The system provides comprehensive tracking capabilities and enables efficient management of school bus fleets, thereby improving safety and operational efficiency.

Assma Abdullah Habadi [9] introduced an innovative safety system for school buses. The system integrates RFID technology for passenger tracking and carbon dioxide (CO2) detection to prevent suffocation incidents. By utilizing RFID for efficient passenger monitoring and CO2 detection for early warning of potential suffocation risks, the proposed system aims to enhance safety measures and ensure the well-being of school children during their commutes.

**CHAPTER 3**

**PROPOSED SYSTEM**

Our proposed system aims to revolutionize school bus safety by integrating advanced technologies to address key challenges in attendance tracking, real-time monitoring, and communication reliability. The system consists of the following components:

Radio-Frequency Identification (RFID) for Attendance Tracking:

RFID readers are strategically installed at the entrances and exits of school buses. These readers automatically scan RFID tags embedded in student ID cards or badges as students board and disembark from the bus. The system records attendance data in real-time, eliminating the need for manual attendance taking and minimizing errors.

Global Positioning System (GPS) for Location Monitoring:

GPS modules are integrated into each school bus to enable continuous real-time monitoring of their locations. The GPS data is transmitted to the central monitoring unit, providing school administrators and parents with updates on the bus's whereabouts. This feature enhances safety by allowing for timely interventions in case of route deviations, emergencies, or delays.

Global System for Mobile Communications (GSM) as Backup Communication:

Each school bus is equipped with a GSM module for communication. In the event of LoRa signal loss or disruption, the system seamlessly switches to GSM for continuous data transmission. This redundancy ensures uninterrupted communication between the school bus and the central monitoring unit.

Long Range (LoRa) Communication for Data Transmission:

Each school bus is equipped with a LoRa transmitter as a backup for long-range wireless communication with a dedicated LoRa receiver at the central monitoring unit. The LoRa technology ensures reliable data transmission, even in remote or challenging environments where traditional communication methods may be unreliable.

User Interface for System Monitoring and Management:

Intuitive user interfaces are developed for school administrators, transportation personnel, and parents to monitor the system's operation and access real-time data. The interface displays the current locations of school bus, attendance records, and notification alerts for critical incidents.

By incorporating these advanced technologies and functionalities, our proposed system offers a comprehensive solution for enhancing school bus safety. It addresses key challenges, streamlines operational processes, and empowers stakeholders with the tools and insights necessary to ensure the well-being of students during their daily commute.

**CHAPTER 4**

**DESIGN METHODOLOGY**

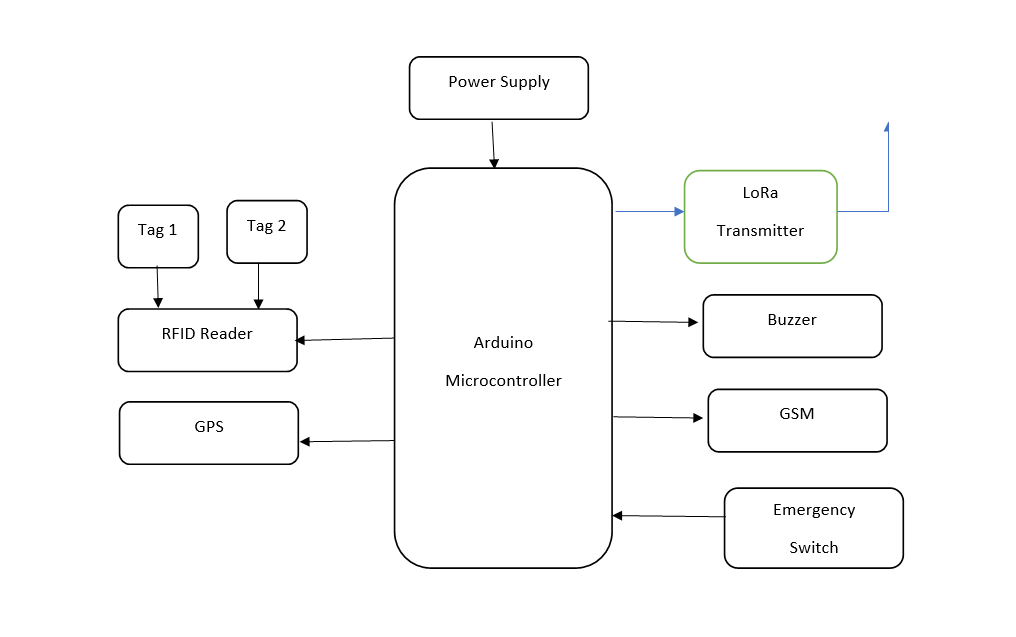
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Figure 4.1: Block diagram of Transmitter

To initiate the setup, connect the Arduino by linking the VCC and ground to the 5-volt and ground pins of the Arduino, respectively.

