School-Child Pickup Assistance System

ELEG/CPEG 480- Capstone Design Project II

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The capstone project report is being submitted in partial fulfillment of the requirements for the degree of

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May, 20 ,2024

Declaration

We certify that this project work titled "***School-Child Pickup Assistance System***" is our own work. The work has not been presented elsewhere for assessment. The material that has been used from other sources has been properly acknowledged / referred.

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Abstract

These days, ensuring the safety and efficiency of school-child pickup procedures has become a paramount concern for both parents and educational institutions. To address this concern, we propose a cutting-edge School-Child Pickup Assistance System that leverages NFC (Near Field Communication) and Face Recognition technologies. This system was proposed to streamline the school-child pickup process, enhance security, and provide real-time information to parents and school staff. The parents will be provided with an NFC tag encoded with their children's identification (ID) information. At the school gate, parents will be requested to scan these tags using a dedicated device (inquiry station). This station was connected to a central server (PC) within the school premises via WiFi. This server serves as the central hub for data processing and communication. Upon scanning the NFC tag, the child's image and information will be displayed an LCD screen connected to the server. The system will employ Face Recognition technology to verify the requested child's identity through a camera that was connected to the PC. Once verified, the supervisor will let the child leave the school, ensuring that the correct child is being picked up. The combination of NFC and Face Recognition technologies would ensure that only authorized parents can pick up students, significantly reducing the risk of unauthorized access. The system would streamline the pickup process, reducing wait times and congestion at school exits.

Key Words: *NFC technology, face recognition, image processing, smart pickup system.*

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Chapter 1 : INTRODUCTION

1.1 Background

Parents place the highest priority on the protection of their children. Even with the greatest safety precautions, children may yet find themselves in a dangerous scenario because they lack the ability to protect themselves. Indeed, kidnapping is a grave and distressing crime with profound consequences, particularly when it involves children. This heinous act transcends boundaries, occurring in diverse settings such as public spaces, and private residences. The unsettling reality is that kidnapping can be perpetrated by individuals acting alone, as well as by organized groups, adding layers of complexity to this criminal phenomenon. Disturbingly, in some instances, the perpetrator may emerge from within the victim's close circle of acquaintances or even family members, betraying the very trust that should be foundational to a child's sense of security.

The pervasive nature of kidnapping underscores the importance of a comprehensive and vigilant approach to safeguarding individuals, especially children, from this threat. It requires not only a commitment to swift and effective response measures but also a proactive focus on prevention. Acknowledging the diverse contexts in which kidnappings can occur underscores the need for tailored strategies that address the unique challenges posed by each scenario. As society collectively grapples with this alarming issue, it becomes imperative to enhance awareness, strengthen security measures, and foster collaboration among communities, law enforcement agencies, and relevant institutions. By doing so, we can work towards creating an environment where the risk of kidnapping is minimized, and our children can grow and learn without the specter of this harrowing crime looming over their lives.

Schools have an obligation to protect students under their supervision. Taking into account how to guarantee that students arrive and depart the premises securely is a crucial component of this. As part of their broader safeguarding obligations, all schools should have clear rules and procedures regarding the dropping off and picking up of children at the school. The policies and processes must to take into account the age of the students as well as any special requirements they might have [1].

1.2 Problem Statement

Due to the high number of kids in schools nowadays, it might be challenging to maintain supervision and guarantee everyone's safety. Parents of students put a lot of pressure on school staff to make sure their children are safe. Without parental or guardian consent, schools shouldn't let kids leave with any unauthorized individuals. The parents and caregivers of the kid should provide their consent in advance if the child's picker intends to pick them up from school. It is the school's responsibility to notify the child's legal guardian if an unauthorized individual shows up to pick them up. The school should inform parents that they are unable to transfer their kid to another person without the legal guardian's consent if they are unable to get in touch with them or if the legal guardian refuses to provide permission. Making certain the school is aware of who is in charge of dropping off and taking a kid is essential to keeping them secure.

Unauthorized pickups raise immediate safety concerns for the students involved. The individuals picking up the students may not have been properly vetted by the school, and their intentions may be unknown. This creates a potential risk of harm, abduction, or other unsafe situations for the students. Schools often have procedures in place to verify the identity of individuals picking up students. However, unauthorized individuals may attempt to circumvent these procedures, making it challenging for school staff to accurately identify who has permission to take a student from the school premises. To address this issue effectively, it is crucial for schools to implement and reinforce stringent security protocols. These measures may include improved identification procedures, enhanced communication channels with parents and guardians, and the use of technology such as electronic sign-out systems.

1.3 Aims and Objectives of the Project

Schools can leverage technology to enhance security measures, such as implementing electronic sign-out systems, requiring identification checks, and using surveillance cameras. These measures can act as deterrents and help identify unauthorized individuals attempting to pick up students. In order to improve children's safety while they are being transported to school each day, this project presents a way to monitor schoolchildren being picked up. The designed project School-Child Pickup Assistance System leverages NFC (Near Field Communication) and Face Recognition technologies to ensure the individual’s identity who wants to pick up the child from school.

So, the objectives of this system are:

1. Using NFC tags to verify the identity of individuals picking up students at a station at the school gate without the need to enter the school.
2. To give parents a confirmation of receiving their requests.
3. To connect the station to the school central server (PC) wirelessly to send the picking up request to the supervisor presented with the student's image and name.
4. To employ Face Recognition technology to verify the requested child's identity to ensure that the correct child is being picked up.

1.4 Significance, Scope and Definitions

Most of the projects are proposing systems that can help in monitoring pickup of school children using transportation (school buses). While none of them proposed a solution for picking up students by their parents. Our system was designed to streamline the school-child pickup process, enhance security, and provide real-time information to parents and school staff. The combination of NFC and Face Recognition technologies would ensure that only authorized parents can pick up students, significantly reducing the risk of unauthorized access. The system will streamline the pickup process, reducing wait times and congestion at school exits.

1.5 SWOT Analysis

- Strengths:
  1. The utilization of NFC technology and face recognition provides an efficient, secure, and accurate way to identify children and confirm their pickup.
  2. Face recognition systems can operate in real-time, providing quick and efficient identification.
  3. NFC tags are low weight and small devices that don't need powering or charging. Additionally, NFC tags are not affected by different environmental conditions.
  4. Ensuring that the correct students is being picked up.
  5. Low cost system.
  6. Wide range of data transmission using WiFi technology.
  7. Solve the problems of long waiting times and congestion at school exits.

- Weakness:
  1. The NFC tags can transfer data in short range; within 4 cm only.
  2. Interruptions in WiFi connectivity can lead to a temporary loss of services.
- Opportunities:
  1. Face recognition technology can be integrated with existing school management systems, making it easier to manage student information and ensure accurate identification.
  2. System flexibility; multi stations can be integrated in the system.
  3. Reports can be generated for providing a record of who picked up each student and when, which can be valuable for administrative purposes and investigations if needed.
- Threats:
  1. The system may not be able to accurately identify children in certain scenarios, such as when a child's face pose has changed.

1.6 Report Outline

1.6.1 Chapter One

It clearly defines the problem or need that led to the consideration of proposing the School-Child Pickup Assistance System. It states the system aims to achieve and objectives. It also defines the SWOT analysis of the proposed system.

1.6.2 Chapter Two

It introduces existing literature, research, and products related to monitoring pickup of school children and identify gaps where our proposed solution can contribute.

1.6.3 Chapter Three

It defines the approach details and methodology that will be followed in implementing the proposed system. It also describes the specific components, devices, and software that will be used in the implementation.

1.6.4 Chapter Four

It defines the system implementation of both sides of the project which are the hardware and software. It introduces the schematic circuits of the hardware part, and the flowchart that describes the system working.

1.6.5 Chapter Five

It defines the approach evaluation by introducing the system technical assessment, project impacts and the major calculation.

1.6.6 Chapter Six

It introduces the conclusions and the future works that can be done to improve the system.

Chapter 2 : LITERATURE REVIEW

2.1 Theoretical Background

Face recognition technology has become increasingly popular in recent years for its ability to accurately and quickly identify individuals. It has been used in a variety of applications such as security, surveillance, and marketing. The technology is based on the idea that each person has a unique facial structure that can be used to identify them. To achieve this, face recognition technology utilizes a range of computer vision techniques and algorithms to process images of faces to extract and analyze facial features [2].

The first step in face recognition is to capture an image of the face. This can be done either by taking a photograph or using a video camera. Once the image has been taken, the face recognition algorithms can begin to extract the facial features. This process involves analyzing the image to identify the various facial features, such as the eyes, nose, mouth, and chin. The algorithms will then compare the extracted features against a database of known faces to look for matches. Once a match is found, a unique identification number is assigned to the face in the image. This number is then used to verify the identity of the person in the image against a database of known identities. This process is known as “verification.” If the person’s identity is confirmed, a “recognition” process is then initiated to determine the identity of the person in the image [3].

Face recognition technologies have been used in a number of different fields, from security to marketing. The technology has been used in biometric identification systems, such as those used in airports and government buildings, to identify individuals. It has also been used in commercial applications, such as social media identification, to identify users and verify their identity. In addition, face recognition technology has been used in marketing campaigns to identify customer demographics and target them with advertisements. The development of face recognition technology has been driven by advancements in computer vision algorithms and computing power. This technology is continuing to be improved upon, and its applications are becoming more widespread. The future of face recognition technology looks bright, as it is expected to become even more accurate and efficient in the coming years [4].

2.2 Related Works

2.2.1 Face Detection and Recognition Student Attendance System

The primary focus of the project was the utilization of LabVIEW due to its efficacy in facial recognition and other applications. The main program in LabVIEW was designed to detect and recognize faces, assigning scores and parameters. Additionally, subsystems included an integrated Excel sheet for student data and a messaging device for communication with absent students or their parents. The components of the project comprised the LabVIEW program as the central system, supplemented by the Office Excel sheet for student records, and a computer or laptop for program integration [5].

2.2.2 Smart Intelligent Tracking System for School Students Using GSM and GPS

The project aimed to illustrate the advantages of tracking systems and develop the design of tracking devices for children. The new method helped in tracking kidnapped children for longer periods by connecting the system with parents' mobile phones, sending messages when the child changed location with greater accuracy. Implementing the School Children Monitoring System via RF transmitter & receiver aimed to alleviate parental concerns. This project combined the latest technology using ZIGBEE transmitter & receiver, and an SMS system. When students entered the school bus, they passed a tag to the ZIGBEE receiver antenna, which read their student ID. Information such as entry and exit times from school was recorded, and the SMS system automatically notified parents that their children had arrived safely [6].

