

**FACIAL RECOGNITION SYSTEM OF
STUDENTS AND FACULTY FOR STI COLLEGE CALAMBA**

**A Thesis
Presented to the Faculty of
Information and Communications Technology Program
STI College Calamba**

**In Partial Fulfilment
of the Requirements for the Degree
Bachelor of Science in Computer Engineering**

**Jed Leander M. Bergola
Carl Mathew D. Morada
Clarence C. Villanueva**

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TITLE OF RESEARCH: **FACIAL RECOGNITION SYSTEM OF STUDENTS AND FACULTY FOR STI COLLEGE CALAMBA**

NAME OF PROPONENTS: Jed Leander M. Bergola
Carl Mathew D. Morada
Clarence C. Villanueva

In Partial Fulfilment of the Requirements
for the degree Bachelor of Science in Computer Engineering
has been examined and is recommended for Oral Defense.

ENDORSED BY:

Marvic M. Espiritu, ECE
Thesis Adviser

APPROVED FOR ORAL DEFENSE:

Marvic M. Espiritu, ECE
Thesis Coordinator

NOTED BY:

Jocelyn G. Llanderal, MIT
Program Head

May 2023

APPROVAL SHEET

This thesis titled: **Facial Recognition System of Students and Faculty for STI College Calamba** prepared and submitted by **Jed Leander M. Bergola; Carl Mathew D. Morada** and **Clarence C. Villanueva**, in partial fulfilment of the requirements for the degree of Bachelor of Science in Computer Engineering, has been examined and is recommended for acceptance an approval.

Marvic M. Espiritu, ECE
Thesis Adviser

Accepted and approved by the Thesis Review Panel
in partial fulfilment of the requirements for the degree of
Bachelor of Science in Computer Engineering

Fe Dalangin Yedra, MAITE, LPT
Panel Member

Jocelyn G. Llanderal, MIT
Panel Member

Carlo Anthony A. Sugaste, MSIT
Lead Panelist

APPROVED:

Marvic M. Espiritu, ECE
Thesis Coordinator

Jocelyn G. Llanderal, MIT
Program Head

May 2023

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ABSTRACT

Title of research: **Facial Recognition System of Students and Faculty for STI College Calamba**

Researchers: **Jed Leander M. Bergola
Carl Mathew D. Morada
Clarence C. Villanueva**

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This study presents a prototype attendance monitoring camera aimed at recognizing faces, sending notifications to parents, and enhancing school security measures. The modified waterfall method was employed, which includes planning, design, implementation, testing, optimization, and deployment. In the planning phase, the objectives, scope, and constraints of the project were defined. The design phase focused on the camera's physical appearance and the software components. During implementation, the camera and software were developed. Testing was performed to ensure the camera's accuracy and efficiency. Optimization involved refining the system based on feedback from users and making necessary adjustments. Finally, the system was deployed for use. The results showed that the prototype can effectively recognize faces and notify parents. The system also improved the security measures of the school. The study concludes that the modified waterfall method is a viable approach for developing similar systems, and the prototype provides a basis for future development and improvement.

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INTRODUCTION

The academic performance of children and youth in schools and colleges is heavily influenced by attendance. The students are less likely to engage in delinquent or destructive behavior when they attend class regularly. When students are absent frequently, it leads to school failure and early dropout. For the following reasons, keeping track of attendance by hand is inefficient: It takes away many lecture hours and is prone to proxies or impersonations (IEEE2018).

There are several ways to implement the attendance solution. In recent years, attendance management systems have become increasingly popular. In 2017, Samet et al. proposed a system that includes three mobile apps that teachers, students, and parents can download to their smartphones to manage and perform the real-time attendance-taking process. In 2020, Dongmei et al. It was proposed that fingerprints be registered on the classroom teacher's computer; an attendance checking management platform was installed; and attendance data was stored in a database that could be accessed via the server.

Though most of the systems have limitations regarding portability, accessibility, authenticity, and cost, As a result of the effort to solve the insufficiency of the respective systems, a facial recognition system for students and faculty at STI College Calamba has been developed. In the Philippines, some schools' attendance monitoring systems do not use innovative technology. As a result, the developers picked this project to assist the school in gathering student attendance data and informing parents about their children's presence in the school. Teachers are also informed that their students are in the school's vicinity throughout this process. Teachers will also be required to report their attendance to the administration, which will be the same as recording student attendance but without the message to parents. The head office will have a file sent to the computer for the attendance of teachers; that way, the head office will be informed of who's absent from work since the head office checks the attendance of the teachers.

However, this is not the only problem that the researchers want to resolve. Long queues and an unorganized line often result in difficulties or untidy records and appointments. It is also known as "first-come, first-served." The queuing system for the development of a facial recognition system for students and faculty will be fast and efficient. It is not just like the standard queuing system where the customer has to take a number and wait for the number to be called. This device is embedded in the system where the customer will be asked the purpose upon entering the building. The process automatically generates the name on the registrar's monitor. It is up to the registrar to determine who is next in line.

Background of the problem

Regular school attendance is one of the most effective strategies to prepare a child for future success. It is critical to encourage children to attend school regularly since this will improve their performance in school and throughout their lives. Consistent attendance will help a child improve their academics, develop healthy life habits, avoid risky conduct, and increase their chances of graduating from high school. In underprivileged regions, a good education is frequently the foundation for breaking the cycle of poverty (Lacooperativa, 2022).

One of the faculty members stated to know if the student has attended the class, they call everyone one by one using their last name; they put it in the class record to base the grade to be given and also to know who attended and who didn't.

When several children are regularly absent, it can be difficult for teachers to educate the class and develop the aptitude of an individual student. On the other hand, if a teacher is not always attending the class, it would be difficult for the students to improve their intellectuality and keep up with the requisite subjects. Students who do not attend school regularly have a low chance of being involved in a crime that results in an issue in a community. And teachers who are not always present can generate a negative result for the children's future.

Excessive use of paper can be detrimental to the environment due to the consumption of trees that results in the deforestation of nature. According to the data, more than 163 million papers were produced this year. And this increases the risk and expands the problem of paper pollution in the world Worldcounts (2020).

Furthermore, the majority of the schools right now are encountering a drawback with tracking the students' attendance manually. In accordance with the study entitled Manual vs. Automated Attendance System: Comparison, the disadvantages of having a manual advance attendance system are that it can be easily manipulated or fabricated, that there are possible human errors, that inserting the attendance manually can consume a lot of time, and that the data can be outdated and useless if it's old Bajpai (2020).

Attendance is crucial in every company, school, hospital, etc. because attendance can distinguish how diligent and punctual students or employees can be, and it is also parallel with the knowledge improvement of a student that can lead to a high chance of success in life. However, as the population grows inside an infrastructure or building, tracking a person is also getting more arduous, which can result in errors and inaccuracies in the manual attendance record. According to feefo reviews, if an employee is required to write on timesheets, the data that they input is most likely incorrect, and the errors can change a hugely significant amount. Moreover, the attendance system is getting innovated throughout the years by using different kinds of biometrics to make attendance more efficient and convenient which can bolster the productivity of every person who works in the infrastructure. Furthermore, having manual attendance can be time-consuming where students and faculties need to spend time writing sheet papers, it also has a limited functionality where it can only produce basic tracking of attendance, and lastly, it can increase the security risk where an unknown person has a higher chance of entering the school by imitating students and faculty members who work at STI or a student of STI.

Moreover, most parents do not have any idea about their son or daughter's school schedule. The reason for this might be a lack of communication or that the relationships between parents and children are not strong enough. It shows that parents or children have a lack of interest in talking about their schedule and think it is only time-consuming. However, for some parents, this might cause anxiety and nervousness due to safety concerns like bullying, shootings, and accidents. As a result, creating a module that can notify the parents every time their child enters the school can diminish their separation anxiety from their child. According to Moss (2018), notifying parents can help enhance student safety, support parental involvement, and improve communication between parents and teachers.

The article emphasizes the role of technology in facilitating parent notifications and provides examples of how schools are using technology to improve this practice. For example, schools can use automated phone calls, text messages, and mobile apps to notify parents about their child's attendance, grades, and other important information. Furthermore, updating the supervisors about the time entry of the faculty members might also lessen their worry, increase productivity, and help the supervisors hold their team members accountable for their work and ensure that they are meeting their responsibilities.

Furthermore, a lack of security in a school can endanger the lives of students and faculty members. Thoroughly securing the safeness Additionally, an abysmal event happening inside a school can cause trauma, fear, and pain to every student and faculty member. In addition, manual attendance also has a limited ability where it may difficult to detect the potential threats that can lead to problem and chaos inside the school. Furthermore, it also gives a delayed response to security threats, without an efficient method of identifying unauthorized individuals on school grounds, response times to security threats may be delayed, increasing the risk of harm to students and staff.

According to Mabasa (2018), several of schools are increasingly faced with threats to safety, including incidents of violence, kidnapping, and terrorism, and to resolved this problem is implementing installing metal detectors and CCTV cameras on the school.

Overview of the current state of the technology

Currently, the school of STI College Calamba's attendance policy for faculty is tapping their I.D. in the turnstile; if the professor forgot to login, it will count as one minute late. while student attendance is only recorded in the record book. The typical instructor roll call in the classroom is inefficient and may result in the emergence of the "proxy" phenomenon. At the end of the semester, teachers are required to collect students' attendance via a roster, which is inefficient and detrimental to the overall management of students' attendance. Given the issues above and the attendance system requirements of college lecturers, the system must developed a unique attendance management system for college students and faculties based on facial recognition. Through facial recognition, comparison, identification, database building, data transfer, receiving notifications, an alert system, and the design of upper and lower computer interfaces, the system realized complete database storage, transmission, check-in information inquiry, and statistics features. It considerably increased the efficiency of roll call in class, streamlined teachers' workloads, decreased the cost of system development and maintenance, and is easily expandable (Feng, Wang, & Zu, 2020).

The current article suggests an improved attendance-taking procedure that utilizes existing technology infrastructure. A mobile automatic classroom attendance management system based on face recognition has been presented, together with a face recognition infrastructure that enables the usage of intelligent mobile devices. A filtering method for face identification has been created in this area using Euclidean distances determined by three face recognition approaches, namely Eigenfaces, Fisherfaces, and Local Binary Pattern (LBP). Three specific applications are recommended for instructors, students, and parents to install on their cellphones to manage and do real-time polling, data tracking, and reporting. The data is stored on a cloud server and accessible from any location. Web services are a standard method of communication for online systems, and RESTful is an excellent example of a web service optimized for mobile online systems. (Samet & Tanriverdi, 2017).

Objectives of the study

Teachers and parents have struggled to manually track attendance for their child's safety. Also, in terms of safety, inefficient queuing systems can lead to overcrowding and unnecessary contact between customers. To meet the needs of current and future generations, the school requires fast and dependable technology.

General Objectives

The developers goal is to establish a Facial Recognition Attendance System– that base on Facial Recognition with student profile, attendance and queuing system for the user's convenience in terms of time, effort, and increased safety by removing direct contact with undesired objects.

Specific Objectives

1. To recognize the faces of students and faculty members and compare their image or profile to the STI database.

A vital student information system makes student-related data, such as attendance, available in real-time. Registered students and teachers will be identified and visible in the database for access to attendance. The STI does not have enough space in case the student and the faculty enter at the same time. Using facial recognition will reduce the wait in line and also reduce contact with other people.

2. To give notification to the student's parents/guardian and Faculty head on the time of entry of each student and faculty members.

Parental participation offers schools a valuable opportunity to enhance present school programs by involving parents in the educational process. Once the students and faculty have entered their attendance in the system, it will notify the parents and the school's

administration. Increased parental involvement has been linked to improved student achievement, parent and teacher satisfaction, and the school climate.

3. To provide additional safety and security measures for STI facility and people.

The school is one of the places where students and faculty must feel safe. This system ensures that when an unregistered person, like a walk-in inquiry, parents for consultation, students from other schools conducting study, or graduates processing documents, is not recognized, the prototype will alarm. With the help of this security, safety can be maintained inside the school.

Scope and limitations of the study

Scope

Many technologies are now spreading everywhere in the world. Attendance is important because students who attend school regularly are more likely to succeed academically. It is difficult for the teacher and the class to progress if many students are absent frequently.

One of the main features and functions of the prototype is face recognition or face detection, where it can detect whether the person is a known person or an anonymous person. It also adds the function of sending an email to the person's recipient who enters the school. Moreover, the developers also added a feature where it can track the schedule of the student; the purpose of this is to avoid the early exit or cutting of the students and faculties. In addition, the developers also built an app where the school could identify what time a student went in and out. Furthermore, the prototype can also give a warning if the person trying the device is unknown.