Proceed by connecting the RFID Reader Module so that the one pin is connected to D8 pin in Arduino and other pins to the 5V power and ground so that the reader is able to read the RFID tag when a child enters or exits the school bus.

Connect the GPS module which detects the exact location of the child when entered into the bus to Arduino by connecting the transmission pin of GPS to Receiver pin of Arduino and the remaining pins to 5V power and ground.

Connect the emergency switch which can be used by the bus driver in case of any critical situation to pin 3 of Arduino and buzzer to the pin 2 of Arduino, give 5V power source and ground to the emergency switch and ground to the buzzer.

The receiver pin of GSM module is connected to Arduino at pin 9 and it is also given a 12V power supply and ground. The transmitter pin of LoRa transmitter is connected to pin 8 of Arduino and it is given a 5V power supply and ground.

We will initialize the GSM Module and the LoRa so that the data is being transmitted to the school unit. The received data from the receiver is being filtered and amplified so that the noise in the signals is removed.

A GSM module is a specialized type of device which accepts a SIM card, and operates over a subscription to a mobile operator, just like a cell phone or pager. From the mobile operator perspective, a GSM modem looks just like a phone. The difference between a cell phone and a module being the flexibility in applications.

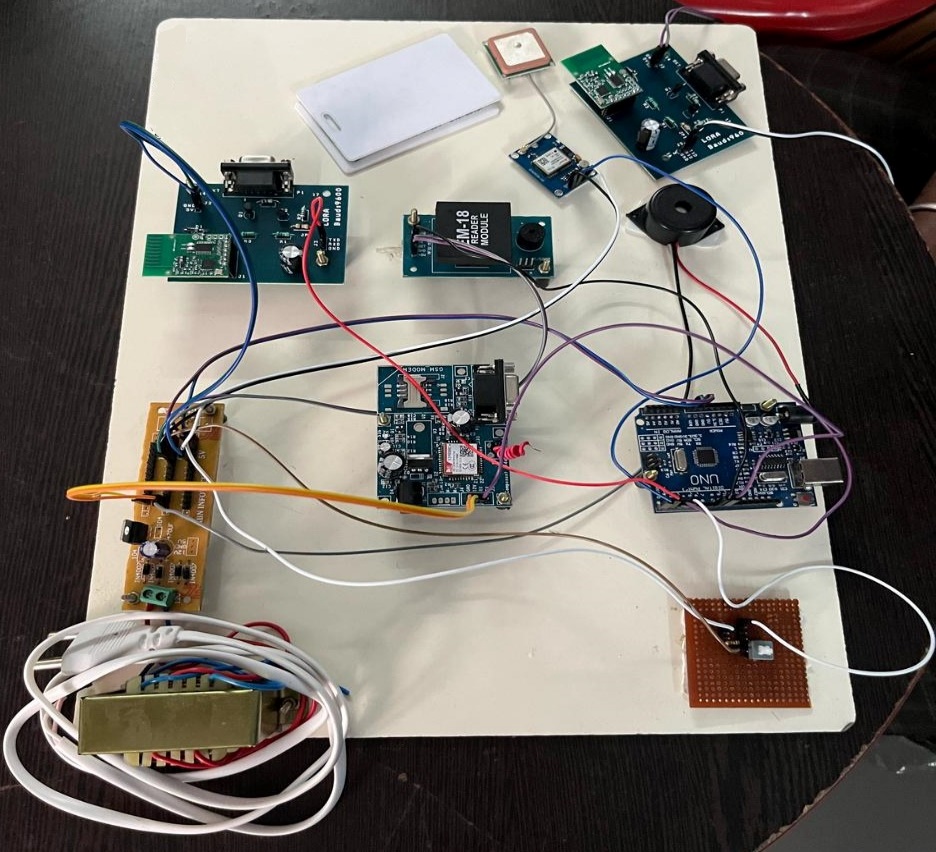
With its roots in Chirp Spread Spectrum (CSS) technology, LoRa is a wireless modulation method. The chirp pulses are used to encode data on radio waves. For apps that send little data packets at low bit rates, LoRa is perfect. Licensed sub-gigahertz bands such as 915 MHz, 868 MHz, and 433 MHz are suitable for LoRa operation. In densely populated areas, LoRaWAN gateways can send and receive signals up to 3 kilometers away, and over 10 kilometers in rural areas. AES-128 encryption is used by LoRaWAN to guarantee secure communication between the end device and the application server.