2.2.3 RFID-Based System for School Children Transportation Safety Enhancement

The paper presented a system designed to monitor the pick-up and drop-off of school children, aimed at enhancing their safety during daily transportation to and from school. The system comprised two main units: a bus unit and a school unit. The bus unit was responsible for detecting when a child boarded or left the bus using RFID technology. This information was then communicated to the school unit, which identified any missing children and issued alert messages accordingly to their parents. The bus unit utilized RFID readers positioned inside the school bus by the entrance, detecting children only when they were inside the bus. Each child wore a card with an RFID tag, which sent relevant information to the school unit for storage and processing. The school unit, consisting of a server interfaced with a GSM modem, received data from the bus and acted as both a database server and web server. It hosted a web-based application for system management and provided useful information about the children to authorized personnel. Additionally, the school unit communicated with an SMS gateway to send notifications in case a child was detected missing. Overall, the system aimed to improve the safety and security of school children during their transportation to and from school [7].

2.2.4 Android Application to Verify Child Pick Up in School to Prevent Kidnapping

The paper described an Android application developed for the writer's thesis using Android Studio. The application's primary purpose was to verify children's pickup persons, ensuring they were either the child's parents or authorized guardians, rather than potential kidnappers. This was achieved through a QR code displayed on the pickup person's device containing the child's ID, which teachers could scan. If the QR code was valid, the child could be released from school, thus preventing them from falling into the wrong hands [8].

2.2.5 Prevention System for Child Abduction by Using Image Processing Algorithm on Intel Galileo Board

In this system, Intel Galileo boards compared the visitor's face with the data in the system and then unlocked the gate if the face was recognized in real-time. The database stored image data and compared it with images of people captured by the camera. Initially, the database had to be trained by face recognition to detect faces. The original image of the visitor matched the face in the database, which contained several guardian images in different poses. Face recognition had no effect if the face was not similar to the data in the database. If the visitor's face matched the image in the database, their name appeared on the screen, and the smartphone then functioned as a key to unlock the gate. This system automatically controlled the main entrance by only allowing the original guardian to enter the school, thereby avoiding kidnappers from entering the school area and reducing the number of cases where children were abducted [9].

2.2.6 GSM Child Tracker Applications Using Assisted Global Positioning System Technology

Introduced in [10], the Child Tracker application on an Android smartphone was utilized to determine the whereabouts of a child. It could locate children during travel using an Android smartphone, enabling them to quickly provide their location and contact parents in emergencies. The application relied on A-GPS technology to ensure precise and accurate positioning of children, leveraging internet connectivity for real-time tracking from anywhere [10].

2.2.7 IoT Based Children Monitoring System in School

The author introduced in [11] a development in IoT for monitoring children in school, aimed at easing parents' worries. For implementing such a system, a GPS with high accuracy was deemed necessary. If a low accuracy GPS was used, the system might provide erroneous child location data. In this system, a message with the keyword "TRACK" was sent to the child's device, triggering the GPS to send longitude and latitude data to the GSM module. The GSM module received this information and forwarded it to the user for tracking the lost child's location. Arduino, a small microcontroller, was utilized to control the entire process in this system. The paper proposed the concept of developing a low-cost, high-accuracy, and user-friendly system by integrating Google Maps, which could enhance the GPS accuracy.

2.2.8 Enhance Safety Security and Tracking System for School Bus and Children

Asundkar's (2016) [12] project outlined a design aimed at enhancing the safety and security of school buses. The project was structured into three main units. The first unit focused on hardware components installed within the bus, including RFID tags and reader, GPS module, GSM modem, switch, and microcontroller (Arduino Mega 328). Passive RFID tags, embedded in student ID cards, were used along with a reader positioned at the bus entry door. The GSM modem facilitated communication, while the GPS module tracked the bus's location and notified authorities via SMS if the driver exceeded speed limits. Another unit was provided to parents, offering an Android application for accessing essential information about their child's bus journey. The third unit, situated at the school, served as a control center, allowing administrators to manage information and maintain records of student movements.

2.2.9 Biometric Based Students' Bus Management System

The paper [13] aimed at designing a student monitoring system to manage the presence of students on school buses. Student presence was recorded using fingerprint identification. A framework was developed to manage attendance based on fingerprint recognition. Fingerprint readers were installed on school buses, requiring students to use their biometrics upon boarding to mark their arrival and departure. Attendance was electronically recorded and sent to the school database, which then generated text messages sent to parents, informing them of their children's safer departure and arrival times.

2.2.10 School Pickup and Drop Off

The "School Pickup and Drop off App" [14] was designed to alleviate the long waiting times parents experienced when picking up their children from school during peak hours. Traffic congestion around schools during pick-up times often posed safety risks to students, parents, and school staff. The app tracked parents' locations and notified teachers and staff when they were near the school pickup spots, allowing for timely dismissal of students.

2.2.11 Design and Implementation of a Smart Kids Transportation System

The objective of the project introduced in [15] was to design and implement a "Smart Kids' Transportation Logistics System Using Smart Cards" to keep parents informed about their children's boarding and alighting times from school buses and aid schools in managing their transportation systems. The project comprised a wireless card reader serving as a central system for contactless customization and encryption of smart cards, storing pertinent data about subscribed children. Smart card readers were installed in each vehicle, where children were required to present their cards for RFID scanning upon boarding and alighting, triggering alerts to their parents. These smart card readers interfaced with a socket server and database, feeding children's activity data to a web application. The project utilized the Angular framework for the web application, JavaScript for the socket server, electronics expertise for the hardware, and a printer for smart card customization. When the children were about to board or alight a bus, they were required to scan their RFID cards using the smart card reader stationed at the bus's entrance. The smart card reader used the unique security keys associated with the cards to read the unique IDs of the cards. The reader then queried the instantaneous location of the bus and the time at which the authentication occurred, and then sent an SMS alert to the parents of the child to indicate the event which occurred and incorporated a link to the location of the child on Google Maps. In addition, the smart card readers transmitted a data payload with the location of the child, the type of event which occurred, the time, and the unique ID of the child to a socket server. The socket server then stored all this data in a Firebase Real-time database. The data packets from the socket server were arranged in the database according to upload time. For monitoring, a web application pulled data from the database and displayed the data on a UI. The smart card readers also supported an SMS command to allow parents to query the last known location of their children.

2.5 Summary and Implications

Table 2.1 shows the summary of all the reviewed projects from different papers.

Table 2.1: Literature review summary.

Project	Arduino controller	NFC technology	LCD	Face recognition	WiFi connection	Server	Mobile app/web app
Face Detection and Recognition Student Attendance System				√	√	√	
Smart Intelligent Tracking System for School Students Using GSM and GPS		RFID	√				
RFID-Based System for School Children Transportation Safety Enhancement						√	
Android Application to Verify Child Pick Up in School to Prevent Kidnapping							√
Prevention System for Child Abduction by Using Image Processing Algorithm on Intel Galileo Board				√	√		√
GSM Child Tracker Applications Using Assisted Global Positioning System Technology					√		√
IoT Based Children Monitoring System in School	√						
Enhance Safety Security and Tracking System for School Bus and Children	√	RFID				√	√
Biometric Based Students' Bus Management System							√
School Pickup and Drop Off						√	√
Design and Implementation of a Smart Kids Transportation System	√	RFID				√	√
Proposed "School-Child Pickup Assistance System"	√	√	√	√	√	√	

Chapter 3 : METHODOLOGY, DESIGN AND ANALYSIS

3.1 Methodology

In this project, Agile methodology (see Figure 3.1) was used which include the following 5 phases:

1. Initiation: This phase involves defining the project scope, objectives, and stakeholders' requirements. The team establishes a clear understanding of the problem they aim to solve or the product they intend to develop. Key activities in this phase include identifying project goals, forming the project team, and conducting initial planning sessions to outline the project roadmap and timeline. Additionally, the team establishes communication channels and sets up project management tools to facilitate collaboration and tracking progress.
2. Planning: In this phase, the team further refines the project plan and defines the specific tasks, deliverables, and timelines for each iteration or sprint. They break down the project scope into manageable units of work and prioritize them based on stakeholder feedback and project goals. Planning sessions involve estimating effort, allocating resources, and identifying potential risks or dependencies that may impact project execution. The team also establishes criteria for measuring success and defines the acceptance criteria for each deliverable.
3. Execution: The execution phase is where the actual development work takes place. The team follows an iterative approach, working in short cycles or sprints to deliver incremental updates to the project. Hardware and software development activities proceed concurrently, with regular integration and testing to ensure compatibility and functionality. Daily stand-up meetings keep the team synchronized, allowing members to discuss progress, identify obstacles, and adjust plans as needed. Continuous communication and collaboration among team members are essential to maintaining momentum and addressing any challenges that arise during development.
4. Monitoring and Control: Throughout the project, the team monitors progress, quality, and adherence to the project plan. Regular reviews and retrospectives provide opportunities for reflection and adjustment, enabling the team to adapt to changing requirements or unforeseen obstacles. Additionally, the team actively manages risks and addresses issues proactively to minimize disruptions to the project timeline.

5. Closure: The closure phase marks the completion of the project and involves finalizing deliverables, documenting lessons learned, and transitioning the project outputs to stakeholders. The team conducts a final review to ensure that all requirements have been met and that the project objectives have been achieved. Any outstanding tasks or unresolved issues are addressed, and a formal project closure report may be prepared to summarize the project's outcomes and recommendations for future work. Celebrating achievements and recognizing team contributions are also important aspects of closing out the project on a positive note.