Another effective queue management is critical to reducing wait times, enhancing customer satisfaction and building brand loyalty. The developers came up with the Development of Facial Recognition System of Students and Faculty for STI College Calamba with Attendance,

The study's entire system consisted of the following components:

- **Raspberry Pi** – allows to control components for physical computing or explore on IoT.
- **Raspberry Pi Camera V2.1** – this allows to capture real-time visual images and photographs.
- **Linux Operating System** – this will be the main operating system of the device.
- **1024x600 inch LCD Monitor** – to display the user interface of the prototype and see who the camera captures.
- **Memory Card 32GB (Local Server)** – for storing images, script files, sounds and database.
- **Email Notification (Yagmail)** – to send an email automatically to every chosen recipient of students and faculties.
- **Internet Connection** – Sending of email through parents and head will only be successful through the help of internet connection.
- **Push Button Module** – the goal of push button is to enable the time-in and time-out attendance.
- **HDMI Cable** – connections between the raspberry pi and the LCD monitor.
- **Power Supply (5V-3A)** – to match the requirements of the device and give power supply to the microcontroller.
- **Tkinter Python Module** – is a toolkit made by python to create Graphical User Interface (GUIs).
- **MySQL Database** – to store all the data that is needed for elucidating the information of the students and faculties.

- **Person Finder** – a GUI that was made by the developers in order to determine if the person is inside or outside the building.
- **Matplotlib** – to create a graph and chart for the analyzation.
- **OpenCV** – it allows the image to be processed in order to encode the train images that was been stored.
- **Bluetooth Speaker** – to play an audio file whenever the face is known or unknown.

Limitations

Despite the benefits of implementing the device to address the resource deficiency crisis, it does have some disadvantages, including the following: it cannot identify the right person between twins that have an identical facial structure. Furthermore, there may be a complication if a person intends to visit the school due to an unregistered face in the device, which may cause alarm to the prototype. Moreover, according to the Center for Strategic and International Studies (2020), when used in this manner, facial recognition algorithms may attain accuracy rates up to 99.97 percent on the National Institute of Standards and Technology's Facial Recognition Vendor Test. Therefore, there are possibilities that it cannot distinguish or identify if the person is wearing eyeglasses, a face mask, or hats.

- The prototype is having difficulties on identifying between the twins and the people wear face mask or eyeglasses.
- The prototype generates complication of detecting face when the environment is too bright and dark.
- When the prototype is not connected on the internet, the email function won't perform because it requires internet.

LITERATURE REVIEW

Review of related literature, studies or systems

The chapter shows the related studies and literature of the system that may help the researchers in developing the project. The purpose of this is to serve as reference for the developers in terms of developing the Facial Recognition Attendance System.

Introduction and Background of the Study for Online Enrollment System

According to Online enrollment systems have evolved over time, incorporating features such as online payment processing, course selection, and document submission. They offer numerous benefits, including increased efficiency, accuracy, and improved communication between stakeholders. However, challenges such as infrastructure requirements, data security, and accessibility need to be addressed to ensure equitable participation. Previous studies have explored the advantages and challenges of online enrollment systems, but further research is needed to understand their specific context and implications within individual institutions and regions. The study aims to delve deeper into these aspects, examining the objectives, methodology, and findings related to online enrollment systems in a particular institution (Innettutor, 2018).

Overall, online enrollment systems have the potential to transform the enrollment experience, providing a streamlined and accessible process. The study aims to contribute to the existing knowledge in this field and provide valuable insights for institutions considering the implementation of online enrollment systems.

Student's Assessment of the Online Enrollment System

The study assessed students' perspectives and experiences with the online enrollment system in educational institutions. The research employed a quantitative approach, utilizing a survey questionnaire to collect data from a random sample of students. The results indicated that the majority of students found the system to be user-friendly, convenient, and reliable. The availability of clear instructions and intuitive design elements contributed to a positive user experience. Students appreciated the convenience of completing the enrollment process remotely, avoiding queues and paperwork. However, some students reported technical challenges and expressed concerns about data privacy and security. The study suggests that institutions should invest in technical infrastructure and data security measures to address these areas for improvement. Overall, the assessment highlights the positive impact of the online enrollment system while providing valuable insights for enhancing the system's effectiveness and user experience (Mina et al, 2021).

Smart Attendance System using OPENCV based on Facial Recognition

The smart attendance system proposed in this study utilizes OpenCV for facial recognition to automate the attendance-taking process in educational institutions. By leveraging computer vision techniques, the system offers improved efficiency and accuracy compared to manual methods. OpenCV is used for face detection, feature extraction, and recognition, comparing real-time images with a database of registered students' facial images. The system eliminates the need for manual attendance-taking, reduces administrative effort, and provides a reliable electronic record of attendance. However, considerations such as lighting, camera positioning, and privacy regulations need to be addressed for successful implementation. The proposed system has the potential to revolutionize attendance management in educational institutions, benefiting both students and administrators. Further research and testing are recommended to refine the system and overcome any implementation challenges (Bussa et al, 2021).

PCA based Facial Recognition Attendance System

The PCA-based facial recognition attendance system proposed in this study offers an automated and accurate solution for managing attendance in educational institutions. By utilizing Principal Component Analysis (PCA) for feature extraction from facial images, the system achieves reliable identification and verification of students. This eliminates the need for manual attendance-taking, reduces errors, and provides electronic attendance records for easy management and analysis. Considerations such as lighting conditions, image quality, and privacy regulations should be addressed for successful implementation. The proposed system has the potential to streamline attendance processes, improving efficiency and accuracy in educational institutions. Further research and testing are recommended to refine the system and overcome any implementation challenges (Kiran et al, 2020).

CAMS: CVCITC ATTENDANCE MONITORING SYSTEM

According to the Cebu City Vocational School (CVCITC) in the Philippines has implemented an Attendance Monitoring System (AMS) that uses biometric technology to record and track the attendance of students and staff in real-time. The AMS system is designed to improve the accuracy and efficiency of attendance monitoring, reduce administrative workload, and promote punctuality and discipline among students. The document outlines the AMS's features, hardware and software components, user interface, and provides instructions on how to use the system. The biometric recognition system captures unique biological characteristics, such as fingerprints and facial features, to verify a person's identity and record their attendance. The system is intended to streamline the attendance process and make it easier for both staff and students to manage attendance records (Cebu City Vocational School, 2021).

Tempus-A Facial Recognition Technology in Attendance Monitoring

As stated in the article titled "Bridging the Philippine Digital Divide: A Case Study on ICT Accessibility and Utilization in a Rural Community" published in the Philippine Social Science Journal, the study aimed to investigate the accessibility and utilization of Information and Communication Technologies (ICTs) in a rural community in the Philippines. The study revealed that despite the government's efforts to promote ICTs, there are still challenges in terms of access and utilization, particularly in rural areas where infrastructure and resources are limited. The study emphasized the need for government and private sector initiatives to bridge the digital divide and ensure that the benefits of ICTs are accessible to all Filipinos, regardless of their location or socioeconomic status.

This study has important implications for policymakers, researchers, and practitioners interested in promoting the use of ICTs in rural communities in the Philippines. The findings suggest that greater investment in infrastructure and resources is needed to ensure that rural communities have access to the necessary technology and training to effectively utilize ICTs. Additionally, the study highlights the importance of understanding the unique social, economic, and cultural contexts of rural communities when designing and implementing ICT interventions. Overall, this study provides valuable insights into the challenges and opportunities of using ICTs to promote inclusive development and social transformation in the Philippines (Sarmiento, 2019).

Class Attendance Using Face Recognition

As indicated in the article titled "Investigating the Perception and Performance of Students in STEM Education Using Inquiry-Based Learning", the study aimed to investigate the effect of Inquiry-Based Learning (IBL) on the perception and performance of students in STEM education. The study involved conducting an experiment with a sample of 30 high school students, half of whom were taught using traditional methods and half of whom were taught using IBL. The results of the study showed that students who were taught using

IBL had significantly better performance in STEM subjects and a more positive perception of the subject matter compared to those who were taught using traditional methods.

The study has significant implications for educators and policymakers interested in promoting STEM education and improving student outcomes in this field. The findings suggest that IBL can be an effective approach for enhancing student learning and engagement in STEM subjects, particularly for students who may struggle with traditional teaching methods. Additionally, the study highlights the importance of incorporating innovative and evidence-based teaching approaches in STEM education to prepare students for future careers in STEM fields (Aboga, 2019).

Overall, this study provides valuable insights into the potential of IBL to improve student performance and perception in STEM education. As STEM education continues to gain importance in the 21st century, the findings of this study can inform the development of effective pedagogical practices and policies that support student learning and success in STEM fields (Gharehchopogh et al).

Attendance System Based on Face Recognition System Using CNN-PCA Method and Real-time Camera

According to the study "Attendance System Based on Face Recognition System Using CNN-PCA Method and Realt-time Camera "published in the IEEE Xplore digital library, facial recognition technology has become an increasingly popular area of research in recent years. The article provides a comprehensive review of various facial recognition techniques, including traditional methods such as Eigenfaces and Fisherfaces, as well as newer deep learning-based approaches like Convolutional Neural Networks (CNNs). The authors also discuss the various challenges and limitations associated with facial recognition, including privacy concerns and issues related to bias and accuracy. Overall, the article provides a valuable overview of the current state of facial recognition research and the potential future directions for this rapidly evolving field (Bhattacharya et al, 2018).

The proposed system uses facial recognition technology for identifying and tracking students' attendance, which involves capturing a real-time image of the student's face and comparing it with the database of registered student faces. The system is designed to be user-friendly and has the potential to reduce the time spent on manual attendance monitoring. However, some concerns, such as data privacy and security, need to be addressed before implementing such a system. The study concludes that the proposed system could be an effective tool for attendance monitoring in educational institutions, but further research is required to fully evaluate its effectiveness (Dhanush et al, 2020).

Implementing CCTV-Based Attendance Taking Support System Using Deep Face Recognition: A Case Study at FPT Polytechnic College

According to the study published in the journal Symmetry, the authors propose a new method to identify hand gestures using a smart glove with integrated motion sensors. The method uses deep learning algorithms to process the data collected by the sensors and accurately classify the hand movements. The proposed system has the potential to be used in various applications, including virtual reality, gaming, and rehabilitation. The authors conducted experiments to evaluate the performance of the system, and the results showed promising accuracy in recognizing different hand gestures.

Furthermore, the study conducted simulations and experiments to validate the effectiveness of the proposed algorithm. The results showed that the proposed method significantly improves the performance of the standard algorithms and can successfully detect multiple attacks simultaneously. The study suggests that the proposed algorithm can be a useful tool in enhancing the security of wireless sensor networks. The study concluded that the proposed algorithm had a superior performance in solving the optimization problem compared to other existing algorithms. The results showed that the algorithm was able to find the optimal solution within a shorter time frame and with higher accuracy, making it suitable for various engineering applications. (Huang X, 2020).

Synthesis

Based on our comparison of various attendance monitoring systems, our device stands out as a comprehensive attendance system that offers a multitude of additional features for added security and convenience. Compared to other systems that focus solely on attendance monitoring, our system offers a range of functions such as student data management, school record keeping, queuing system, facial recognition, email notifications, alert system, anti-spoofing, and object detection. One study we compared our device to is "An Automated Attendance Management System Using RFID for a University" by Bhat and Thirunavukkarasu (2018). The study focuses on implementing an automated attendance management system in a university setting using RFID technology. While their system is able to accurately track attendance, it lacks the additional features offered by our system, such as facial recognition and object detection. Another study we analyzed is "Wireless Attendance Management System Using ZigBee and RFID" by Muley and Khune (2019). Their system uses both ZigBee and RFID technologies to automate attendance tracking in a classroom setting. While their system does incorporate RFID technology, like the previous study, it also lacks many of the additional features of our system, such as facial recognition and object detection. Our facial recognition feature allows for a more accurate and efficient attendance taking, which can save significant time and effort for schools and universities. The anti-spoofing feature ensures the system's security against fraud attempts, while the object detection feature provides additional security measures by alerting the system administrators in case of any suspicious object in the vicinity. The queuing system is also a unique feature that allows for a more organized and efficient attendance taking process. Overall, our attendance system offers a more sophisticated and comprehensive approach to attendance monitoring, which can greatly benefit schools and educational institutions in terms of security, efficiency, and convenience. With the added features such as facial recognition, object detection, and anti-spoofing, our system provides enhanced security measures to protect students, faculty, and staff. The integration of student data management and school record keeping further streamlines administrative processes, allowing for more efficient use of time and resources. The email notifications and alert system also provide convenient and effective communication channels between

administrators, teachers, and parents. In conclusion, our attendance system offers a more holistic and advanced solution to attendance monitoring, which can greatly benefit educational institutions in a variety of ways.

Table 1. Similarities and Differences

Local Studies and Foreign Studies	Similarities	Differences
Smart Attendance System using OPENCV based on Facial Recognition	Both prototypes used a OpenCV library for image processing. Moreover, it also deals with a complication on camera positioning and privacy regulations.	Data collecting, the developers used MySQL database while the other used csv for the data collection.
PCA based Facial Recognition Attendance System	Reduce the errors on the attendance by eliminating the manual-taking, also addresses the problem about the lightning conditions and image quality for the data.	The study utilized different algorithm and programming language on implementing the face recognition attendance.
CAMS: CVCITC ATTENDANCE MONITORING SYSTEM	Apply a variety of types of attendance systems using biometrics such as facial recognition.	Additional biometrics features which fingerprint, and also provide different software for the manual of the system.
Tempus-A Facial Recognition Technology in Attendance Monitoring	Approving the implementation of facial recognition as an alternative attendance method in educational establishments	The prototyped was implemented on the rural area.