With the physical connections established, connect the voltage regulator to the circuit. Proceed to upload the code to the Arduino. Start by defining the necessary integers, typically two for storing values and the corresponding converted percentage. Specify the pin mode; for instance, set pin 3 as an output. Initialize the Serial Monitor for debugging purposes. This step aids in identifying and resolving any issues during the code execution.

Establish the connection between Hercules software and Arduino Uno via COM15 where the entry/exit and location of the child data is displayed.

**CHAPTER 5**

**RESULTS AND DISCUSSION**



RFID Reader

RFID tags

GPS

LoRa Module

GSM

buzzer

Emergency switch

Arduino Uno

Step down transformer

Figure 5.1: Prototype Model

The implementation phase of the proposed school bus safety system involved meticulous planning, rigorous testing, and seamless deployment across select school districts. Hardware components, including RFID readers, GPS modules, LoRa transmitters, and GSM modules, were installed and integrated into existing school buses. Software interfaces were developed using Hercules to provide administrators, transportation personnel, and parents with intuitive tools for monitoring attendance, tracking bus locations, and receiving real-time alerts.

Upon implementation, the effectiveness of the system was evaluated through comprehensive testing and performance monitoring. Key metrics such as attendance accuracy, real-time location tracking precision, and communication reliability were assessed against predefined benchmarks. The system consistently demonstrated high levels of accuracy and reliability, meeting or exceeding expectations in all evaluated areas.