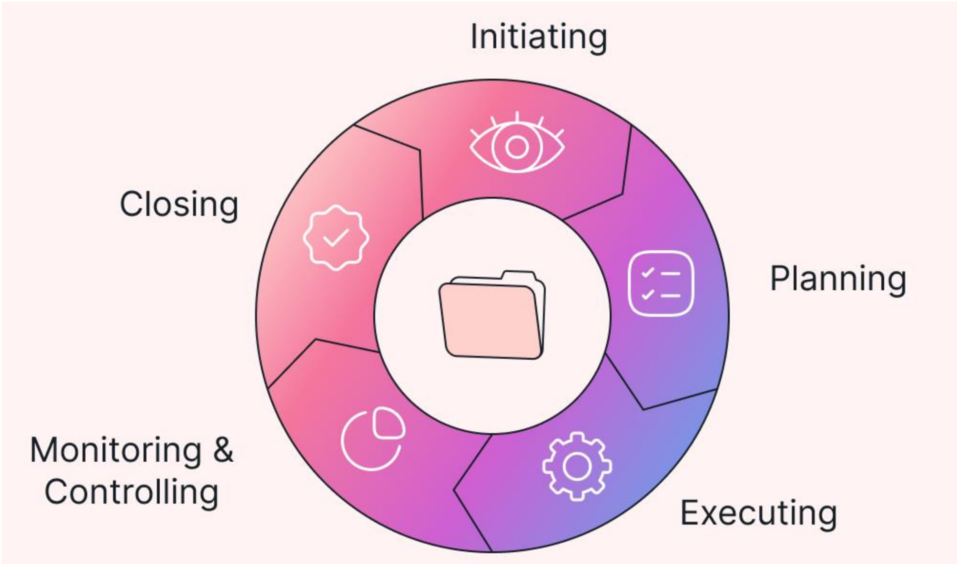

Figure 3.1: Agile methodology phases.

3.2 Research Design

The general block diagram is shown in Figure 3.2. The parents will be provided with an NFC tag encoded with their children's identification (ID) information. At the school gate, parents will be required to scan these tags using an external unit (inquiry station). This unit is connected to the central server (PC or computer) within the school premises via WiFi. To provide WiFi connectivity, an Access point was used. The server will serve as the central hub for data processing and communication. Upon scanning the NFC tag, the child's image and information will be displayed on the PC or the screen that can be connected to the PC using HDMI. The system will employ Face Recognition technology to verify the requested child's identity through a camera that is connected to the PC. Once verified, the supervisor will let the child leave the school, ensuring that the correct child is being picked up. Otherwise, the system outputs displays a messages on the screen and a voice message as alarm that the child is not allowed to leave.

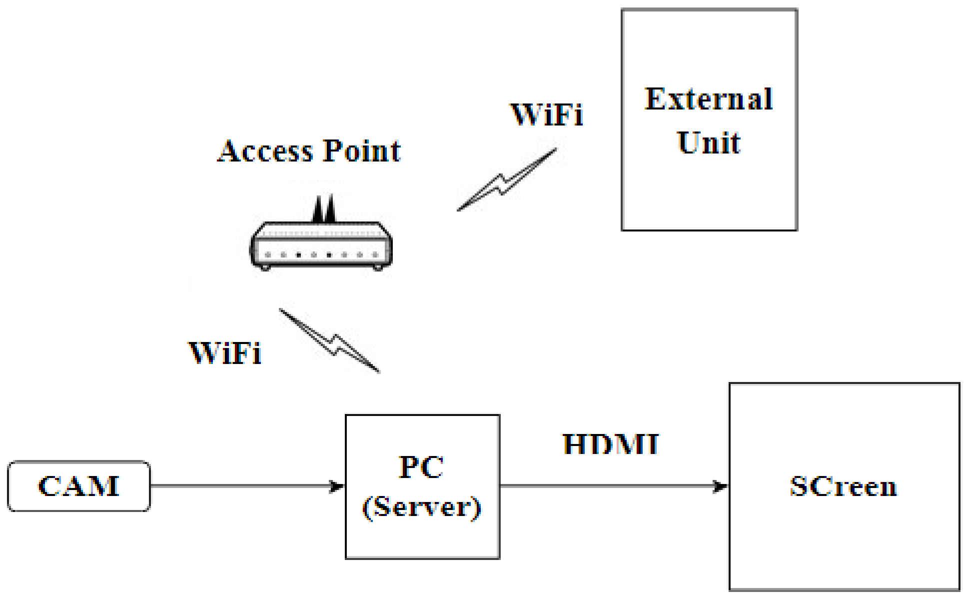

Figure 3.2: General block diagram.

The external unit block diagram is shown in Figure 3.3. The unit's controller is the Arduino Uno which is responsible to read inputs from some components and output commands to other components to work based on its inputs. The NFC reader was used to read the NFC tags data which represents the child number and name. The LCD was used to show the parents a confirmation message with the requested child number. The parent can cancel the request through pressing the cancel button. After that, the Arduino sends the student data to the server using the WiFi module. Which in turns displays the child's image, number, and name on the PC/screen. The unit is powered using rechargeable lithium batteries where a charging module is connected with the batteries to protect it from damage, and a boost converter is used to step up the batteries voltage to 5 volt to suite the components operation voltage.

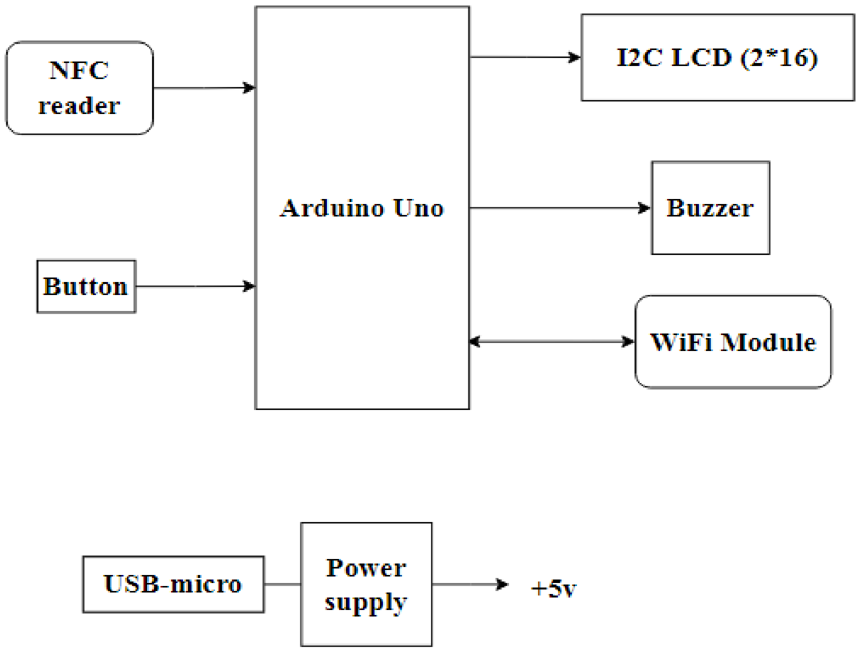

Figure 3.3: External unit block diagram.

3.2.1 Design Alternative 1

Image processing involves manipulating or analyzing digital images to extract information, enhance visual quality, or make automated decisions based on the image content. It can include tasks like filtering, object recognition, image enhancement, and more. Image processing can be done using either a computer or Raspberry Pi. Then, by making a comparison between both of them [16] as introduced in Table 3.1.

Computers have more computational power, faster processors, and larger memory, making them suitable for complex and resource-intensive image processing tasks. Computers provide higher performance and are suitable for applications demanding real-time image processing. Additionally, a wide range of image processing software and libraries, such as OpenCV, is available for computers, making development more accessible. On the other hand, the computational capabilities of a Raspberry Pi are more limited compared to a standard computer, which may impact the speed and complexity of image processing tasks it can handle. Due to the application of the project that needs real-time image processing, a computer was chosen for image processing due to its faster processors, larger memory, and higher performance.

Table 3.1: Comparison between computer and Raspberry Pi

Device	Pros	Cons
Computer	- High performance - more computational power - faster processors - larger memory - Upgradeability	- Expensive - Consume more power - Computers are usually larger and less portable compared to Raspberry Pi
Raspberry pi	- Affordability - Consumes very little power compared to computers - Small size - Ability to interface with external hardware and sensors.	- The computational capabilities are more limited - less processing power - Limited upgradeability - Uses microSD cards for storage which may have limited capacity and slower read/write speeds.

3.2.2 Design Alternative 2

The wireless connection can be established using various technologies, such as Wi-Fi, Bluetooth, or other wireless communication protocols. A comparison between WiFi and Bluetooth as wireless connection [17] is shown in Table 3.2. Then, WiFi connectivity is more reliable to be used for in the system.

Table 3.2: Comparison between WiFi and Bluetooth

Wireless technology	Pros	Cons
WiFi	- High data transfer rates - Multiple device connectivity - Higher Security	- Power consumption - Complex setup - WiFi signals can be susceptible to interference - More costly
Bluetooth	- Low Power Consumption - Simple Pairing - Low Interference from other devices - Cost-Effective	- Lower data transfer rates - Shorter range - Limited device connectivity - Bluetooth connections may be susceptible to security vulnerabilities

3.3 Software and Hardware

3.3.1 Arduino Uno

The Arduino Uno is a popular microcontroller board in the Arduino family, widely recognized for its versatility and ease of use in electronics projects. Featuring an ATmega328P microcontroller, it provides a robust platform for beginners and advanced users alike to explore the world of embedded systems and programming. One of the key features of the Arduino Uno is its simplicity in design, making it accessible to hobbyists, students, and professionals alike. It offers a wide range of digital and analog input/output pins, which can be easily interfaced with various sensors, actuators, and other electronic components. This flexibility enables users to create a diverse array of projects, from simple LED blinking exercises to complex robotics and automation systems.

The board is equipped with 14 digital input/output pins, of which 6 can be used as PWM (Pulse Width Modulation) outputs, allowing for precise control of analog devices such as motors and LEDs. Additionally, there are 6 analog input pins, providing the capability to read analog sensors and signals. The Uno also includes a USB interface for programming and power, simplifying the process of uploading code and powering the board from a computer or USB power adapter. In terms of specifications, the Arduino Uno operates at a clock speed of 16MHz and has 32KB of flash memory, 2KB of SRAM, and 1KB of EEPROM. These resources provide ample storage for program code and data, allowing users to implement a wide range of functionalities in their projects. Furthermore, the Uno supports a variety of programming languages, including C and C++, making it compatible with a vast ecosystem of libraries and resources for embedded development [18].