Class Attendance Using Face Recognition	Both of the proposed studies introduce innovative methods for enhancing student productivity by implementing various types of attendance systems.	Used different techniques for executing an alternative attendance system.
Attendance System Based on Face Recognition System Using CNN-PCA Method and Real-time Camera	Both systems use facial recognition to reduce the time consumed for tracking the attendance system. I also used an image as data to compare the faces to the real-time image of the students faces.	The system employed different type of algorithm such as Eigenfaces and FisherFaces that is based on the Convolutional Neural Networks. While the developers of this study only used hog algorithm.

Based on our comparison of various attendance monitoring systems, our device stands out as a comprehensive attendance system that offers a multitude of additional features for added security and convenience. Compared to other systems that focus solely on attendance monitoring, our system offers a range of functions such as student data management, school record keeping, queuing system, facial recognition, email notifications, alert system, anti-spoofing, and object detection. One study we compared our device to is "An Automated Attendance Management System Using RFID for a University" by Bhat and Thirunavukkarasu (2018). The study focuses on implementing an automated attendance management system in a university setting using RFID technology. While their system is able to accurately track attendance, it lacks the additional features offered by our system, such as facial recognition and object detection. Another study we analyzed is "Wireless Attendance Management System Using ZigBee and RFID" by Muley and Khune (2019). Their system uses both ZigBee and RFID technologies to automate attendance tracking in a classroom setting. While their system does incorporate RFID technology, like the previous study, it also lacks many of the additional features of our system, such as facial recognition and object detection.

Our facial recognition feature allows for a more accurate and efficient attendance taking, which can save significant time and effort for schools and universities. The anti-spoofing feature ensures the system's security against fraud attempts, while the object detection feature provides additional security measures by alerting the system administrators in case of any suspicious object in the vicinity.

The queuing system is also a unique feature that allows for a more organized and efficient attendance taking process. Overall, our attendance system offers a more sophisticated and comprehensive approach to attendance monitoring, which can greatly benefit schools and educational institutions in terms of security, efficiency, and convenience. With the added features such as facial recognition, object detection, and anti-spoofing, our system provides enhanced security measures to protect students, faculty, and staff. The integration of student data management and school record keeping further streamlines administrative processes, allowing for more efficient use of time and resources. The email notifications and alert system also provide convenient and effective communication channels between administrators, teachers, and parents. In conclusion, our attendance system offers a more holistic and advanced solution to attendance monitoring, which can greatly benefit educational institutions in a variety of ways.

Table 2. Benchmarking

Features	Smart Attendance System using OPENCV based on Facial Recognition	PCA based Facial Recognition Attendance System	CAMS: CVCITC ATTENDANCE MONITORING SYSTEM	Tempus-A Facial Recognition Technology in Attendance Monitoring	Class Attendance Using Face Recognition	Attendance System Based on Face Recognition System Using CNN-PCA Method and Real-time Camera	Implementing CCTV-Based Attendance Taking Support System Using Deep Face Recognition: A Case Study at FPT Polytechnic College	FACIAL RECOGNITION SYSTEM OF STUDENTS AND FACULTY FOR STI COLLEGE CALAMBA
Log-in	✓	✓	✓	✓	✓	✓		✓
Student Data	✓	✓	✓			✓		
School Record	✓	✓	✓	✓	✓	✓		✓
Queuing			✓	✓	✓			
Facial Recognition	✓	✓	✓	✓	✓	✓	✓	✓
Anti-Spoofing	✓							✓
Object Detection	✓						✓	✓
Convolutional Neural Network						✓	✓	
Email Notification								✓

Conceptual Framework

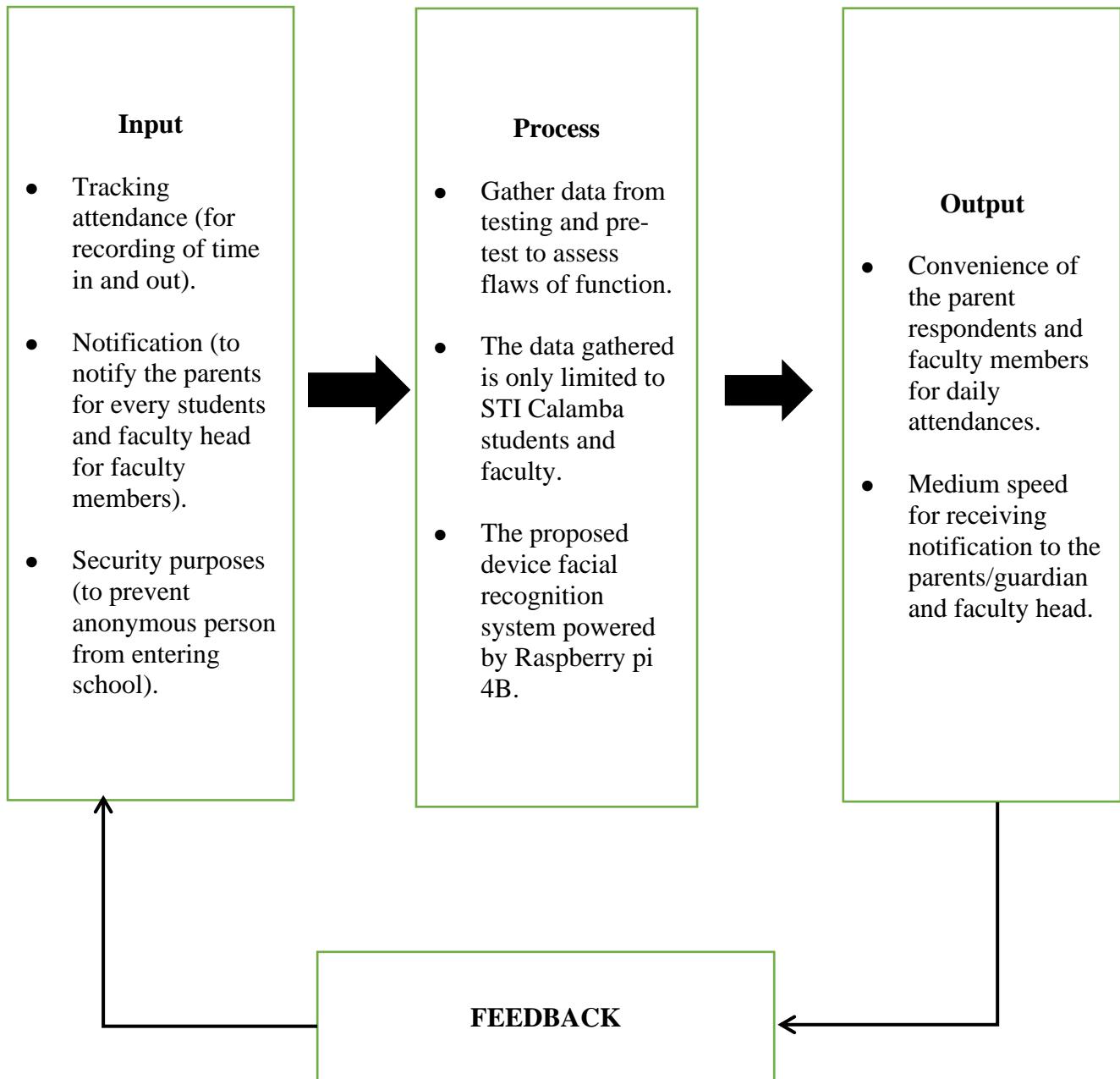


Figure 1. Conceptual Framework

FACIAL RECOGNITION SYSTEM OF STUDENTS AND FACULTY FOR STI COLLEGE CALAMBA

Overview of the project

According to the stated goals, the developers are required to unquestionably follow the framework of activities that was based on the problems that were identified. Through testing, examination, and evaluation that can aid in the development of an original solution to a problem in the modern world, the developers integrated the concept and areas of various research as well as to result in the development of the device. It was ensured that the software and all of the hardware were included in the system project. The project's capacity to use a Raspberry Pi 4 camera to take pictures of people and send emails to both parents/guardians and the faculty head will allow it to accomplish the above-mentioned general and particular goals.

Methodology

The waterfall model is one of the simplest and easiest to understand. In a waterfall model, the process or flow of the subsequent development will be accomplished by finishing the first stage before the next, just to ensure that there will be as few defects as possible. The developers used the waterfall method to establish a constructive and organized plan to prevent a misleading and ambiguous implementation of all components and libraries that will be employed on the prototype. Furthermore, the waterfall method will also assist the developers in distinguishing all of the negative and positive outcomes that will occur in each phase. The waterfall method will consist of planning, design, implementation, testing, optimization, and deployment. These must be followed in a sequential order; if not, this will result in a higher chance of failure on the prototype system.

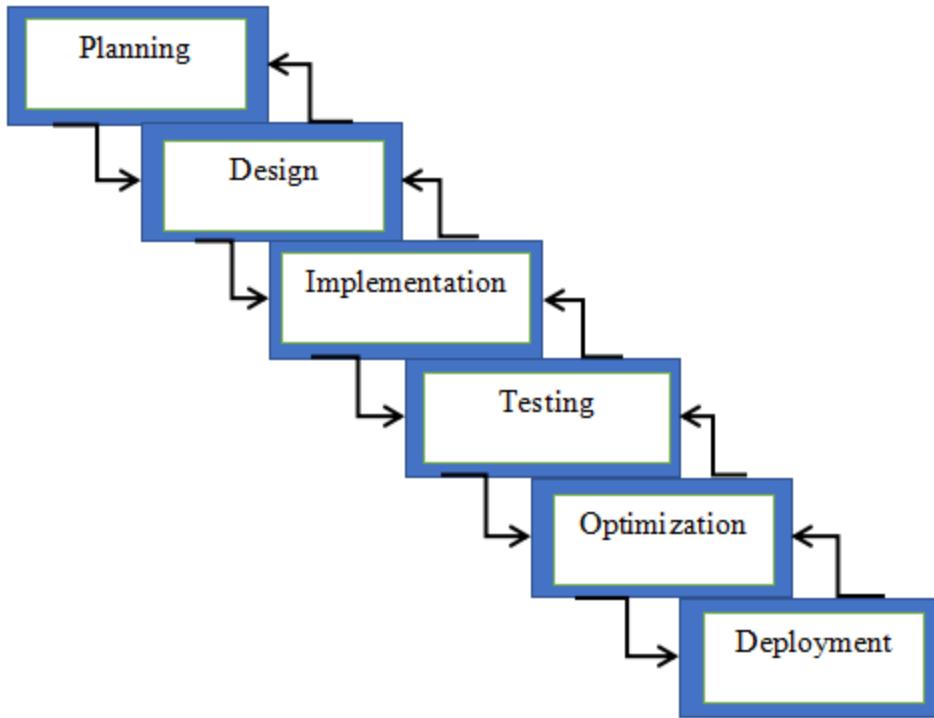


Figure 2. Modified Waterfall Model

Planning Phase

The first step is gathering all the ideas and planning all the functions that will be applied to the prototype. Moreover, this phase will also help to ponder more innovations that will be installed on the system and prototype. Here, it is indicating the specifications of the input and output, or the final product, are studied and marked. During this phase, the developers first strategize what materials will be needed for the software and the hardware of the prototype. Moreover, all of the prospective software to be used, like the IDE, database, programming language, etc., was proposed during this phase.

Design Phase

The specifications of the requirement and the preparation of the system are going to be in this phase. The phase will help to specify the most efficient components and system requirements to utilize on the prototype. The developers construct various kinds of charts

and diagrams in order to initiate the implementation of all functions and operations that will be placed on the prototype system.