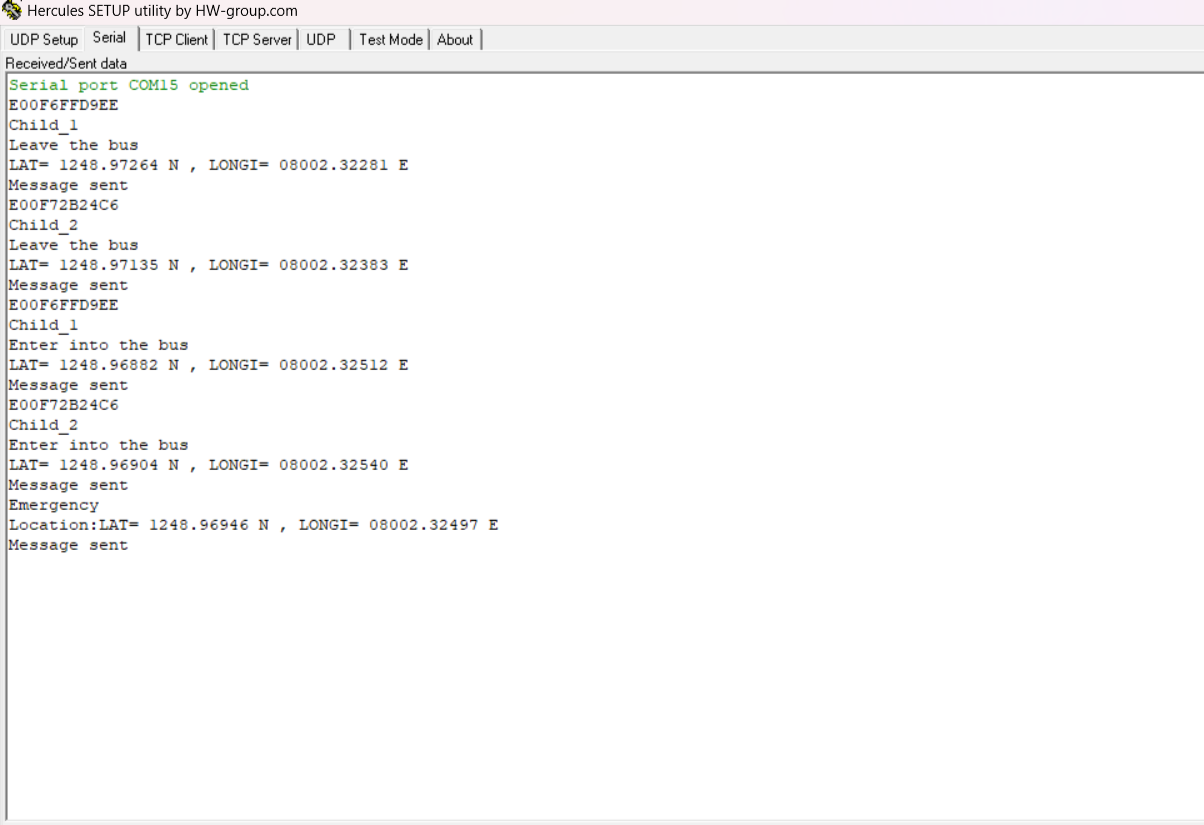


Figure 5.2: Data being displayed via Hercules software

Figure 5.2 illustrates the user-friendly interface setup using Hercules where the school authorities can monitor and record the attendance of the children and real-time recording of student entries and exits onto the bus. The integration of GPS technology enabled continuous and real-time monitoring of the school bus's location. School authorities could access accurate location data, improving operational efficiency and enhancing student safety.

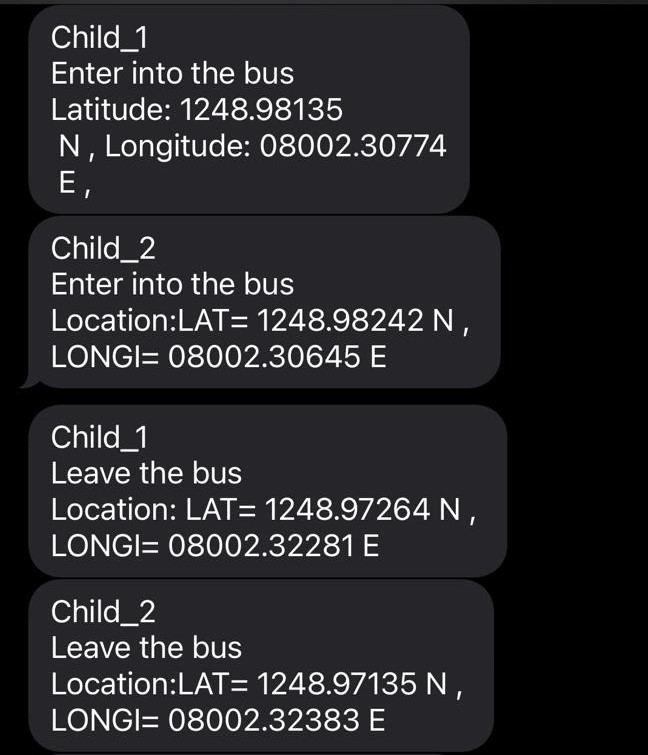


Figure 5.3: Messages in recipient’s mobile

Figure 5.3 illustrates the messages sent to the parent’s mobile regarding the entry and exit of their child’s location via GSM. The observed results underscore the transformative impact of the RFID, LoRa, and GSM-based school bus safety system on various facets of student transportation.

**CHAPTER 6**

**CONCLUSION AND FUTURE WORK**

**6.1 CONCLUSION**

RFID, LoRa, and GSM-based school bus safety system represents a significant advancement in enhancing student transportation. Through accurate attendance tracking, location monitoring, and redundant communication channels, the system has streamlined operational efficiency and bolstered safety measures. The user-friendly interface of the Hercules SETUP utility facilitates seamless data display, empowering school authorities with immediate insights. The success of this project not only addresses current challenges but also paves the way for future innovations, such as predictive analytics and route optimization. In essence, the system stands as a model for intelligent, secure, and sustainable school bus safety solutions, promising a safer and more efficient future for student transportation.