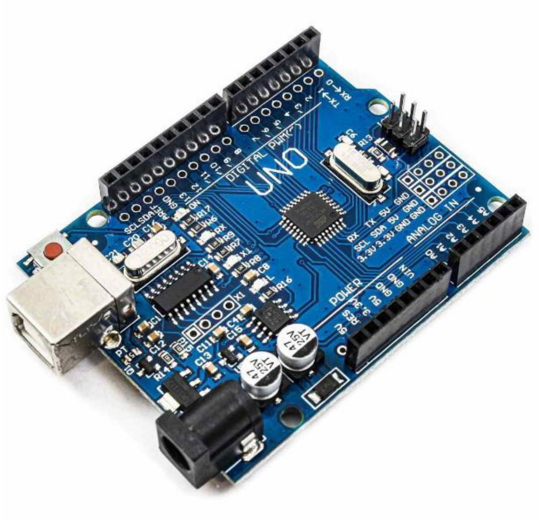

Figure 3.4: Arduino Uno board.

3.3.2 NFC Reader

NFC, or Near Field Communication, is a wireless technology utilized for data transfer between nearby devices. It's commonly employed for various applications such as mobile payments, replacing QR codes due to its speed and security. The process involves reading data from NFC tags via electronic reader devices. These tags are highly adaptable, particularly useful for instant transmission of small data amounts. The PN532 NFC reader, based on the 80C51 microcontroller, operates at 13.56 MHz, enabling contactless communication. It boasts a data transmission rate of up to 424 kbit/s bidirectionally. Compatibility with Arduino is a significant advantage, with the PN532 supporting various communication protocols like UART, I2C, and SPI. Acting as a reader and writer, the PN532 can extract data such as credit from NFC tags and update information, like writing a new balance value to the tag. Indeed, the PN532 NFC module offers versatility in communication with Arduino through various protocols, including UART, I2C, and SPI. Each protocol utilizes specific pins and corresponding libraries of the microcontroller to facilitate seamless interaction between the PN532 module and the Arduino board. This flexibility allows users to choose the most suitable communication method based on their project requirements and preferences. Whether it's the simplicity of UART, the multi-device capability of I2C, or the high-speed data transfer of SPI, the PN532 module accommodates different needs, enhancing its usability across a wide range of applications in the realm of NFC technology [19].

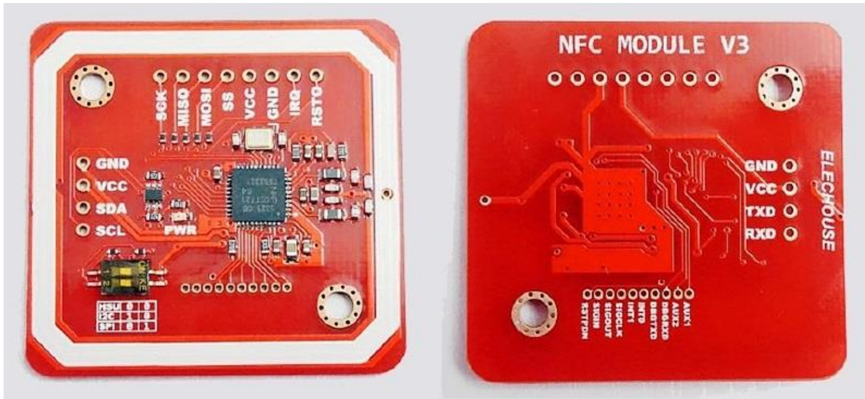

Figure 3.5: PN532 NFC module.

3.3.3 I2C (2*16) LCD

The I2C interface 16x2 LCD display module is a high-quality LCD module featuring two lines and sixteen characters per line. It comes equipped with on-board contrast control adjustment, backlight, and an I2C communication interface. This module offers significant advantages, particularly for Arduino beginners, as it eliminates the need for complex LCD driver circuit connections. One of the key benefits of this I2C Serial LCD module is its ability to simplify circuit connections, thereby saving valuable I/O pins on the Arduino board. This streamlines the overall hardware setup and reduces complexity, making it easier for beginners to get started with their projects. Additionally, the module facilitates simplified firmware development, thanks to the availability of widely-used Arduino libraries. By leveraging these libraries, users can quickly and efficiently interface with the LCD module, without the need for extensive low-level programming [20].

Figure 3.6: 2*16 LCD and I2C Adapter.

3.3.4 WiFi Module (ESP8266)

The ESP8266 WiFi Module is a versatile and cost-effective system-on-a-chip (SOC) that provides microcontrollers with WiFi connectivity. It has an integrated TCP/IP protocol stack and can function independently or complement other application processors. Pre-programmed with an AT command set firmware, it can be easily integrated with Arduino devices to provide WiFi capabilities similar to a WiFi Shield. With robust processing and storage capabilities, it can interface with sensors and other devices through its GPIOs, requiring minimal upfront development and runtime loading. Its high level of integration reduces the need for external circuitry, making it space-efficient on PCBs. The ESP8266 supports features like APSD for VoIP applications and interfaces with Bluetooth co-existence, while its self-calibrated RF functionality eliminates the need for external RF components. Additionally, it benefits from a large and active community for support and further development [21].

Figure 3.7: ESP8266 module.

3.3.5 Camera

The 1080p Full HD webcam is designed for professional-quality video calling, recording, conferencing, and gaming purposes. Equipped with a full HD glass lens, it delivers crisp images and crystal-clear video at a smooth 30 frames per second. Featuring automatic light correction and HDR technology, this webcam adjusts color and brightness for natural lighting, ensuring you look your best even in dim or poorly-lit environments. Setting up the webcam is easy, with a plug-and-play setup requiring no additional drivers. It comes with a tripod-ready adjustable universal clip and a 1.8m (6 feet) USB power cable, making it compatible with laptops, desktops, computers, Mac, PC, and LCD monitors to meet various angle needs. With a 110-degree widescreen view and built-in digital stereo microphone with automatic noise reduction, the webcam captures high-definition video and clear sound, even from up to 10 feet away. It is ideal for live streaming, webinars, video conferencing, and more. The webcam utilizes advanced facial enhancement technology to optimize images automatically, making you look great in recordings, video calls, online teaching, and gaming sessions. It is compatible with various operating systems including Windows, Mac OS, Chrome OS, Smart TV, and Android, and works seamlessly with popular platforms such as Skype, OBS, YouTube, Facebook, Twitch, Facetime, Zoom, Xbox One, and Hangouts. For privacy protection, the webcam includes a privacy cover to ensure safe digital life when not in use, preventing unauthorized access. Additionally, it comes with a tripod stand for convenient placement, offering flexibility and ease of use. [22].

Figure 3.8: camera.

3.3.6 Lithium-ion Battery

The 3.7V lithium-ion battery is a rechargeable power source widely used in portable electronic devices due to its high energy density, lightweight design, and long cycle life. These batteries utilize lithium-ion technology, where lithium ions move between the positive and negative electrodes during charging and discharging cycles. This results in a reliable and efficient power supply suitable for a diverse range of applications. Energy Density: Lithium-ion batteries offer one of the highest energy densities among rechargeable battery types, meaning they can store a large amount of energy in a relatively small and lightweight package. This makes them ideal for lightweight systems where space and weight are critical considerations.

Lithium-ion batteries are known for their lightweight construction compared to other battery chemistries such as lead-acid or nickel-metal hydride. This makes them particularly well-suited for portable and wearable devices where minimizing weight is essential for user comfort and mobility. 3.7V lithium-ion batteries typically have a longer cycle life compared to other rechargeable batteries, allowing them to be recharged and discharged many times before experiencing significant degradation in performance. This longevity ensures reliable operation over extended periods, reducing the need for frequent battery replacements. Lithium-ion batteries often support fast charging technology, allowing them to be recharged quickly compared to traditional rechargeable batteries. This feature is beneficial for lightweight systems that require rapid turnaround times between uses or extended operation without downtime. 3.7V lithium-ion batteries come in various shapes, sizes, and configurations, providing flexibility to designers and manufacturers to tailor the battery pack to fit the specific requirements of the lightweight system. This versatility enables integration into a wide range of devices across different industries, including consumer electronics, medical devices, drones, and more [23].

Figure 3.9: Lithium ion Battery.

3.3.7 Boost Converter

The DC-DC Converter Step-Up module shown in Figure 3.10 capable of boosting input voltages ranging from 5V to 28V to a higher output voltage. This module utilizes the MT3608 chip and is designed to deliver an output current of up to 2A.The MT3608 DC-DC Converter is a popular choice for projects requiring efficient voltage conversion, such as powering higher voltage components or devices from lower voltage sources. It is particularly useful in applications like battery-powered systems, where boosting the voltage to meet the requirements of certain components is necessary. It is capable of boosting input voltages to higher levels, depending on the specific application requirements. It offers a maximum output current of 2A, suitable for powering a variety of electronic components and devices. It also provides efficient voltage conversion, helping to minimize power loss and maximize battery life in battery-operated systems. The compact module design allows for easy integration into electronic projects with limited space constraints. [24].

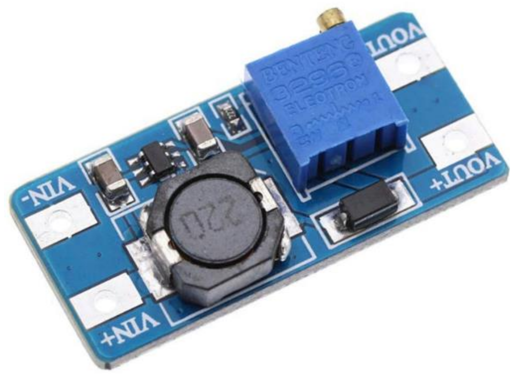

Figure 3.10: boost converter.

3.3.8 Charging Board

The TP4056/TC4056A Lithium Battery Charger and Protection Module is a versatile charging solution designed for lithium-ion and lithium polymer batteries. This module is compact and efficient, making it suitable for various portable electronics projects and devices. The module is capable of charging single-cell lithium-ion or lithium polymer batteries with a nominal voltage of 3.7V. It provides a reliable and stable charging current to ensure the safe and efficient charging of batteries. This module incorporates multiple protection features to safeguard the battery during charging. It includes overcharge protection, over-discharge protection, overcurrent protection, and short-circuit protection, helping to prevent damage to the battery and ensuring safe operation. The module features a micro USB input port, allowing easy and convenient connection to a USB power source for charging. This makes it compatible with a wide range of USB power adapters, power banks, and computer USB ports, providing flexibility in charging options. The module includes an LED indicator to display the charging status, making it easy to monitor the charging process. The LED typically changes color or blinks to indicate when the battery is charging, fully charged, or if there is an error condition. With its small form factor, the TP4056/TC4056A module is space-saving and suitable for integration into compact electronic devices or projects where size constraints are a consideration [25].