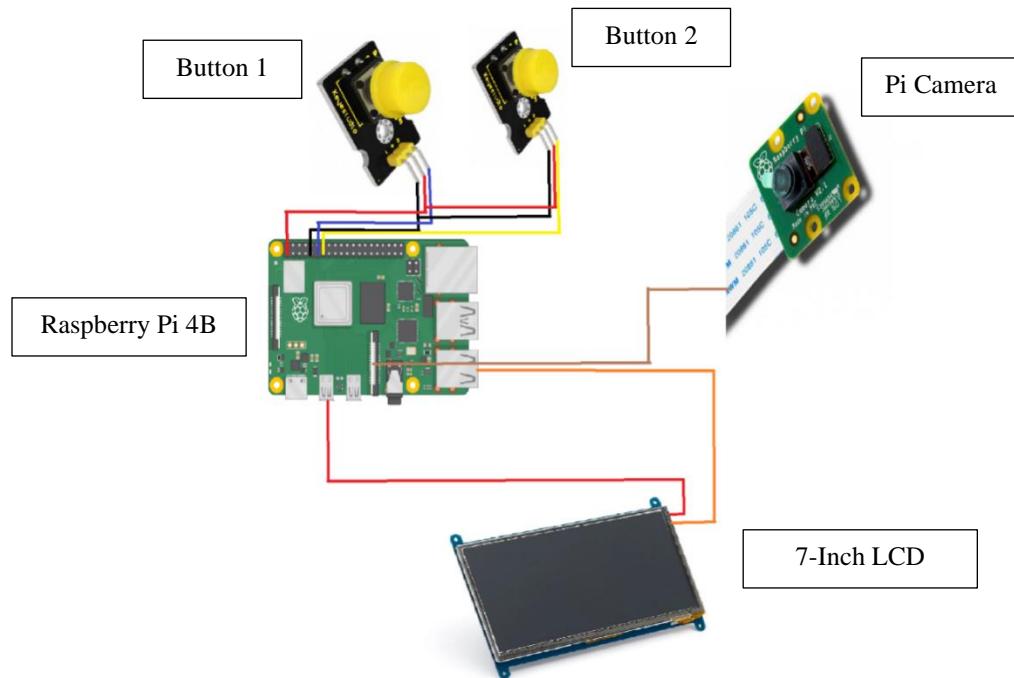
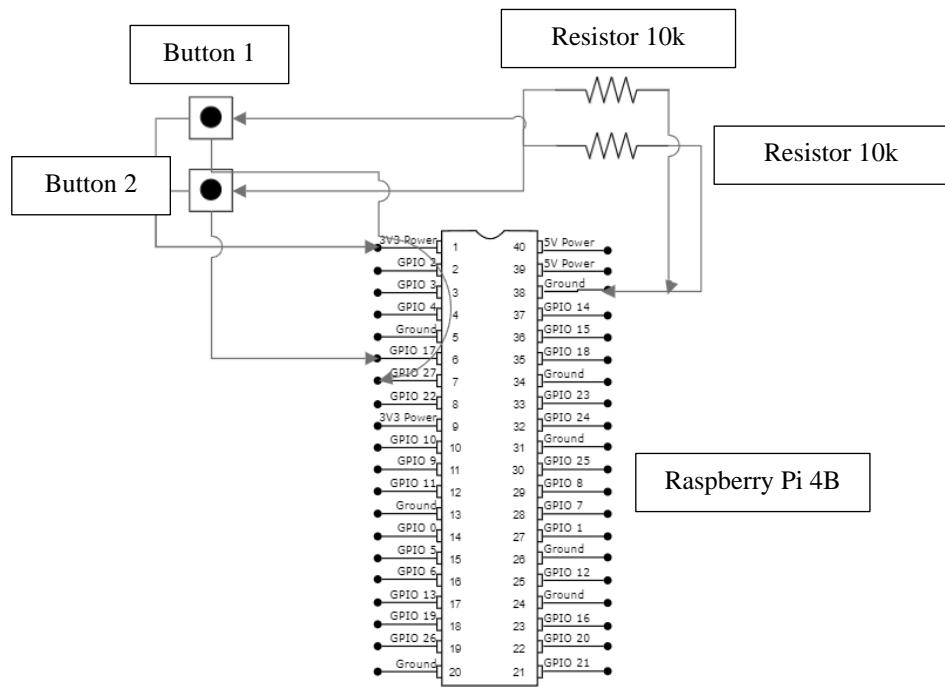


Figure 3. Schematic Diagram



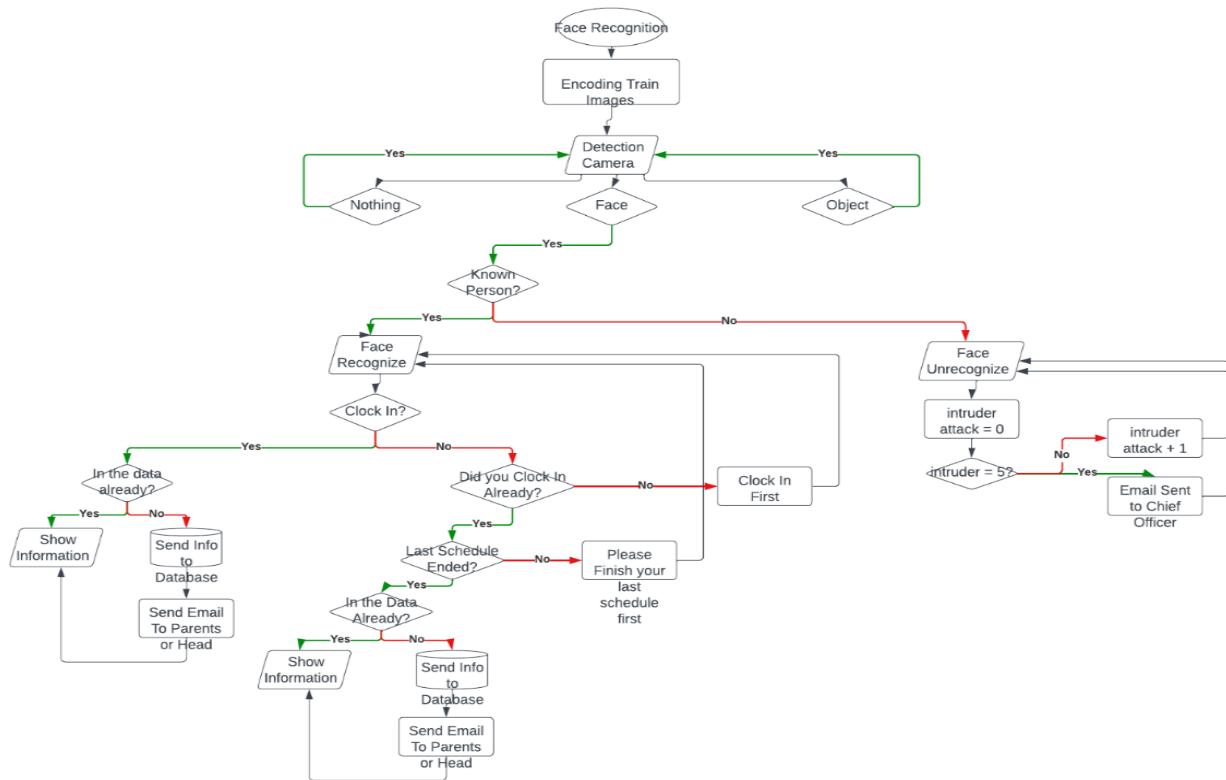


Figure 4. Flow Chart

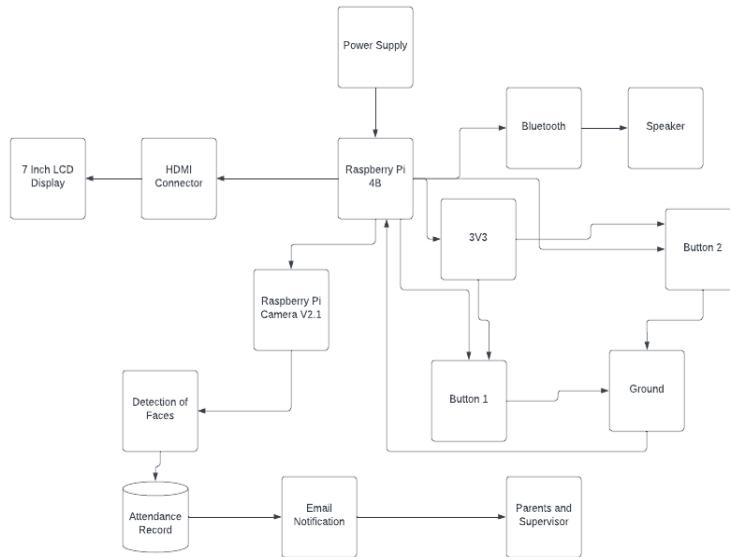


Figure 5. Block Diagram

Implementation Phase

The system is first developed on an algorithm called image processing, this can be implemented through the help of libraries and packages, which the developers will integrate in the next phase. Each unit is developed and tested for its functionality and performance based on how accurate the detection and how faster the system will perform. Moreover, the notion of the flowchart was been executed in this phase. Furthermore, the addition of other features will also be applied on this phase like creating its own database, email sending and etc.

Testing Phase

All of the units are developed in the implementation phase and will be examined in the testing phase. It is significant for the developers to constantly test the software and hardware of the prototype in order to find out if there are going to be any flaws, errors, or weaknesses that will affect the performance of the system and prototype. Same with the algorithm; it will be constantly tested to see if it is compatible with the microcontroller. To finalize the testing phase successfully, the developers used statistical analysis to determine the performance and capabilities of the prototype. It is also tested in different environments to determine the maximum accuracy of the device. Furthermore, the developers also conducted research based on data privacy since the prototype will capture images of students and faculty.

Optimization Phase

The phase will involve modifications and alterations in the system and to every individual component that can expand attributes and improve performance of the prototype. The purpose of this phase is to reconstruct and enhance system if there is any deficiencies and weak points that was found after doing the testing phase. use of the system and can be improve in the future.

Deployment Phase

When the functional and non-functional aspects of the system are culminated and the performance is optimized and configured thoroughly, the developed prototype will be ready to be deployed for the students and faculties.

System Design Specification

Hardware

Raspberry Pi 4B



Figure 6. Raspberry Pi 4B

Raspberry Pi 4 is one of the most common microcontrollers that is used to employ in different kind of projects like home automation, hardware projects, implement Kubernetes and edge computing. The pi is even use in industrial application (RBPI2018). The developers utilized raspberry pi as the brain of the prototype because the microcontroller can handle image processing along with a complex algorithm for the system. The inputs and outputs of the final product will be inserted in this component.

Table 3. Microcontroller

CPU	Quad-Core Broadcom BCM2711BO1.15GHz (Cortex A-72)
Memory	1-4GB DDR4
GPU	500MHz VideoCore VI
Video output	Dual Micro HDMI ports
Maximum resolution	4k 60Hz + 1080p or 2x 4k 30Hz
Multimedia	H.265 decode (4kp60) H.264 decode (1080p60) H.264 encode (1080p30) OpenGL ES 1.1, 2.0, 3.0 graphics
UBS port	2x USB 3.0/ 2x USB 2.0
Wired network	True Gigabit Ethernet

Wireless network	802.11ac (2.45GHz), Bluetooth 5.0BLE
Charging port	USB Type-C
Electricity demand	3A, 5V
Size	3.5x 2.3x 0.76 inches (88x 58x19.5mm)
Weight	0.1 lb (46g)

Pi Camera V2



Figure 7. Pi Camera V2

The Raspberry Pi Camera Module V2 is a high-quality 8-megapixel Sony IMX219 image sensor custom designed as an add-on board for the Raspberry Pi. It connects to the Raspberry Pi board through the Camera Serial Interface (CSI) connector, which provides a high-speed link between the camera and the processor. The developers will install this on the prototype as a sensor or eye of the device. The purpose of the Pi Camera V2 is to help the system to detect faces and identify people between known and unknown.

Table 4. Pi Camera V2 Specification

Image sensor	Sony IMX219
Sensor resolution	8 megapixels
Lens	Fixed focus
Lens aperture	F/2.0
Field of View(FOV)	62.2 degrees diagonal
Video	1080p30, 720p60 and 640x480p60/90
Dimensions	25mm x 24mm x 9mm
Weight	3g

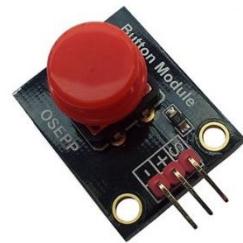
7-inch Raspberry Pi LCD Monitor**Figure 8. 7-inch Raspberry Pi LCD Monitor**

The 7-inch Raspberry Pi LCD monitor is a display device designed specifically for use with Raspberry Pi boards. It is a touchscreen display with a resolution of 800 x 480 pixels and is compatible with Raspberry Pi 2, 3, 4, and Zero models. The monitor connects to the Raspberry Pi board through the board's Display Serial Interface (DSI) connector and requires no additional power supply as it is powered directly from the Raspberry Pi board. The monitor also features a built-in driver board, making it easy to connect to your Raspberry Pi project. The goal of the LCD monitor is to display the UI of the proposed prototype; this will also elucidate the information of the person who is using the device for thorough confirmation if the student is included in the data. By applying the LCD, the prototype will be more user-friendly.

Table 5. 7-inch Raspberry Pi LCD monitor Specification

Resolution	800 x 480 pixels
Displays Technology	TFT LCD
Screen Size	7 inches
Aspect Ratio	16:9
Interface	HDMI
Viewing Angle	170 degrees
Brightness	300 cd/m ²
Contrast Ratio	800:1

Button Module

**Figure 9. Button Module**

A push-button module is a hardware component commonly used in electronic circuits and microcontroller-based projects to provide a momentary switching action. It is a type of button or switch that requires physical pressure to be applied in order to change its state and typically springs back to its original position when released. It is applied to the hardware of the prototype to initiate the time in and time out of faculty members and students. This will trigger the execution of time attendance, and it will also determine whether a student will only enter the school or go out of school.

Software

Python



Figure 10. Python

Python is a dynamically semantic, interpreted, object-oriented high-level programming language. Its high-level built-in data structures, together with dynamic typing and dynamic binding, make it ideal for rapid application development and as a scripting or glue language for connecting existing components. Python's concise, easy-to-learn syntax promotes readability, which lowers software maintenance costs. The developers used Python as their programming language due to its easy access to machine learning and image processing. Python has tons of libraries for machine learning, like Scikit-learn, TensorFlow, and PyTorch. Thus, by implementing this programming language, it will be facile for the developers to create a model and face recognition algorithm for the prototype.