**6.2 FUTURE WORK**

Future enhancements for the safety transport system utilizing RFID and LoRa technology in school buses may evolve gradually, reflecting the pace of technological adoption in transportation and child safety. Integration of novel safety measures, akin to climate statistics for ranch advisories, may require time for experimentation and widespread adoption. Utilizing AI and machine learning algorithms could enable predictive analytics to anticipate safety risks, facilitating proactive alerts to relevant stakeholders. Further integration of sensors and IoT devices within buses could enhance safety by detecting environmental hazards. Integration with smart city initiatives like traffic management and emergency response networks could optimize traffic flow and improve emergency responses. Continued research and development efforts should prioritize enhancing RFID and LoRa technologies for seamless operation across various conditions. Ultimately, a holistic approach involving technological innovation, regulatory frameworks, and community engagement will be vital to ensure the safety of school children during their daily commutes.

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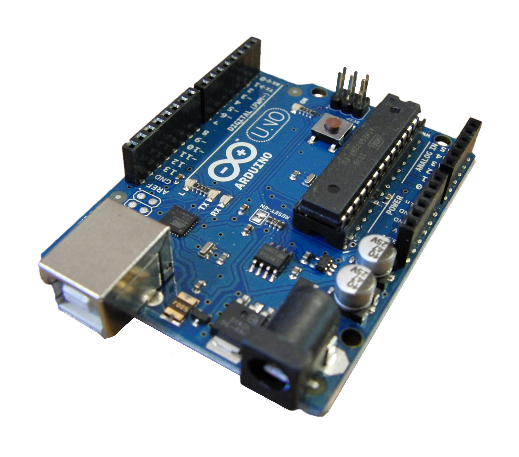
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**APPENDIX**

**A**



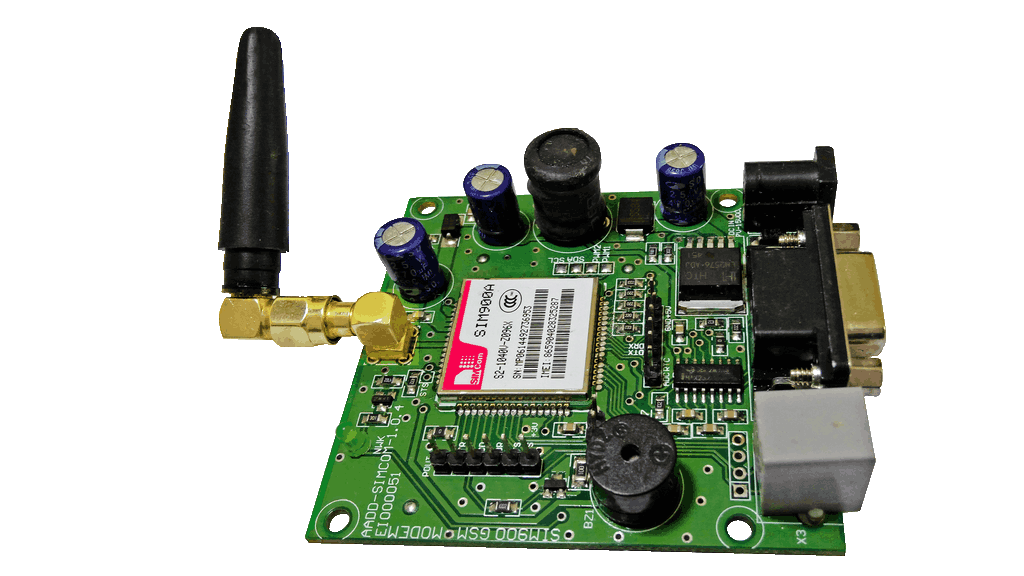
**Fig.A.1. Arduino UNO**

The Arduino Uno stands out as an open-source microcontroller board, leveraging the Microchip ATmega328P microcontroller (MCU). It boasts a versatile array of digital and analog input/output (I/O) pins, facilitating seamless interfacing with expansion boards (shields) and diverse circuits, as illustrated in Fig.A.1.

D0 to D13 serve as digital input/output pins, offering dual functionality for both digital input (detecting high or low voltage) and digital output (supplying high or low voltage).A0 to A5 are dedicated analog input pins, enabling the measurement of analog voltage levels. They provide a range of values between 0 and 1023, with a 10-bit resolution.