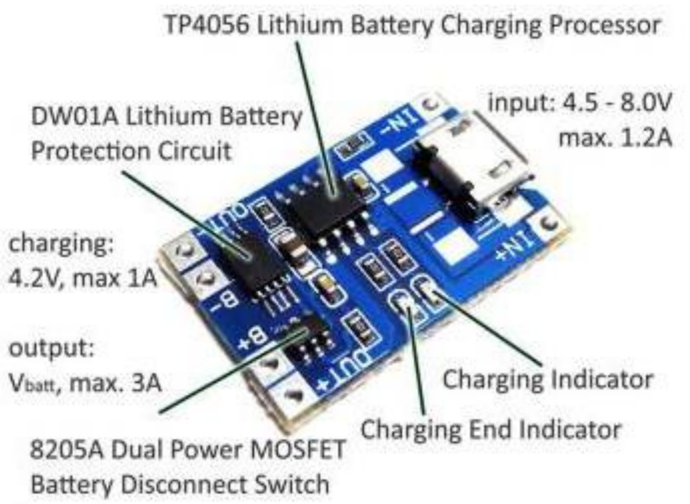

Figure 3.11: charging module.

3.3.9 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a versatile cross-platform software application developed in Java. It provides a comprehensive set of tools for programming and uploading code to compatible Arduino boards. With built-in functions, it enables coding in C and C++ languages and facilitates seamless communication between the IDE and Arduino hardware. The IDE offers a user-friendly interface with various development tools, including code editor, compiler, and uploader, all within a single application. It supports programming in C and C++ languages, allowing users to write code for their Arduino projects efficiently. The IDE includes an error-checking mechanism that helps users identify and troubleshoot issues in their code, ensuring smoother development processes. A wide range of libraries is available for users to access and incorporate into their projects, providing additional functionality and simplifying development tasks. The IDE highlights syntax to improve code readability and comprehension, making it easier for users to write and understand their code. It features a serial monitor that allows bidirectional communication between the IDE and the Arduino board, facilitating debugging and real-time data exchange. Arduino IDE can be used offline without an internet connection, offering flexibility and convenience for users, especially in environments with limited internet access [26].

3.3.10 PyCharm IDE

PyCharm is a popular integrated development environment (IDE) specifically designed for Python programming language development. Developed by JetBrains, PyCharm provides a robust set of features tailored to enhance the productivity of Python developers across various domains, including image processing projects. PyCharm offers a powerful code editor with features such as syntax highlighting, code completion, code formatting, and code navigation. These features help developers write clean and efficient Python code for image processing projects. PyCharm provides intelligent code assistance, including code inspections, quick-fix suggestions, and context-aware code completion. This helps developers identify and fix errors in their code quickly, improving overall code quality and productivity. PyCharm includes robust debugging tools that allow developers to debug Python code easily. It provides features like breakpoints, watches, and a debugger console, enabling developers to identify and resolve issues in their image processing algorithms efficiently. PyCharm seamlessly integrates with popular version control systems like Git, Mercurial, and SVN. This allows developers to manage their code repositories directly from the IDE, making collaboration on image processing projects more efficient. PyCharm provides support for popular scientific computing libraries like NumPy, SciPy, OpenCV, and scikit-image. These libraries are widely used in image processing projects and provide powerful tools and algorithms for image manipulation, analysis, and computer vision tasks. When it comes to image processing projects, Python is a popular choice due to its simplicity, readability, and extensive collection of libraries for image manipulation and analysis. Libraries like OpenCV, scikit-image, and Pillow provide comprehensive support for image processing tasks, making Python an ideal language for developing image processing applications.

The cost of the proposed system’s components is expressed in Table 3.3

Table 3.3: Cost analysis

Component	Quantity	Cost ($)
Arduino Uno	1	27
WiFi module (ESP8266)	1	6
Buzzer	1	2
NFC reader PN532	1	10
I2C LCD	1	13
Lithium ion battery	1 pack	16
Boost converter	1	5
Charging board	1	5
box	1	17
others		20
Total cost	200	

3.4 Analysis

Once the NFC tag is approached to the NFC module, the tag data will be read and sent to the Arduino Uno. Then the Arduino will send the child’s number and sends it to the server via the WiFi module. The server will extract the child’s image and name and show them on the screen. The child should stand opposite to the camera to verify his identity. If the child’s face was verified that he is on the queue or not. If he is verified, then the system outputs a voice message “goodbye” and the child’s image and data will be removed from the queue. Otherwise, the system will output a voice message “not allowed”.

3.5 Ethics and Limitations

Research into smart child pick-up systems at schools raises several ethical considerations that must be carefully addressed. Firstly, there are concerns regarding privacy and data security. The collection and storage of children's identification information, including their images, raise questions about consent, ownership, and the potential for misuse. It's crucial for researchers to implement robust data protection measures, such as encryption and strict access controls, to safeguard this sensitive information. Additionally, clear policies should be established regarding the retention and deletion of data to prevent unauthorized access or long-term storage of unnecessary information. Transparency with parents and guardians about how their children's data will be used and protected is essential to build trust and ensure ethical research practices.

Secondly, there are implications for equity and fairness in the implementation of smart pick-up systems. While these systems aim to enhance security and efficiency, there is a risk of exacerbating existing inequalities. For example, families without access to smartphones or reliable internet connections may face barriers in participating or accessing information about the system. Researchers must assess and mitigate these risks by ensuring accessibility, diversity, and inclusivity in system design and implementation. Furthermore, ongoing monitoring and evaluation are essential to identify and address any unintended consequences or disparities that may emerge throughout the research process. By prioritizing ethical considerations, researchers can develop smart pick-up systems that promote safety, fairness, and respect for individuals' rights and dignity.

Chapter 4 : IMPLEMENTATION

4.1 Hardware Implementation

Figure 4.1 shows the schematic circuit of the power supply circuit. Tow lithium ion batteries were used which are connected is parallel as a one pack. The batteries terminals were connected with the USB charging module pins B+ and B-. The out pins of the charging module were connected with the boost converter input terminals. The boost converter was adjusted to output 5v needed to operate the external unit components. Its output terminals indicate the unit's power and common ground.

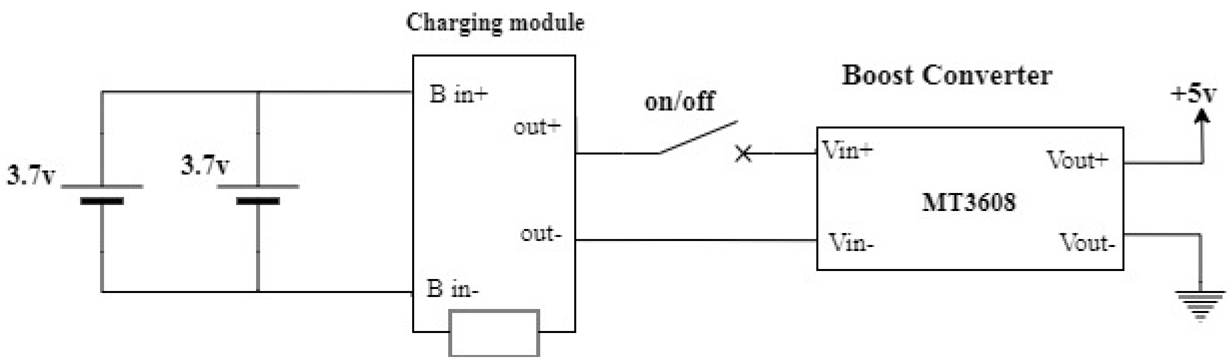

Figure 4.1: power supply schematic circuit.

Figure 4.2 shows the schematic circuit of the components interface with the Arduino. The integration of the I2C LCD and the NFC reader (PN532) with the Arduino Uno using the I2C protocol allows for the connection of multiple devices to the same pins, thereby optimizing hardware usage. Both the I2C LCD and the NFC reader are connected to the Arduino Uno's SCL (A5) and SDA (A4) pins, which support the I2C protocol. This configuration enables efficient communication between the Arduino and the connected devices. The I2C protocol facilitates serial communication between devices using a master-slave architecture, where the Arduino Uno acts as the master device, controlling the communication with the connected peripherals. By connecting multiple devices to the same SCL and SDA pins, the I2C protocol simplifies the wiring and conserves GPIO pins on the Arduino Uno, making it an ideal choice for projects requiring multiple peripherals. The cancel button was connected with the Arduino Uno pin D6, while the buzzer was connected with pin D7.

The ESP8266 WiFi module was interfaced with the Arduino Uno using UART (Universal Asynchronous Receiver/Transmitter) communication protocol. The Arduino Uno's digital pins D2 and D3 were utilized for this purpose, as they support UART communication. Specifically, the transmitter pin (TX) of the ESP8266 module was connected to Arduino Uno's digital pin D2, while the receiver pin (RX) of the ESP8266 module was connected to Arduino Uno's digital pin D3.This configuration enables bidirectional serial communication between the Arduino Uno and the ESP8266 module. The Arduino Uno can send commands and data to the ESP8266 module via its transmitter pin, and receive responses and data from the ESP8266 module via its receiver pin.

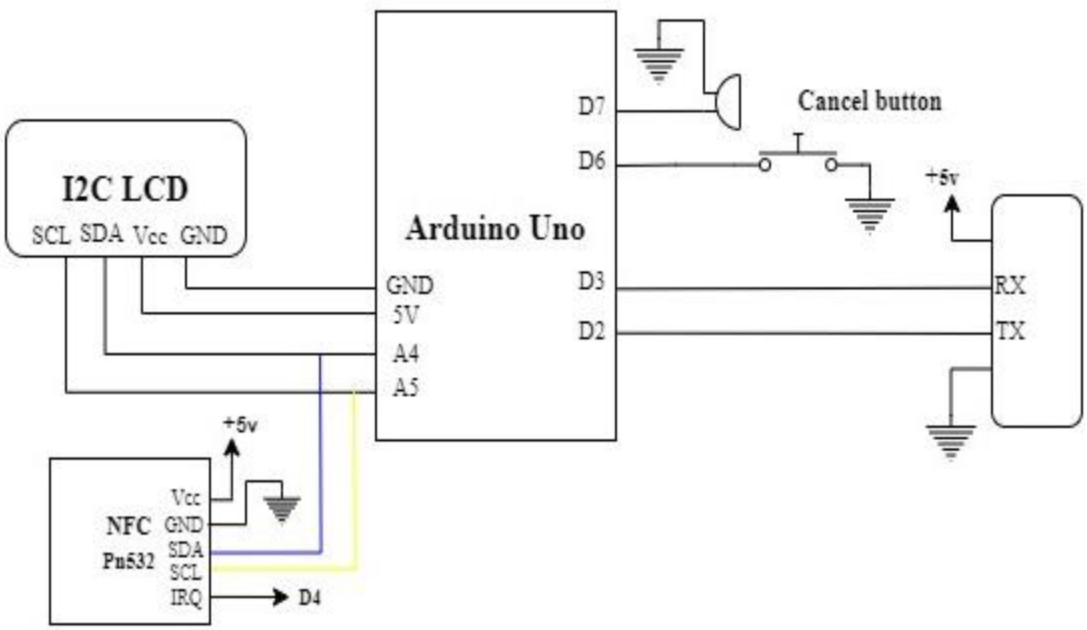

Figure 4.2: schematic circuit.