Microsoft Excel



Figure 11. Microsoft Excel

Microsoft Excel is a Microsoft spreadsheet tool that is part of the Office product group for business applications. All of the data that was collected throughout the day will be stored in CSV format, so using Microsoft Excel can help the user make the data more eligible.

Open CV



Figure 12. Open CV

OpenCV (Open-Source Computer Vision Library) is a free software library for computer vision and machine learning. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses

to utilize and modify the code. This is where the image processing and prototype vision will be contrived. OpenCV provides functions including resizing, filtering, cropping, and color space conversions. Therefore, the developers used this library for converting the image from BGR to RGB, and it was also utilized for cropping the image and resizing it.

Cmake



Figure 13. Cmake

CMake is a cross-platform open-source build system that helps automate the build process for software projects. It is designed to support multiple platforms, compilers, and operating systems, making it an excellent choice for developers working on multi-platform projects. Dlib won't start unless CMake is installed on the operating system, and Dlib is the main package of the prototype.

MySQL



Figure 14. MySQL

MySQL is compatible with multiple operating systems and programming languages, making it a popular choice for developers building web applications. It uses the Structured Query Language (SQL) to manage data in relational databases. MySQL will be the database of the prototype; it will contain all of the information about students that will be used for the GUI and tracking of attendance.

Thonny

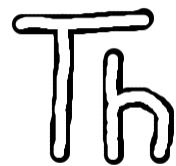


Figure 15. Thonny

Thonny has a simple and user-friendly interface that makes it easy for beginners to write and debug Python code. This will be used as the main IDE of the lead programmer. The developers chose this IDE because it is simple and convenient. Furthermore, all of the written programs, packages, class, functions, and libraries will be saved in this IDE.

RESULTS AND DISCUSSIONS

Introduction

The chapter will include a variety of statistical data treatment and graphs that will be used to assess the overall data. The data set will be completely organized using a data frame to make the analysis more efficient and perfect. The developers use systematic random sampling to collect all of the essential data in order to specify the stability and accuracy of the prototype, with the assistance of several tests by applying Raspberry Pi Camera v2.1 on identifying faces, the device provides a variety of outcomes. In addition, the developers used basic random sampling in conducting a poll (pre-survey) to ascertain respondents' thoughts regarding the anticipated prototype. The data will be extremely useful in determining all of the system's mistakes, defects, and inadequacies, the developers will promptly enhance and eliminate all the vulnerabilities if the data result is erroneous. Furthermore, this will assist the researchers in drawing conclusions about the system's performance, accuracy, and speed. It will also help the developers in writing recommendations regarding the prototype's innovation and enhancement for future researchers.

Accuracy Analysis

The developers employed several formulae (Mean, percentile, Confidence Interval, etc.) and tools such as Pandas and Seaborn to examine, evaluate, and create graphs based on the data collected for the Facial Recognition System.

Table 6. Tolerance Points

Tolerance_Points	Name	Test No.
0	0.526238	Alliza
1	0.368889	Alliza
2	0.355839	Alliza
3	0.371930	Alliza
4	0.363064	Alliza
...
895	0.403427	Tricia
896	0.367085	Tricia
897	0.355241	Tricia
898	0.368151	Tricia
899	0.388637	Tricia

900 rows × 3 columns

The tables above displays the tolerance points of each test participant acquired by the developers. The developers gathered 30 sample students from STI Calamba and a 30 tolerance points for each student. The tolerance points define how accurate the recognition will be; lower tolerance points indicate more accuracy, while higher tolerance points indicate less accuracy.

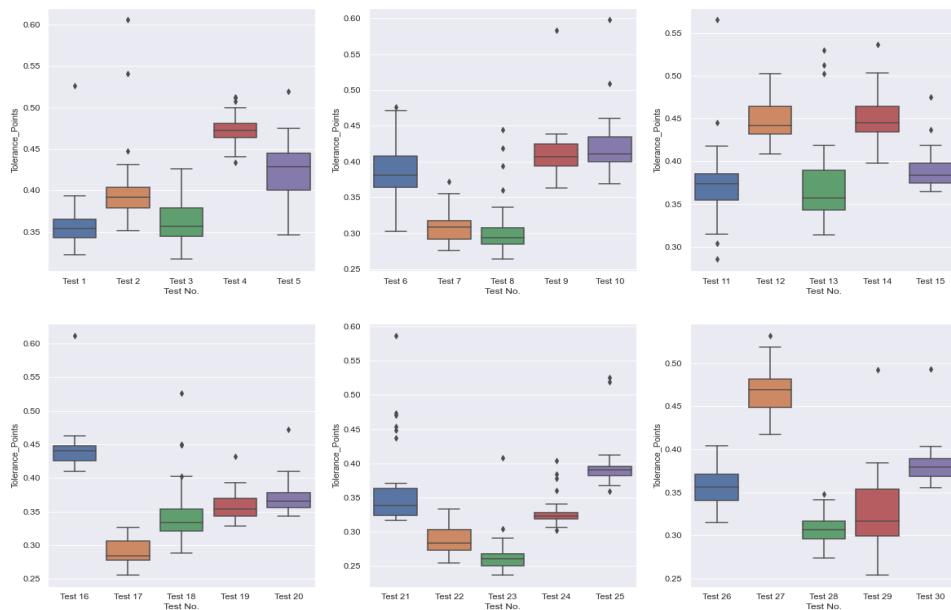


Figure 16. Identifying the Median of Each Samples

$$= \frac{(\frac{n}{2})^{\text{th}} + (\frac{n}{2} + 1)^{\text{th}}}{2}$$

Where N = Total number of Data Set

th = Position of two values

The boxplot graph is used to illustrate the median tolerance points of each individual sample. In the figure above several samples produced a normal boxplot result. This type of result may be seen in Test 1, Test 2, Test 9, Test 15, Test 20, Test 24, Test 26, Test 28, and Test 30; however, practically all of the samples were not mention are left and right skewed, indicating that the line inside the box is not exactly centered. Furthermore, some of the test subject also furnish outliers on their dataset values. Outliers defined as the value is located far away from values of in the dataset, and it can result measurement errors and data entry errors. For Instance, Test 1, Test 3, Test 13. Test 17, Test 22, Test 26 and Test 29 don't have any outliers while the other sample subjects that are not been stated provide outliers.

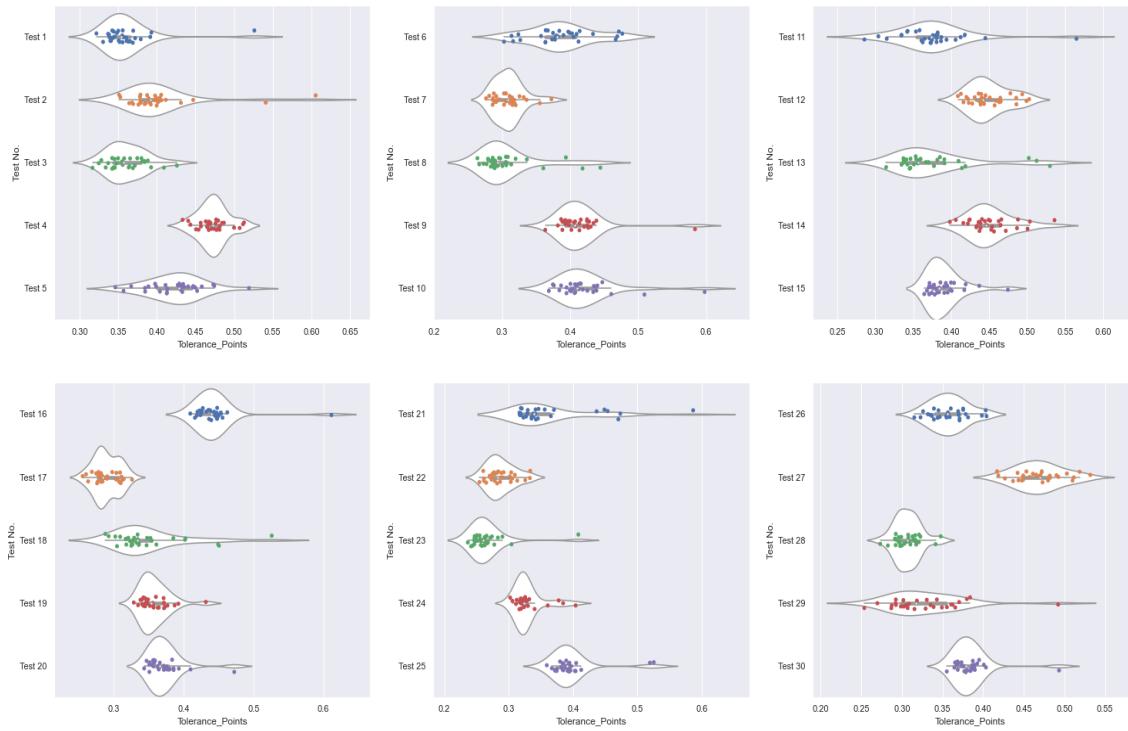


Figure 17. Determining the density and dispersion of each sample

The density and dispersion of each individual sample are depicted in the figure above. The wider the violin plot, the denser the dataset values; conversely, the thinner the violin plot, the less dense it will be. For example, test 1 data points are ranging from 0.35 to 0.40; therefore, the results on the plot show an expand violin plot between 0.35 and - .40 since practically all of the data points are within the range. The graph also shows the outliers for each individual sample.

Table 7. Tolerance Points Average

Test No.	Tolerance_Points			mean
0	Test 1	0.359852		
1	Test 2	0.402543		
2	Test 3	0.360837		
3	Test 4	0.472783		
4	Test 5	0.423032		
5	Test 6	0.386629		
6	Test 7	0.308815		
7	Test 8	0.307466		
8	Test 9	0.412511		
9	Test 10	0.420471		
10	Test 11	0.374812		
11	Test 12	0.449009		
12	Test 13	0.376677		
13	Test 14	0.450642		
14	Test 15	0.389941		
15	Test 16	0.443119		
16	Test 17	0.289256		
17	Test 18	0.348851		
18	Test 19	0.357556		
19	Test 20	0.371240		
20	Test 21	0.363340		
21	Test 22	0.287321		
22	Test 23	0.265489		
23	Test 24	0.329274		
24	Test 25	0.396570		
25	Test 26	0.357765		
26	Test 27	0.468538		
27	Test 28	0.306661		
28	Test 29	0.327860		
29	Test 30	0.382988		
			Tolerance_Points	0.373062

$$X_{\text{average}} = \frac{\sum X_i}{n}$$

Where = The value of data points

n = Total number of data set

The table above displays the average of each test subject's tolerance points. The computation was performed by taking the average of the 30 tolerance points that was collected on each sample. The developers will distinguish who are the sample's subject that is below and above the total estimated average. The total estimated average can be calculated by taking the averages of each tolerance point listed above.

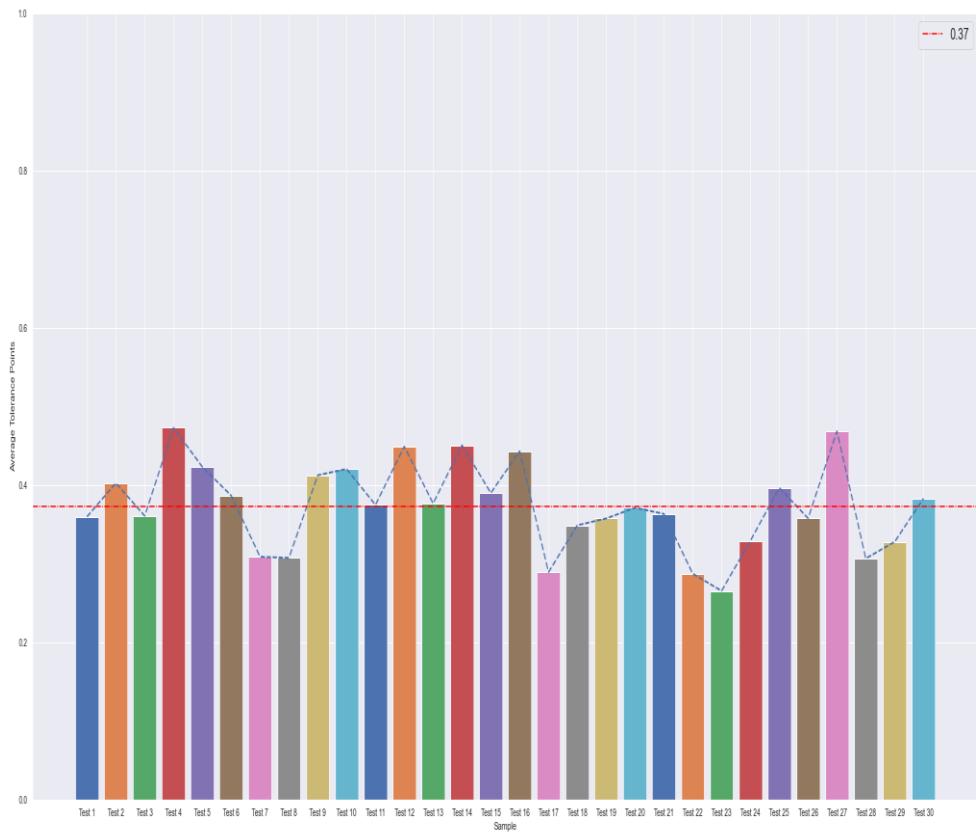


Figure 18. Average of each test sample

The graph above depicts the average amount of each sample subject data points using a bar plot. A bar plot is a graphical depiction of data that uses bars of varied heights or lengths to illustrate the frequency or value of a categorical variable. The height of the bar plot represents the average, while the length represents the sample. The bars are usually organized along the x-axis, with the y-axis showing the data's frequency or value. The horizontal red line represents the projected overall average, which is equal to 0.37; this was derived by averaging the averages of each individual sample. 11 of the sample participants acquire a greater average than the overall estimated average, while 19 had an average that was lower than the overall estimated average. Moreover, the blue line represents the average of each sample.