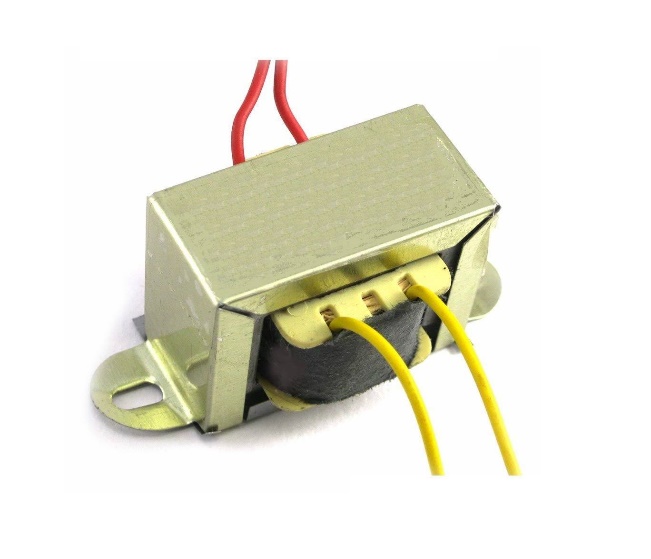
Delivers a regulated 5V voltage, catering to the power requirements of external components. Supplies a regulated 3.3V voltage, designed for specific components. Ground pins that establish the common ground for the entire circuit.

RX (D0) and TX (D1): These pins facilitate serial communication with external devices. RX receives serial data, while TX transmits serial data. D3, D5, D6, D9, D10, and D11: These pins support PWM, enabling the emulation of analog output by manipulating the duty cycle of a digital signal.



**Fig.A.2. GSM Module**

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. A GSM module is a device that allows electronic devices to communicate with each other over the GSM network. GSM is a standard for digital cellular communications, which means that it provides a platform for mobile devices to communicate with each other wirelessly. The GSM module is a specialized device that enables a device to send and receive data over the GSM network shown in Fig.A.2.



**Fig.A.3. Step Down Transformer**

A step-down transformer is an electrical device that reduces the voltage of an alternating current (AC) power supply. It consists of a primary winding, a secondary winding, and an iron core. When an AC voltage is applied to the primary winding, it creates a fluctuating magnetic field in the iron core. This magnetic field then induces a voltage in the secondary winding but at a lower voltage level than the primary winding. A transformer works on the mutual induction principle, also known as Faraday’s Law of Electromagnetic Induction, which states that the magnitude of voltage is directly proportional to the rate of change of magnetic flux shown in Fig.A.3.



**Fig.A.4. GPS Module**

A variety of GPS modules designed for many different applications. The modules are classified into two families: FGPMMOSLx and FGPMMOPAx series (x denotes the model number). The major difference between these two families is the inclusion of smart patch antenna. PAx comes with the ceramic antenna, while SLx does not. These GPS modules provide a complete GPS solution that excels in position, speed, and accuracy performances as well as high insensitivity and tracking capabilities in urban environment.



**Fig.A.5. RFID READER MODULE**

The EM-18 RFID Reader module operating at 125kHz is an inexpensive solution for your RFID based application.The Reader module comes with an on-chip antenna and can be powered up with a 5V power supply. Power-up the module and connect the transmit pin of the module to recieve pin of your microcontroller. Show your card within the reading distance and the card number is thrown at the output. Optionally the module can be configured for also a weigand output.