4.2 Software Implementation

Programming an Arduino Uno using the C language in the Arduino IDE involves writing code to control the system components. The Arduino IDE provides a user-friendly environment for writing, compiling, and uploading code to the Arduino Uno board. In the IDE, users create a new sketch (Arduino program) and write their C code. Within the C code written in the Arduino IDE, users can access Arduino-specific functions and libraries to control the board's digital and analog pins, read from components, write to output devices. These functions and libraries abstract away the low-level details of hardware interaction, allowing users to focus on writing high-level code to achieve their desired functionality. Additionally, the Arduino IDE includes features such as syntax highlighting, auto-completion, and error checking to assist users in writing and debugging their code, making it accessible to both beginners and experienced programmers alike. Once the code is written, it was compiled within the IDE to check for any syntax errors or warnings and then uploaded it to the Arduino Uno board via a USB connection, where it will run and execute the defined tasks according to the programmed logic.

The system's flowchart is shown in Figure 4.3. First, the NFC reader and the LCD will be initialized. Then the system checks if the NFC tag is read by the NFC reader. When NFC is approached by the NFC reader, then the system reads its ID (child ID). After that, the system checks if the tag is stored on the Arduino. If the tag is not stored, it displays “wrong tag” on the LCD. If the tag is stored, then the system checks for a timeout. If time runs out, then it sends the ID via WiFi to the PC. If the time is not out and the cancel button is pressed, then the system displays “cancelled” on the LCD.

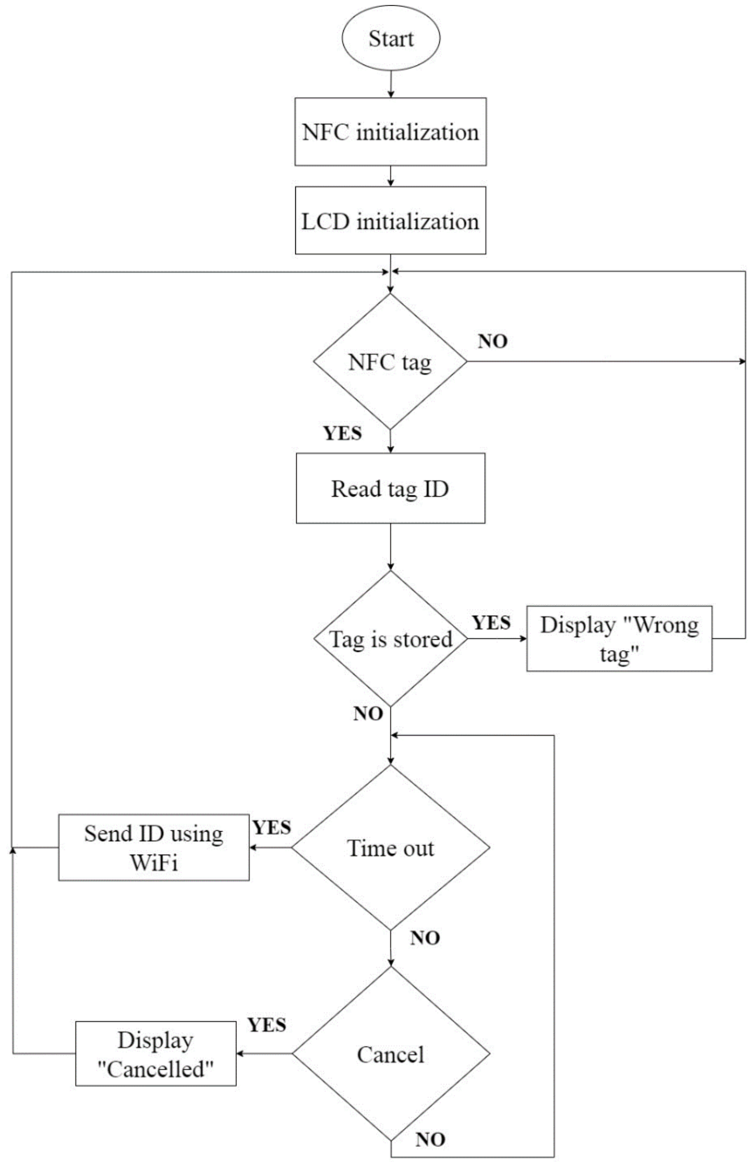

Figure 4.3: Flowchart

4.3 System Working

Figure 4.4 shows the external unit. The defaults message appears on the LCD is “approaching tag”.

Figure 4.4: External unit’s LCD default message.

Figure 4.5 shows what the unit’s LCD displays when a wrong tag is used; this means that the tag’s data is not saved in the unit’s Arduino.

Figure 4.5: Wrong data used case.

Figure 4.6 shows the case of approaching NFC tag that its data is prestored in the Arduino; the LCD displays the student's ID and gives the option to cancel the request.

Figure 4.6: Requested child's data.

Figure 4.7 shows the case when scanning the NFC tag, the children's images and information are displayed on the PC.

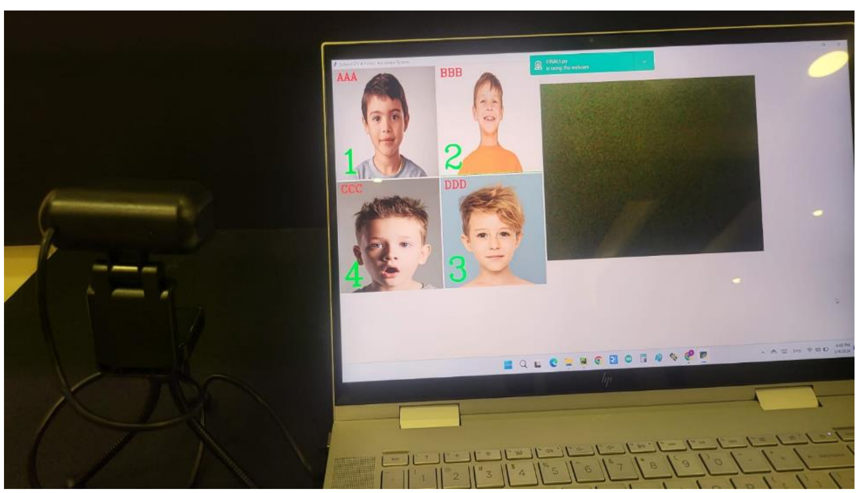

Figure 4.7: Requested children's queue.

Figure 4.8 shows the case when the child's face is verified, good bye message is shown on the screen and a voice message is heard.

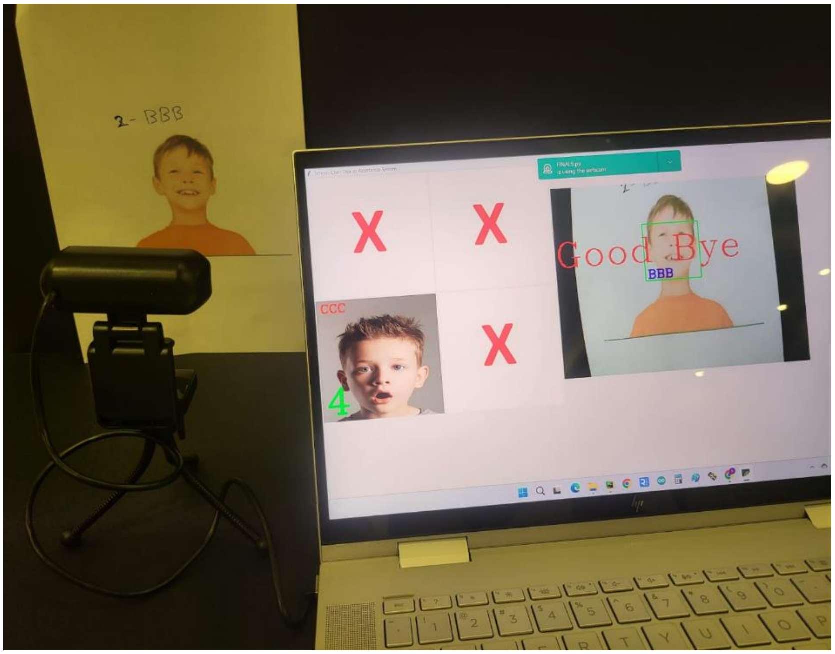

Figure 4.8: Child’s face verified case.

Figure 4.9 shows the case when the child’s face is not verified, not allowed message is shown on the screen and a frequently voice message is heard “not allowed”.

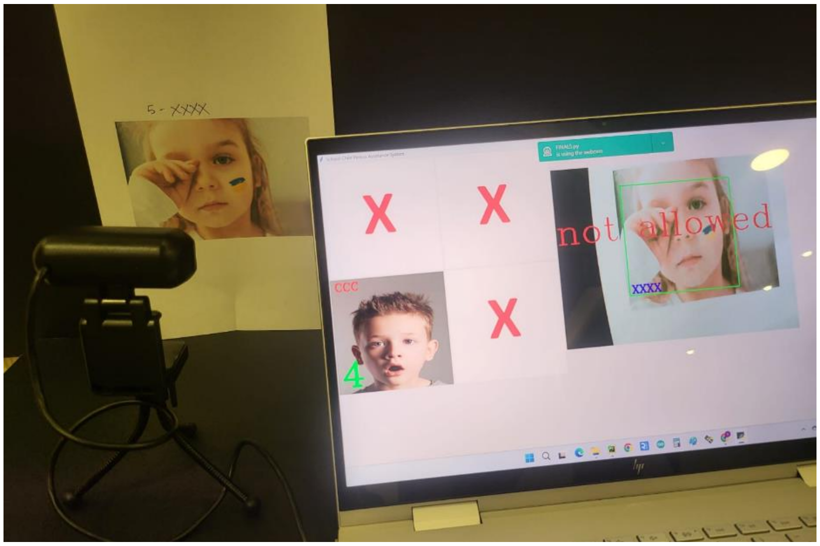

Figure 4.9: child’s face not verified case.