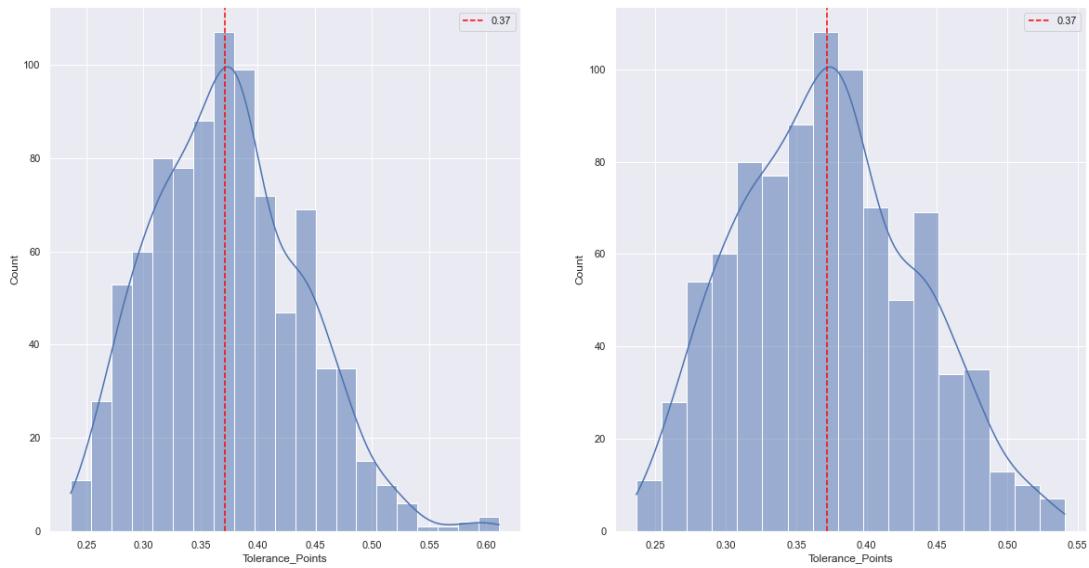


Figure 19. the density of all the number of tolerance points

The developers utilize a histogram to assess and evaluate how dense the tolerance points will be. A histogram is a graphical representation of data distribution that use bars of varied heights to display the frequency or proportion of data that falls within specific numerical ranges. The graph also includes a KDE plot to help denser the denser tolerance points interval. The left graph contains outliers, while the researchers use a formula to eliminate the outliers that is visible on the right graph.

$$\text{Lower fence} = q1 - (1.5 \times IQR)$$

$$IQR = q3 - q1$$

$$\text{Higher fence} = q3 + (1.5 \times IQR)$$

Where $q1 = 25\%$ of the data

$q3 = 75\%$ of the data

Table 8. Removing Outliers

Furthermore, the bell curve on the KDE plot is shown on the graph above. Therefore, the developers use confidence interval to determine the range of a specific percentage.

$$\sigma = \sqrt{\frac{\sum(X_i - \mu)^2}{N-1}} \quad \mu = \frac{\sum X_i}{n}$$

$$\text{Low Confidence Interval} = \mu - \frac{z_a}{2} \times \left(\frac{\sigma}{\sqrt{n}}\right),$$

$$\text{High Confidence Interval} = \mu + \frac{z_a}{2} \times \left(\frac{\sigma}{\sqrt{n}}\right)$$

Where N or n = Total Number of data

μ = Average of data

σ = Sample Standard Deviation

$\frac{z_a}{2} = 1.96$

Table 9. Mean, Standard Deviation and Standard Error

	Mean	Standard Deviation	Standard Error
Estimation	0.187	0.0552	0.55

The table shows the final estimation of the mean, standard deviation, and standard error. Furthermore, the developers use Z-test table since the number of total samples is equal to 30 and also the developers employ 95% confidence level or 0.05 beta, which are the most typically used on statistic. As a result, the final standard error calculation is 0.01005.

	Low Confidence Interval	High Confidence Interval
Estimation	0.353	0.393

Figure 20. Confidence Interval

With a 95% confidence level, the tolerance points of the data on low confidence interval is equivalent to 0.353 while the calculation for high confidence interval is equivalent to 0.393.

Furthermore, the developers also used sampling distribution to check if the results on the table above are precise or will be equal to the given result of confidence interval.

$$\text{Sampling Distribution} = \frac{X - \mu_x}{\frac{\sigma}{\sqrt{n}}}$$

Where $X = 0.40$

$\mu_x =$

Average of the dataset

$$\frac{\sigma}{\sqrt{n}} = \text{Standard Error}$$

After estimating the sample distribution of the data. The result gave a z-score of 2.67 or a p-value which is equal to 0.9962. The result represents that 99.62% of the tolerance points are less than 0.40. Therefore, the developers conclude the accuracy of the face recognition is at a maximum of 99.62%. However, it's is not fully proven yet since the evaluation of testing will begin on the next evaluation.

Testing Evaluation

The testing assessment will include a study of the prototype's performance and accuracy. The developers employed several types of statistical analysis to assess how quick the recognition might be. Furthermore, in this paragraph, the proponents gather 51 students for test data to ensure that the prototype's operation is flawless.

	True Negative	False Positive
Result	21	0

Figure 21. Result of testing 0.1

The table above displays the true negative and false positive results after the testing was completed by the developers. True Negative refers to a scenario in which a model properly predicts that a sample belongs to a certain class even though it does not, whereas false positive refers to a situation in which a model mistakenly predicts that a sample belongs to a particular class even when it does not. The developers collect 21 samples that are not included in the data to see if the system successfully unrecognized the 21 unknown samples, which would result in a true negative; conversely, if the system recognizes the unknowns, the number of false positives will increase

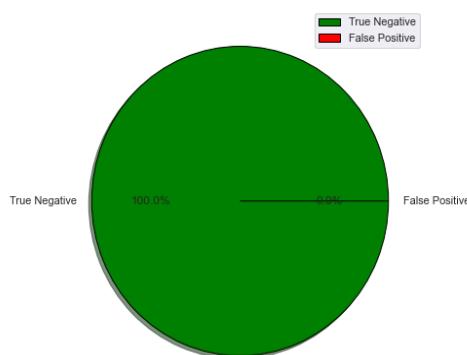


Figure 22. Percentage of True Negative and False Positive

The graph above illustrates the overall proportion of true negatives and false positives derived from test results. The test resulted with a perfect score of 21/21 (100%) on the true negative and 0/21 (0%) on the false positive with a tolerance of 0.40. As a result, the developers conclude that the system is fully capable of identifying unknown persons.

	True Positive	False Negative	Accuracy Score
Result	29	1	29

Figure 23. Result of Testing 0.2

Furthermore, the table above shows the true positive, false negative, and accuracy score of the gathered results after doing the testing. The developers gathered 30 sample students for the test. True positive refers to a circumstance in which a model accurately predicts that a sample belongs to a specific class when it really does, whereas false negative refers to an event in which a model mistakenly predicts that a sample does not belong to a specific class even though it really does. Furthermore, the accuracy score indicates the precision in detecting a specific person; the accuracy score will increase if the system correctly recognizes the sample with the provision of valid information, however the accuracy score will decrease if the sample is recognized by the system but provides invalid information about the test subject.

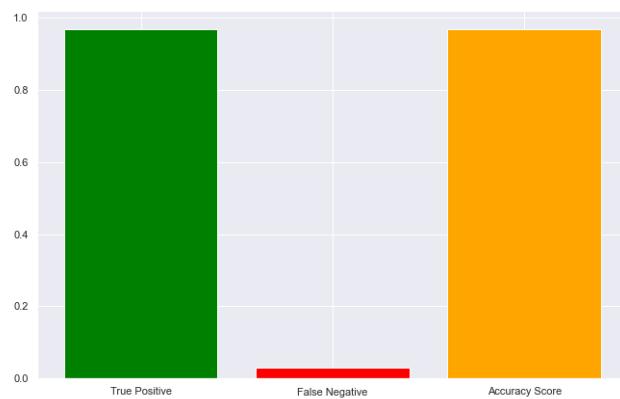


Figure 24. Overall percentage of true positive, false negative, and accuracy score

The graph in the table above conveys the total percentage of the results. Explaining the figure above, true positive obtained a score of 29/30 (97%) means that the system perfectly recognized the test subject who is actually in the data, yet the system produced an error on recognizing a known individual with a score of 1/30 (3%), indicating that one test subject did not get detected by the system even though the test subject is actually in the data. Therefore, the accuracy score decreases by 1 with a total percentage of 97% since one test subject failed to be recognized by the system.

In conclusion, the testing yielded a result of 100% accuracy in detecting the unknown individual or person who is not actually part of the class and a 97% accuracy in recognizing the known individual or person who is a member of the class. Furthermore, the recognition accuracy scored up to 97%, which is approximately close to the sample distribution result, which is equal to 99.62%; hence, the difference between the final testing result and the sample distribution is 2.62%.

Performance Analysis

Analysis

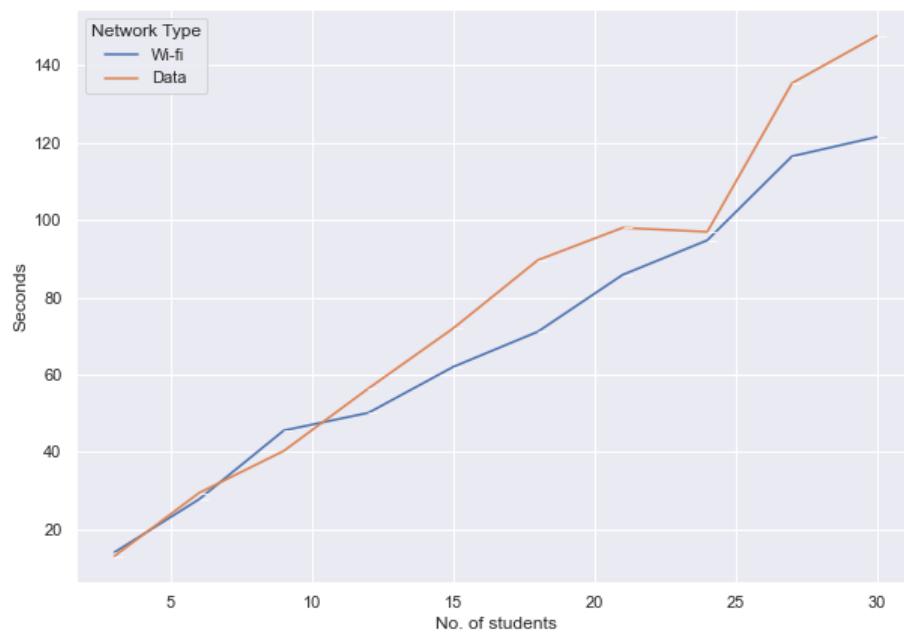
This analysis will cover about the quickness of the prototype and how fast it can recognize a group of individuals. The developers used a line plot to compare the speed of data connections and wi-fi connections, since the two networks can be utilized for sending emails.

Table 10. Performance Data

No. of students	Seconds
0	14.00
1	27.73
2	45.54
3	50.12
4	62.00
5	71.11
6	85.82
7	94.76
8	116.50
9	121.49

No. of students	Seconds
0	13.00
1	29.39
2	40.25
3	56.43
4	71.97
5	89.63
6	98.00
7	96.95
8	135.41
9	147.63

The table above represents two columns, which are the number of students and seconds. No. of Students is a group of individual persons, while seconds indicates how long it took the prototype to send an email and recognize the group of individuals.

**Figure 25. Distinction of speed between Wi-fi and Data**

The graph above depicts the difference in speed between the two networks. The data connection takes more seconds to recognize a group of people; however, the Wi-Fi network is faster on detecting a group of people. The data shows that it will take 121.49 seconds or 2.02 minutes to detect 30 people while using a wi-fi connection, whereas a data connection will yield a longer result of 147.63 seconds or 2.46 minutes for detecting 30 people. Therefore, wi-fi is more efficient to use on the prototype since it takes less time to send an email and recognize a person however this will still depend on the network latency of the Wi-fi.