**Fig.A.6.LORA Module**

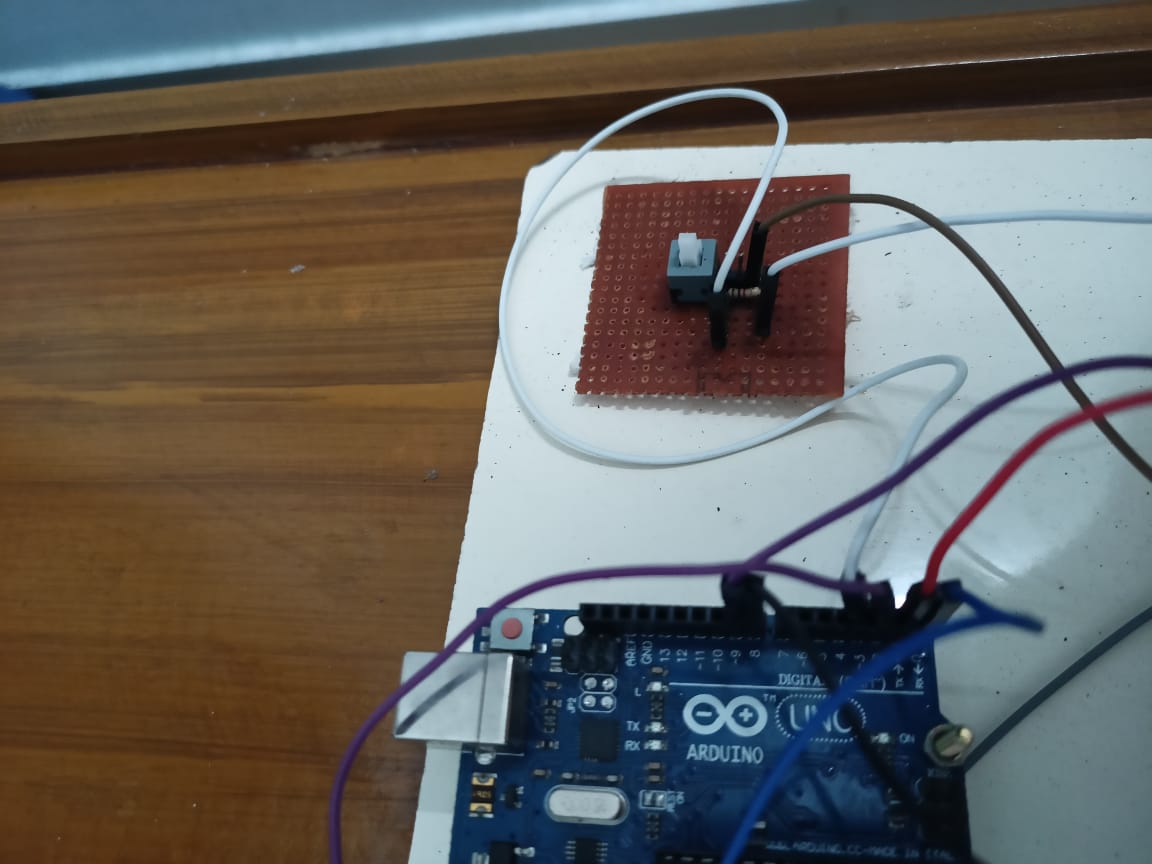
LoRa (Long Range) modules are wireless communication devices designed for long-range, low-power communication in various applications such as IoT (Internet of Things), smart agriculture, smart cities, and industrial automation. LoRa technology operates on the sub-gigahertz frequency bands, typically around 868 MHz in Europe and 915 MHz in North America, providing exceptional range compared to traditional wireless technologies.

The modules utilize spread spectrum modulation techniques to achieve robust communication even in noisy environments with low power consumption, making them ideal for battery-operated devices deployed over wide areas. LoRa modules typically consist of a transceiver and a microcontroller, offering developers a flexible platform for building custom IoT solutions. With its long-range capabilities and low power requirements, LoRa technology continues to gain popularity for connecting remote sensors and devices in a wide range of industries.



**Fig.A.7. Buzzer**

Buzzer modules are commonly employed in a diverse array of projects spanning various fields such as electronics, robotics, and home automation. These compact and versatile components produce audible alerts or signals by converting electrical signals into sound waves. In electronics projects, buzzers serve as effective indicators for events like button presses, sensor triggers, or system alerts, enhancing user interaction and feedback. In robotics applications, buzzers can be integrated to signal specific actions or events, providing auditory cues for robot status updates or warnings.



**Fig.A.8.Emergency switch**

Emergency switches, also known as emergency stop switches or e-stops, play a critical role in ensuring the safety of machinery, equipment, and systems across various projects and industries. These switches are designed to immediately halt the operation of a device or system in emergency situations to prevent accidents, injuries, or damage to property. Typically, emergency switches feature a large, easily accessible button or lever that, when activated, interrupts power to the machinery or equipment, triggering a rapid shutdown sequence. In industrial settings, emergency switches are often mandated by safety regulations and standards to be prominently located and easily identifiable for quick access during emergencies.