Figure 4.10 shows the case when cancel button is pressed.

Figure 4.10: Pressing cancel button.

4.4 IEEE Standards

- IEC 61784: This standard provides guidelines for industrial communication networks, including protocols and interfaces used in image processing systems for industrial applications.
- IEC 62351: This standard addresses the security of industrial automation and control systems, including measures to protect image processing systems from cyber threats.
- IEEE 1233-2014: This standard provides a framework for the description and classification of image processing systems, including terminology and concepts used in the field.
- The IEEE standard overseeing Wi-Fi technology is IEEE 802.11, which establishes the parameters for wireless local area network (WLAN) communication protocols. This standard encompasses a spectrum of protocols, such as 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac, and 802.11ax (also known as Wi-Fi 6). The WiFi module used in this project is ESP8266, it is protocol is 802.11 b/g/n. IEEE 802.11n: standard was ratified in 2009, this amendment introduced multiple-input multiple-output (MIMO) technology, significantly improving data rates and range compared to previous versions. It operates in both the 2.4 GHz and 5 GHz frequency bands, offering data rates up to 600 Mbps.

- IEC 62133: This standard specifies requirements and tests for the safe operation of portable sealed secondary lithium cells and batteries for use in portable applications. It covers aspects such as electrical, mechanical, and environmental properties.

Chapter 5 : EVALUATION

5.1 Technical Assessment

- Accuracy and reliability of the system: The core of the system lies in its ability to accurately identify and verify children through image processing. The system employs robust algorithms for face recognition to ensure high accuracy in identifying children and prevent unauthorized individuals from picking up children.

A thorough assessment of the system's performance in various lighting conditions, angles, and facial expressions is necessary to ensure reliability. To prove this, the system ability to recognize faces was tested in different facial expressions as shown in Figure 5.1.

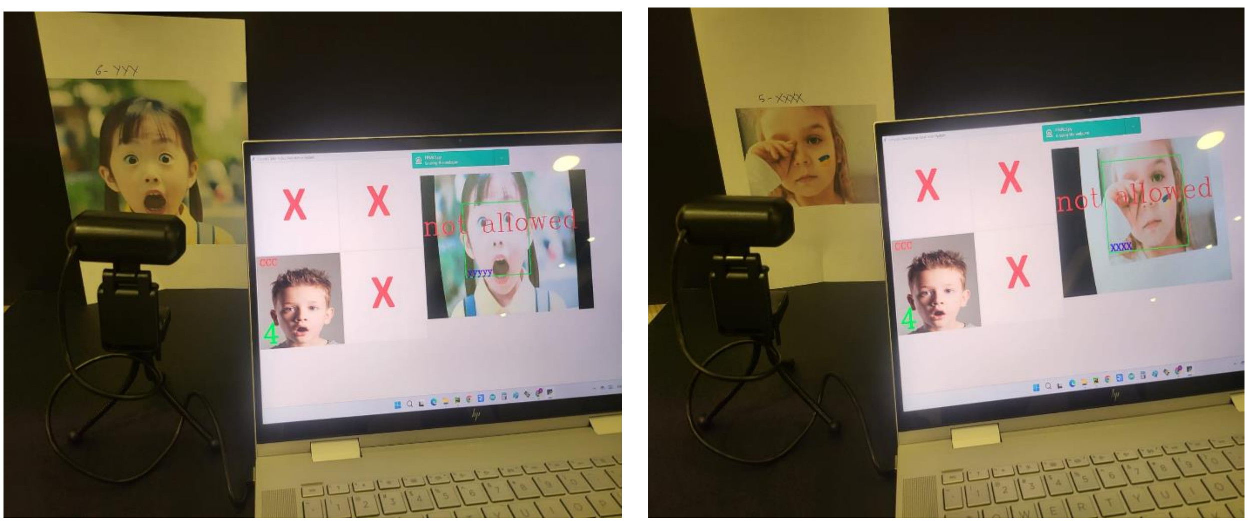

Figure 5.1: testing the system by different facial expressions.

- The system's hardware components, such as cameras and processing unit (PC) have been selected carefully to meet the requirements of real-time image processing. High-resolution camera with wide-angle lense is necessary to capture clear images of children. Additionally, the processing unit which is the PC was choosed because it has sufficient computational power to perform face recognition tasks efficiently.
- The system should seamlessly integrate with the existing infrastructure at the school pickup area. That’s why the external unit was implemented as a battery based power unit. This includes installing cameras and processing units. As well as the system can be connected to the school's network for data transmission and communication.

- The system was designed to scale efficiently as the number of students and parents using the system grows.

5.2 Project Impacts

- Business Impact: The system can lead to cost savings by streamlining pick-up processes, reducing administrative workload, and enhancing security, thus potentially improving the school's efficiency and reputation.
- Economic Impact: The system may create opportunities for technology companies specializing in image processing, software development, and hardware manufacturing. Additionally, increased efficiency in pick-up processes could result in time savings for parents and school staff, potentially leading to improved productivity and economic gains.
- Marketing Impact: Implementing a modern and secure pick-up system can enhance the school's reputation and attract parents seeking advanced safety measures for their children. Marketing the system's features, such as real-time monitoring, secure identification, and ease of use, can differentiate the school from competitors and attract new enrollments.
- Ethical Impact: Ethical considerations include ensuring data privacy, obtaining consent from parents for collecting and processing children's images, and addressing concerns about potential biases or inaccuracies in the image processing technology. Respecting individuals' rights to privacy and informed consent is essential for maintaining trust and ethical integrity.
- Social Impact: The system can contribute to improved safety and security for children, providing peace of mind for parents and caregivers. By reducing the risk of unauthorized individuals accessing school premises and ensuring that children are picked up by authorized individuals only, the system helps create a safer learning environment and fosters trust within the school community.
- Environmental Impact: While the direct environmental impact of the system may be minimal, indirectly, it can contribute to environmental sustainability by reducing the need for paper-based processes and physical ID cards. Additionally, by optimizing pick-up

routes and reducing wait times, the system can potentially lower carbon emissions associated with transportation.

5.3 System Calculations

Calculating the operating time and charging time of a battery-based system involves considering various factors such as the battery capacity, load current, and charging current.

- Battery capacity is 3.3Ah.
- Battery voltage is 3.7V.
- Load current is measured and found that it is 0.3A.
- The Charging current is 2A.
- Battery power = V(v)*I (Ah) = 3.7*3.3 = 12.21wh (for one cell, 24wh for 2 cells).
- The operation time of the system can be calculated as follows:

$$\boldsymbol{Topertaion} = \frac{\boldsymbol{Battry\ power(Wh)}}{\boldsymbol{system\ power\ consumption\ (W)}} \qquad \textbf{Equation 1}$$

$$Toperation = \frac{24Wh}{5v*0.3A} = \frac{24}{1.5}\ 16 \text{ hours}$$

- The charging time of the system can be calculated as follows:

$$\boldsymbol{Tcharging} = \frac{\boldsymbol{Battry\ power(Wh)}}{\boldsymbol{Charger\ power\ (W)}} \qquad \textbf{Equation 2}$$

$$Tcharging = \frac{24Wh}{5V*2A} = 2.4 \text{ hours}$$

5.4 Validation of Design Specifications

The system design specifications validation is listed in Table 5.1.

Table 5.1: Validation of Design Specifications

#	System Requirements: Functional Requirements	System Requirements: Non-Functional Requirements	Validated? (Yes/No)	Comments
1	The system should ensure to pick up the child by his parents only.	Security	Yes	Each parent is provided by NFC tag where child ID is stored in it.
2	The system should enable parents to request their child without the need to enter the school.	Usability	Yes	An external unit is designed that can be attached at the school gate and connected with the system via WiFi.
3	To enable parents to know that their request is verified	Security	Yes	The external unit uses an LCD to show the parents a confirmation message.
4	Enable the supervisor to recognize the requested child identity.	Reliability	Yes	The system uses a PC to show the requested student's image and name.
5	Enable the supervisor to ensure that the correct child is being picked up.	Reliability and utility	Yes	The system uses a camera and face recognition technology to verify the requested child's identity.
6	The system should alert the supervisor if the child face is not verified to leave school.	Security and utility	Yes	In case the child's is not allowed to leave, a message will be shown on a screen, outputs a voice message as an alert.
7	The system should work successfully in various conditions.	Performance and reliability	Yes	the system ability to recognize faces was tested in different lighting conditions, angles, and facial expressions
8	The external unit's battery shouldn't need a long time for charging	Performance	Yes	It only needs 2.4 hours.
9	The external unit should work for a long time	Performance	Yes	It can work for 16 hours continuously.

Chapter 6 : CONCLUSIONS AND FUTURE WORKS

6.1 Conclusion

The safety of students in schools, amidst the increasing numbers, poses a significant challenge for supervision. Parents expect schools to ensure the safety of their children and insist on stringent measures to prevent unauthorized individuals from picking them up. Schools must obtain parental consent in advance for authorized individuals to pick up students, and they are obligated to inform legal guardians if unauthorized individuals attempt to do so. It's crucial for schools to know who is responsible for dropping off and picking up students to maintain their security. Unauthorized pickups raise immediate safety concerns as the individuals involved may not have undergone proper vetting, posing risks such as harm or abduction to the students. Schools typically have procedures to verify the identity of pickup individuals, but unauthorized persons may attempt to bypass these protocols, complicating the identification process. To effectively address this issue, schools need to implement stringent security measures, including enhanced identification procedures, improved communication with parents, and the adoption of technology such as electronic sign-out systems. These measures are essential for maintaining the safety and security of students in schools. The system aims to optimize the school-child pickup procedure by integrating NFC and Face Recognition technologies, enhancing security measures and facilitating real-time communication between parents and school staff. By leveraging these technologies, only authorized parents can access students, effectively minimizing the chances of unauthorized entry. Additionally, the system is designed to expedite the pickup process, alleviating congestion and reducing wait times at school exits. Overall, it represents a comprehensive solution to improve efficiency, security, and communication in the school pickup system.