Prediction

This content will provide the prediction of the developers on how long it will take to detect a group of people given by a specific number of individuals. The developers used simple linear regression in their model since the data only has one independent variable, which is the number of students, and one dependent variable, which is the seconds.

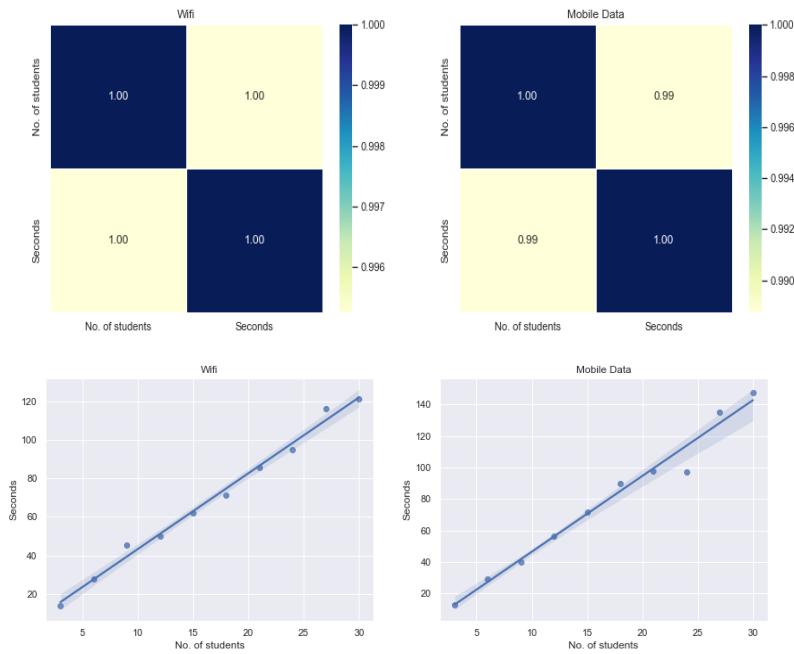


Figure 26. Correlation of the independent variable

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n\Sigma x^2 - (\Sigma x)^2} \times \sqrt{n\Sigma y^2 - (\Sigma y)^2}}$$

Where n= The length of data

Σxy = the sum of $(x * y)$

Σx^2 = the sum of x – squared

Σy^2 = the sum of y – squared

Σx = the sum of x

Σy = the sum of y

The graphs above depict the correlation between the dependent and independent variables. In accordance with the wi-fi dataset, it shows a perfect 1 correlation that defines a strong correlation. It also indicates as the number of people increases, so does the time it takes to recognize them, in addition the data connection graph shows a 0.99 correlation, which is near to the correlation of wi-fi data.

In order to predict the outcome of a specific number, the developers need to use the simple linear regression formula:

$$y = \beta_0 + \beta_1 X$$

Where:

β_0 = is the intercept, is the predicted value of y when x is 0

β_1 = is the regression coefficient – The expectations of changing y as the x increases

X = is the given independent variable

The developers first calculate the r in order to find the best fit line on the model. More specifically, r is the slope coefficient in simple linear regression that represents the change in the response variable for every one-unit increase in the predictor variable. It is calculated by multiplying the r to standard deviation of y divided by standard deviation of x . The next process is to obtain the value of β_0 , β_0 is the estimate of the population parameter that represents the true value of the response variable when the predictor variable is zero. It is the point where the regression line intersects the y -axis, this can be calculated by subtracting the dependent variable from β_1 where it is multiplied by the mean of independent variable.

Table 11. Result from Wi-Fi and Data Connection

	Regression coefficient	Intercept Value		Regression coefficient	Intercept Value
Result from Wi-fi data	3.94	0.17	Result from Data connection	4.81	-1.46

The table above shows the regression coefficient and the intercept value of the two data sets. The final calculation of the regression coefficient in the wi-fi data set is equal to 3.94, while the result of the regression coefficient in the data dataset is equal to 4.81. Moreover, the intercept value gives a lower value; the output on the wi-fi dataset is 0.17, while the result on the data dataset gave a negative number that is equal to -1.46.

Table 12. Final Computation of RSS and TSS

No. of students	Seconds	Prediction	Squared Error w/ Line	Squared Error Mean	No. of students	Seconds	Prediction	Squared Error w/ Line	Squared Error Mean		
0	3	14.00	11.99	4.0401	3014.778649	0	3	13.00	12.97	0.0009	3125.592649
1	6	27.73	23.81	15.3664	1695.545329	1	6	29.39	27.40	3.9601	1561.593289
2	9	45.54	35.63	98.2081	546.016689	2	9	40.25	41.83	2.4964	821.223649
3	12	50.12	47.45	7.1289	352.951369	3	12	56.43	56.26	0.0289	155.675529
4	15	62.00	59.27	7.4529	47.706649	4	15	71.97	70.69	1.6384	9.381969
5	18	71.11	71.09	0.0004	4.853209	5	18	89.63	85.12	20.3401	429.442729
6	21	85.82	82.91	8.4681	286.049569	6	21	98.00	99.55	2.4025	846.402649
7	24	94.76	94.73	0.0009	668.377609	7	24	96.95	113.98	290.0209	786.409849
8	27	116.50	106.55	99.0025	2265.093649	8	27	135.41	128.41	49.0000	4422.649009
9	30	121.49	118.37	9.7344	2764.971889	9	30	147.63	142.84	22.9441	6197.310729

$$\text{Square Error w/ Line} = (y_{True} - y_{hat})^2$$

$$\text{Square Error Mean} = (y_{True} -$$

Where: y_{True} = The value of seconds

y_{hat} = The value of prediction

y_{Avg} = The mean value of the independent variable

The tables above show the squared error line and square error mean of each dependent value of the two datasets. Moreover, calculating the squared error line and squared error mean will help the developers determine the value of each dataset. ranges from 0 to 1, with 0 indicating that the independent variable does not explain any of the variation in the dependent variable and 1 indicating that the independent variable explains all of the variation in the dependent variable.

Table 13. R-Squared

R-Squared	
Wifi	0.978585
Data	0.978599

$$R^2 = 1 - \frac{RSS}{TSS}$$

Where:

RSS = Sum of Squared Error with Line

TSS = Sum of Squared Error Mean

The table depicts the estimated R-squared of the wi-fi dataset and data dataset. Wi-fi has an equivalent R-squared of 0.978585, whereas the data got a R-squared of 0.978599, which indicated that the two values have no so much difference since both of their correlations (r) are almost similar with only a 0.01 difference.

Table 14. Prediction

Wi-Fi			Data				
No. of Students	Predicted Seconds	Minutes	No. of Students	Predicted Seconds	Minutes		
0	50	197.17	3.29	0	50	239.04	3.98
1	100	394.17	6.57	1	100	479.54	7.99

As a result, the developers calculated that if the system is utilizing a wi-fi network and there are 50 people outside who will enter the school, it will take 197.17 seconds, or 3.29 minutes, to detect everyone and send the email to each individual recipient. Moreover, if there are 100 people outside who will enter the school, the detection will take 394.17 seconds, or 6.57 minutes. However, if the system used data and there were 50 students outside the school, it would take them 239.04 seconds, or 3.98 minutes. Furthermore, if there are 100 students outside who plan to enter the school, it will take 479.54 seconds or 7.99 minutes to finish the detection. Henceforth, the developers conclude that wi-fi is faster at recognizing and sending email.

Twins Data

The paragraph will distinguish the preciseness of the algorithm when working with twins. Identical Face become one of the difficulties for face recognition due to subtle facial features and same genetic makeup.

Table 15. Twins Tolerance

Tolerance_Score_twin1	Tolerance_Score_twin2	Tolerance_Score_twin1	Tolerance_Score_twin2		
0	0.504466	0.541904	0	0.436561	0.404716
1	0.324525	0.456652	1	0.434924	0.425385
2	0.358474	0.440978	2	0.408922	0.392047
3	0.327116	0.462048	3	0.395598	0.401941
4	0.319497	0.459059	4	0.419584	0.418441
5	0.313582	0.448944	5	0.399241	0.375430
6	0.294440	0.449878	6	0.402221	0.390425
7	0.294460	0.443204	7	0.410395	0.375672
8	0.308581	0.465993	8	0.406927	0.389207
9	0.299659	0.439319	9	0.404196	0.397726
10	0.309817	0.455980	10	0.402689	0.418810
11	0.280146	0.426777	11	0.383238	0.352692
12	0.291882	0.438348	12	0.417344	0.360115
13	0.297422	0.446365	13	0.399545	0.389276
14	0.295195	0.451083	14	0.410565	0.401919
15	0.298442	0.432161	15	0.411420	0.358046
16	0.270934	0.419939	16	0.395947	0.348331
17	0.285473	0.428649	17	0.402549	0.404400
18	0.287154	0.433217	18	0.393043	0.387569
19	0.281676	0.425304	19	0.388587	0.394446
20	0.287490	0.432036	20	0.389793	0.389975
21	0.269562	0.420803	21	0.406167	0.387900
22	0.293463	0.437587	22	0.414496	0.400159
23	0.284580	0.423823	23	0.407696	0.397591
24	0.285919	0.437006	24	0.408784	0.355539
25	0.290343	0.412805	25	0.401251	0.365491
26	0.287651	0.430043	26	0.410824	0.372974
27	0.278832	0.431353	27	0.414472	0.378797
28	0.280492	0.429447	28	0.394138	0.375602
29	0.284439	0.429396	29	0.412224	0.394413

The table above shows the tolerance points of each twin from the testing.

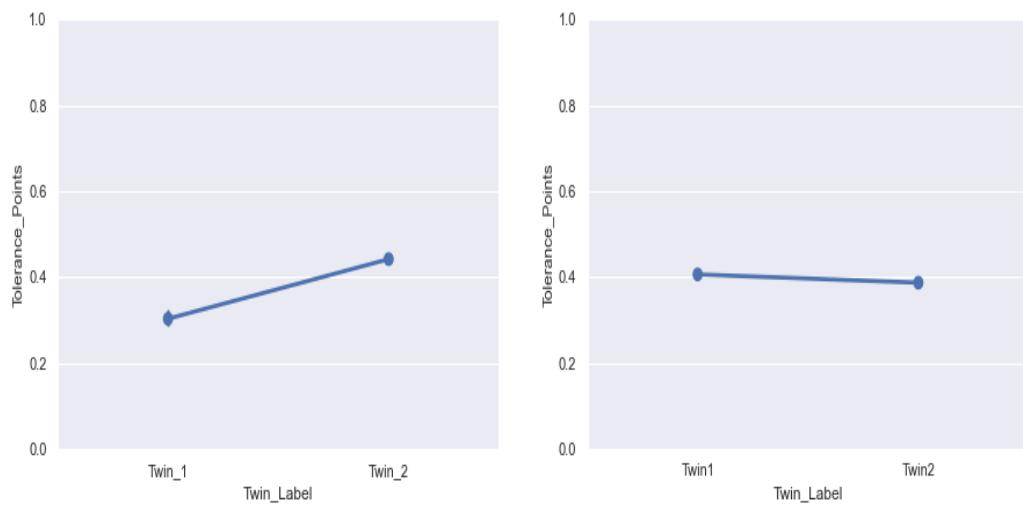


Figure 27. Difference between Twin 1 and Twin 2

The graph above shows the difference in tolerance points between twin 1 and twin 2. The developers test both twins to find out how many data points are going to vary. The graph on the left side indicates a higher difference of tolerance points between the two twins that signify successful recognition; however, as you can see on the right-side graph, the difference between their tolerance points becomes lower, hence the system fails to recognize both twins.

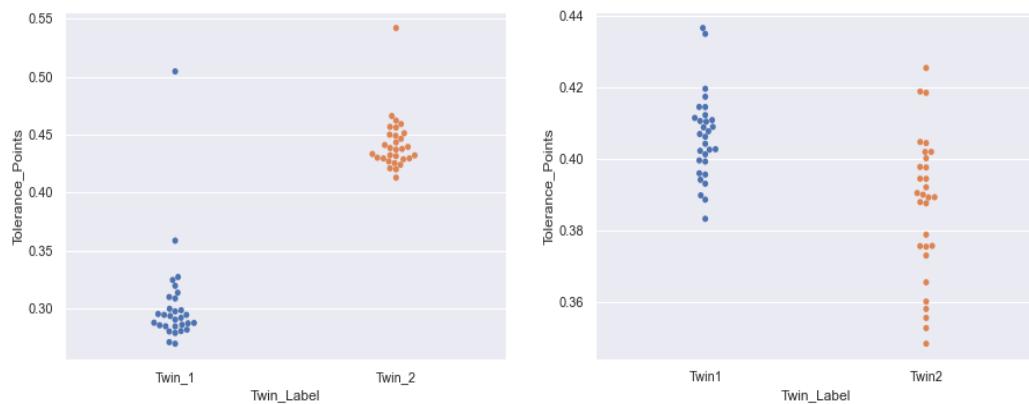


Figure 28. Plotted tolerance points of the twins

The graph above depicts the plotted tolerance points of the twin. The developers used a swarm plot to visualize the change in tolerance points between the twins. The left-side graph shows a more sustainable recognition, which indicates that the interval of the tolerance points between the twins is small. Although the right-side graph shows a large interval on twin 2, which means that the system can hardly recognize both twins.

$$|(X_{avg} - Y_{avg})| \pm Z_a/2 \times \sqrt{\frac{S^2 p}{N_x} + \frac{S^2 p}{N_y}}$$

Where: $S^2 p = \frac{(N_x - 1) \times S^2 x + (N_y - 1) \times S^2 y}{N_x + N_y - 2}$

X_{avg} = Average of the X values Y_{avg} = Average of the Y values

$S^2 x$ = Sample variance of X $S^2 y$ = Sample Variance of Y

N_x = Total Number of X N_y = Total number of Y

The developers used confidence interval to identify the difference of each tolerance points between the two twins. The developers also used a 95% confidence level which indicates that there is a 5% percent chance that the calculation is wrong.