6.2 Future Work

- A motor can be used and controlled to open the gate automatically when the system recognize someone.
- Enable the system to record the departure time of each child.
- Tow cameras can be used at different locations where two units will be used at different exit gates.

- Add the feature of sending a confirmation SMS to the child's parents that their child is leaving the school.

REFERENCES

1. Dropping off and picking up before and after school | NSPCC Learning. (n.d.). NSPCC Learning. https://learning.nspcc.org.uk/research-resources/schools/dropping-off-and-picking-up-before-and-after-school
2. Richardson, R. (2022). Facial recognition in the public sector: the policy landscape. German Marshall Fund of the United States.
3. Mohan, Vijayarani. (2015). Comparative Analysis of Facial Image Feature Extraction Algorithms.
4. Kugell, A. (2024, April 8). Applications of Facial Recognition Technology - Trio. Trio. https://trio.dev/facial-recognition-applications/
5. Abuazh, R., Abdullah, Y., Alluwaimi, A., & Aldakhail, Y. (2020). Face detection and recognition student attendance system. https://www.pmu.edu.sa/attachments/academics/pdf/udp/coe/dept/ee/face_detection_system_report.pdf
6. Kumar, G. S., Selvaraju, S., Manikanda, N., & Muthumanickam, T. (2015). Smart Intelligent Tracking System for School Students Using GSM and GPS. vol, 3, 122-124.
7. Al-Lawati, Anwaar & al Jahdhami, Shaikha & Al-Belushi, Asma & Al-Adawi, Dalal & Awadalla, Medhat & Al-Abri, Dawood. (2015). RFID-based system for school children transportation safety enhancement. 10.1109/IEEEGCC.2015.7060047.
8. Cahyadi, J. (2020). ANDROID APPLICATION TO VERIFY CHILD PICK UP IN SCHOOL TO PREVENT KIDNAPPING (Doctoral dissertation, Universitas Atma Jaya Yogyakarta).
9. Hasni, N., Hariyanti, dan Salina., (2016). Prevention System for Child Abduction by Using Image Processing Algorithm on Intel Galileo Board. Vol 5 (2)
10. Juansyah, A., (2015)., Pembangunan Aplikasi Child Tracker Berbasis Assisted – Global Positioning System (A-Gps) Dengan Platform Android, Jurnal Ilmiah Komputer dan Informatika, Vol (1).
11. Tesfaye, Fitsum. (2020). IOT BASED CHILDREN MONITORING SYSTEM IN SCHOOL.
12. Asundkar, V. (2016). ENHANCE SAFETY SECURITY AND TRACKING SYSTEM FOR SCHOOL BUS AND CHILDREN. (2016)
13. BHUVANYA, R., & UMA, S. BIOMETRIC BASED STUDENTS'BUS MANAGEMENT SYSTEM.
14. Uxb. (2021, August 9). School pickup and drop off – CSE Senior Design. https://websites.uta.edu/cseseniordesign/2021/08/09/school-pickup-and-drop-off/
15. Daniel, N. (n.d.). Design and implementation of a smart kids transportation system. Scribd. https://www.scribd.com/document/627877472/Design-and-implementation-of-a-smart-kids-transportation-system

16. James Simpson. (2021, May 28). What's the difference between a raspberry pi and a computer? https://www.jamessimpson.co.uk/whats-the-difference-between-a-raspberry-pi-and-a-computer/
17. Bluetooth vs Wi-Fi. Diffen. Available at: https://www.diffen.com/difference/Bluetooth_vs_Wifi
18. Krishna, M. & Shivprasad, Lingampally & Ravinder, S. & Prathibha, S.. (2020). RFID BASED SMART SYSTEM FOR STORING DATA. Turkish Journal of Computer and Mathematics Education (TURCOMAT). 11. 2682-2685. 10.61841/turcomat.v11i3.14484.
19. Admin, & Admin. (2023, May 29). Interfacing PN532 NFC RFID Module with Arduino. How to Electronics. https://how2electronics.com/interfacing-pn532-nfc-rfid-module-with-arduino/
20. I2C serial interface 1602 LCD module - handsontec.com. (n.d.-a). https://handsontec.com/dataspecs/module/I2C_1602_LCD.pdf
21. WiFi Module - ESP8266 (4MB Flash). (n.d.). WRL-17146 - SparkFun Electronics. https://www.sparkfun.com/products/17146
22. Amazon.com: Tolulu 1080p webcam with microphone, HD webcam web camera with Tripod Stand, widescreen USB computer camera, streaming mic webcam for online calling/conferencing, Zoom/Facetime/YouTube Laptop Desktop : Electronics. (n.d.-a). https://www.amazon.com/ToLuLu-Webcam-with-Microphone-04485/dp/B084ZJFNKN
23. Ct. (2024, March 27). Unveiling the battle between lithium-ion and Nickel-Metal hydride batteries. Professional Lithium Battery Manufacturer Vendor. https://www.lithiumbatterytech.com/unveiling-the-battle-between-lithium-ion-and-nickel-metal-hydride-batteries/
24. DC-DC Converter Step-Up 5-28V 2A - MT3608. (n.d.). grobotronics.com. https://grobotronics.com/dc-dc-converter-step-up-5-28v-2a-mt3608.html?sl=en
25. Addicore. (n.d.-a). TP4056 / TC4056A Lithium battery charger and protection module. https://www.addicore.com/products/tp4056-tc4056a-lithium-battery-charger-and-protection-module
26. Lab, M. (2020, June 10). INTRODUCTION TO ARDUINO IDE. Microcontrollers Lab. https://microcontrollerslab.com/introduction-arduino-ide/

Appendix 1: Gantt chart

Tasks	**Sep 2023**	**Oct 2023**	**Nov 2023**	**Dec 2023**	**Feb 2024**	**March 2024**	**April 2024**	**May 2024**
Idea selection								
Recent solutions pros and cons								
System objectives and								
Sketching the block diagram								
Components selection								
Power supply implementation								
External unit design								
Components interface with Arduino								
Writing Arduino code								
Python code								
System working testing and evaluation								
Report								
Presentation								

Appendix 2: Arduino Code

```
void setup() {
Serial.begin(9600);
wifis.begin(9600);
pinMode(buzzer,OUTPUT);
pinMode(button,INPUT);
nfc.begin();
lcd.begin(16, 2);
lcd.print("  Approach Tag");

id1="2112507822";
id11="1472556222";
id2="32315724";
id22="2432227222";
id3="2462296175";
id33="24318521563";
id4="991127122";
active=false;
}//setup
void loop() {
success = nfc.readPassiveTargetID(PN532_MIFARE_ISO14443A, uid, &uidLength,500);
  for(int y=0;y<uidLength;y++){
  room+=uid[y];
  }
  digitalWrite(buzzer,1);
  delay(100);
  digitalWrite(buzzer,0);
```

```
if ((room.indexOf(id1)>=0)or(room.indexOf(id11)>=0)){
  tos='1';
  lcd.print(" Student ID: 1");
  lcd.setCursor(0,1);
  lcd.print("Press to Cancel");
}
else if ((room.indexOf(id2)>=0)or(room.indexOf(id22)>=0)){
  tos='2';
  lcd.print(" Student ID: 2");
  lcd.setCursor(0,1);
  lcd.print("Press to Cancel");
}
  else if ((room.indexOf(id3)>=0)or(room.indexOf(id33)>=0)){
  tos='3';
  lcd.print(" Student ID: 3");
  lcd.setCursor(0,1);
  lcd.print("Press to Cancel");
}
  else if ((room.indexOf(id4)>=0)or(room.indexOf(id4)>=0)){
  tos='4';
  lcd.print(" Student ID: 4");
  lcd.setCursor(0,1);
  lcd.print("Press to Cancel");
}
else{
  lcd.print("   Wrong Tag");
  delay(2000);
  lcd.clear();
  lcd.print("  Approach Tag");
```

```
    }

}//success
if(digitalRead(button)==0){
lcd.print("Cancelled ....");
delay(3000);
lcd.print("  Approach Tag");
}
 if(millis()-last>1000)

   cc++;
   if(cc>=8){
   lcd.clear();
   lcd.print(" Request Sent..");
   wifis.println(tos);
   active=false;
   delay(3000);
   lcd.print("  Approach Tag");
   }}

 }

}//loop
```

Appendix 3: Python Code

Initializations

```
from ress2 import *
import socket
from guizero import App,Text,PushButton,Picture
import cv2
import os
import face_recognition
import numpy as np
from pygame import mixer


mixer.init(44100)
mixer.music.set_volume(90)



list=read_cont_ip()
contip=list[4]
print(contip)



print("connecting to External unit ")
cs = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
cs.connect((contip, 12345))
print(" done.......")


occupiedslots=['0','0','0','0','0']

path = 'pictures'
images = []
classNames = []
myList = os.listdir(path)
print(myList)


for cl in myList:
    curImg = cv2.imread(f'{path}/{cl}')
    images.append(curImg)
    classNames.append(os.path.splitext(cl)[0])
print(classNames)

encodeList = []
for img in images:
    img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    encode = face_recognition.face_encodings(img)[0]
    encodeList.append(encode)
print('Encoding 1 Complete')
```

Graphical user interface

```
app = App(title="School-Child Pickup Assistance System ", width=1400,
height=600,layout="grid")



slot1 = Picture(app, image="x.png",width=300,height=300,grid=[1,1])
slot2 = Picture(app, image="x.png",width=300,height=300,grid=[2,1])
slot3 = Picture(app, image="x.png",width=300,height=300,grid=[1,2])
slot4 = Picture(app, image="x.png",width=300,height=300,grid=[2,2])


picture1 = Picture(app,
image="camstream.png",width=640,height=480,grid=[7,1,1,6])
picture1.repeat(2000, getid)  #
picture1.repeat(1000, vid)  #
```

Read new ID

```
def getid():
    send_tcp(cs, '???')
    data = str(data)


    if data[0].isdigit():
        childid = data[0]

    else:
        childid ='0'
        print('no id available')

    if childid!='0':

dispque(childid,door,slot1,slot2,slot3,slot4,images,occupiedslots,mixer)
       door+=1
```