Table 16. Confidence interval of test 1

	Low Confidence Interval	High Confidence Interval
Estimation	0.122	0.156

The table above shows the confidence interval for the difference between two means. With a 95% confidence level, the final computation of the low confidence interval is 0.122, while the high confidence interval is 0.156, which indicates that the difference of the tolerance points from both twins is higher, resulting in a more accurate recognition from the twins.

Table 17. Confidence interval of test 2

	Low Confidence Interval	High Confidence Interval
Estimation	0.011	0.028

A confidence interval is a range of values used in statistics to estimate an unknown population parameter with a high level of confidence. It expresses the degree of uncertainty associated with the estimate.

Consider the following example to better grasp the concept of a confidence interval. To calculate the average height of all adults in a certain city. Because measuring the height of every adult is impracticable, you take a sample of, say, 100 individuals and get the sample mean height. However, that the sample may not exactly reflect the full population, and hence the sample mean may differ from the real population mean.

However, the table above shows a lower difference interval. With a 95% confidence interval, the final estimation of low confidence interval is 0.011 while the high confidence interval is equal to 0.028 which means that there is a high possibility that recognition between the twins will be faulty since the variation is larger.

Several factors determine the breadth of the confidence interval, including sample size, data variability, and desired degree of confidence. A higher sample size or a lower degree of desired confidence will result in a smaller confidence interval, suggesting a more exact estimate.

It is vital to remember that a confidence interval does not indicate the likelihood that a certain parameter value falls inside the interval. It instead estimates the degree to which the approach used to compute the interval would produce an interval containing the real parameter value if the sampling process were repeated many times.

A confidence interval is a range of values in statistics that offers an estimate of an unknown population parameter and measures the uncertainty associated with that estimate.

Pretest and Post-Test Results

The developers applied a quasi-experimental design for contrasting of the proposed functions of the device according to the clients of this study, hence, the dependent and independent variables, wherein the developers prepared a pretest and post-test questionnaire to determine the outcome of the research in regards with the dependent variable and without the interference, or with the proposed solution by the developers, nor by the independent variable. The demonstration of the output will be interpreted as the results of the pretest results and re-evaluated in accordance with the improvement of the respondents' perception per the aid of the proposed device, that will be gathered by a post-test. Furthermore, this design will also imply an equal bias in internal and external by the respondents, as they were selected to be the appropriate ones to validate the device through their geographical designation. The success rate of this study will also be determined if the post test results were higher than the pretest results.

The developers conducted a simple random sampling to gather relevant information and data statistics in student's parents of STI College Calamba regarding the time entry and schedule of their child in school. Simple random sampling is often used in research studies, opinion polls, and surveys, where the goal is to obtain a representative sample of the population in order to make inferences about the entire population.

Table 18. Pretest Survey Result

Questions	Yes	Percentage	No	Percentage
1. Are you aware about the time entry of your child in his/her school?	34	68%	16	32%
2. Are you once informed by the teacher that your child	10	20%	40	80%

is inactive in terms of his/her attendance?				
3. Can you say that your child is safe inside the school?	42	84%	8	16%
4. Do you agree on generating a system where it can notify you about the time entry of your child?	49	98%	1	2.0%
5. Everytime your child goes to school, are you certain that they will attend their individual class?	12	24%	38	76%

The table shows information about the survey evaluation. The data gathered on the first question shows that more than half of the respondents know their child's schedule, while only 32% of the respondents did not. Most students get away with cutting classes, and only 20% of those were known. Parents put their trust in their child whether he/she attends school. In terms of safty, most respondents think their child is safe at school from any outside threats. Therefore, all respondents agreed to generate a system that will notify them of their child's entry to school.

Table 19. Post-Test Survey Result

Questions	Yes	Percentage	No	Percentage
1. After using the device, are you aware about the time entry of	50	100%	0	0%

your child in his/her school?				
2. After using the device, are you satisfied that you received an email if your child is active in terms of his/her attendance?	45	90%	5	10%
3. After using the device, can you say that your child is safe inside the school?	43	86%	7	14%
4. Implementing the prototype in school will increase the security and safeness of students.	49	98%	1	2%
5. After using the device, do you think it is necessary to send an email for time in and	48	96%	2	4%

time out of the student?				
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Evaluation

To further efficiency assessment of the proposed device, the developers used ISO Product Quality Model of ISO/IEC 25010 on the proposed device entitled, Facial Recognition System of Students and Faculty for STI College Calamba.

Numerical Rating	Categorical Response	Verbal Interpretation
4	Strongly Agree (SA)	Highly Accepted
3	Agree (A)	Accepted
2	Disagree (D)	Less Accepted
1	Strongly Disagree (SD)	Less Accepted

The table mention above of ISO Evaluation Criteria indicates the measurement of the level of agreement, acceptability, and efficiency of the developed system using a 4-point Likert Scale. The formula used to calculate the weighted average mean is as follows:

$$WM = \frac{SA * 4 + A * 3 + D * 2 + SD * 1}{TNR}$$

Where:

WM = Weighted Average Mean

D = Disagree

SA = Strongly Agree

SD = Strongly Disagree

A = Agree

TNR = Total Number of Respondents

The developed device is evaluated by the member of faculty members of STI College Calamba, that the developers chosen to be the fit respondents on this evaluation.

Numerical Rating	Categorical Response	Verbal Interpretation
4	Strongly Agree (SA)	Highly Accepted
3	Agree (A)	Accepted
2	Disagree (D)	Less Accepted
1	Strongly Disagree (SD)	Less Accepted

Table 20. ISO/IEC 25010

	INDICATORS	STATEMENTS	SA 4	A 3	D 2	SD 1
FUNCTIONALITY	Completeness	The device can produce a complete output.				
	Correctness	The device operates in accordance with its intended purpose.				
	Appropriateness	The device produces the proper output based on its correct method.				
RELIABILITY	Maturity	After the final implementation, the device is completely functioning.				
	Availability	When needed, the device is functioning and accessible.				
	Recoverability	In the case of an interruption or breakdown, the device can restore the desired state of the system.				
USABILITY	Operability	The device contains features that make it simple to use and control.				
	Learnability	The device may be utilized by certain users to achieve specific goals such as learning how to use the product effectively.				
	Accessibility	The device is used by persons with a wide range of characteristics and abilities.				
	Capacity	The device satisfies the maximum limit parameter criteria.				

PERFORMANCE	Time behavior	Based on the device needs, the machine processing time responds well.				
EFFICIENCY	Resource utilization	To satisfy the right performance of the functions, the device utilized the appropriate quantity and kind of resources.				
MAINTAINABILITY	Reusability	The device may be utilized in a variety of industries.				
	Modifiability	The device may be updated without causing flaws or lowering the quality of the present product.				
	Modularity	The device is made up of components that may be swapped out with minimum influence on other components.				
PORTABILITY	Adaptability	The device may be successfully customized for new or changing hardware.				
	Installability	In the appropriate environment, the device can be successfully installed and/or removed.				
	Replaceability	In the same environment, the device can be replaced with another specified part for the same purpose.				
SECURITY	Confidentiality	In the same environment, the device can be replaced with another specified part for the same purpose.				
	Authenticity	The asserted device identity and resources may be proven.				
	Accountability	The device can track the user's actions while utilizing each function.				

Table 21. Result of Evaluation for Faculty

Categorical Response	Numerical Rating	Characteristics																		Total	Percentage		
		Functionality			Reliability			Usability			Performance Efficiency			Maintainability			Portability						
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3				
SA	4	18	20	23	15	13	20	21	23	23	20	23	18	12	17	12	23	19	21	17	20	23	
A	3	5	3	0	8	10	2	1	0	0	3	0	3	8	6	11	0	4	2	6	3	0	
D	2	0	0	0	0	0	1	1	0	0	0	0	2	3	0	0	0	0	0	0	0	7	
SD	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	
Total Respondents		23																		= 483	= 100%		
Weighted AverageMean		$WM = \frac{401 * 4 + 75 * 3 + 7 * 2 + 0 * 1}{23}$																		= 80. 13	= 80.13%		

Table 22. The Eligibility Percentage

No.	Interval Percentage	Value
1	< 25%	Very Not Good
2	25% - 50%	Not Good
3	51% - 70%	Good
4	71%-100%	Very Good

The evaluation above shows the relative frequency of the functionality, reliability, usability, performance efficiency, maintainability, portability, and security of the prototype. The developers commence a survey for faculties in accordance with ISO/IEC 25010. Based on the accumulated data, 401 out of 483 respondents, or 83%, strongly agree about the functionality, reliability, usability, etc. On the other hand, 75 out of 483 respondents, or 16%, only agreed about functionality, reliability, usability, etc. In addition, 7 out of 483 respondents, or 1%, disagree about the functionality, reliability, usability, etc. of the proposed device. Furthermore, 0 out of 483 people strongly disagree on the functionality, reliability, usability, etc. of the device.

Table 23. Pre-test for Students

Questions	Yes	Percentage	No	Percentage
Is attendance important to you?	172	87.3%	25	12.7%
Does attendance affect your grades?	171	86.8%	26	13.2%
Do you let your parents know about your school schedule?	170	86.3%	27	13.7%
Do your parents ask if you've already entered into school?	48	24.4%	149	75.6%
Do your parents know the exact time of your school entry?	65	33%	132	67%
Do you ever think that whenever there are outsiders in school, there might be a chance of chaos or trouble occurring?	43	21.8%	154	78.2%
Do you go straight home when you leave school?	129	65.5%	68	34.5%
Would you agree to have a device that will inform your parents of your arrival and departure from school, including a picture of you?	142	72.1%	55	27.9%

The table above depicts the overall evaluation that was gathered from the pre-test survey. The developers distributed the questionnaire to 197 students from STI Calamba. With an 87.3%, 172 students agreed that attendance was important for them, while 25 or 12.7% disagreed. Additionally, 171 students, or 86.8%, said that the attendance affected their grade, while only 26 students, or 13.2%, said that it didn't. Moreover, most of the parents don't know the time of entry whenever their child goes to school, with 67% saying no and 33% of the sample population saying yes. In addition, most of the students in the STI go home immediately after they finish their last subject, with 129 students, or 65.5%, saying yes and 68 students, or 34.5%, saying no. Furthermore, the majority of the students agreed to create a device that will inform their parents whenever they enter the school, with 72.1%, or 142 out of 197 students, saying yes; however, 55 out of 197, or 27.9%, said no about implementing this device on the STI.

Table 24. Post-test for Student

Questions	Yes	Percentage	No	Percentage
Will the device help to speed up the process of taking your attendance?	168	85.3%	29	14.7%
After using the device, do you think it helped in informing your parents about your school attendance?	167	84.8%	30	15.2%
After using the device, do you think it is okay if your parents received a picture of you every time you	114	57.9%	83	42.1%

enter and exit into school?				
After using the device, Do you think this will help enhance the security of STI?	179	90.9%	18	9.1%

The table above represents the conclusive evaluation of the post-test. This was held after doing the testing with the students of STI Calamba. Based on the result, 168 out of 197, or 85.3%, agreed that the device will lessen the time consumption of taking attendance; however, 14.7% of the sample population disagreed regarding the speeding up process. Additionally, 84.8% agreed that the device will help inform the parent about the time of entry of the student, whereas 15.2% disagreed about this. Moreover, 57.9% approve that it's okay for them to capture an image that contains their faces, while 42.1% disagree about this feature. Furthermore, 90.9% of students think that the device will tighten the security of the STI; however, 9.1% said that this will not have a great effect on the security.

Table 25. Performance Analysis

Hardware	Description	Trial Result	Remarks
Power Supply 12V 3A	This will provide an electrical power to the microcontroller.	Good	Choose the right volts and amperes for the power supply. Not meeting the requirements can damage the microcontroller.
Raspberry Pi 4B	The microcontroller that the developers used for their system.	Good	Pick the right model. This will depend on how complex and how substantial is the computational power of the innovation.
Memory Card 32 GB	All of the data like images, wav,	Good	Make sure to not expose it to any

	information and etc. will be stored in the memory card		static electricity. Moreover, do not repeatedly remove it and insert it into the microcontroller.
RJ45	This will be the path to make a connection between user's pc or laptop to raspberry pi 4B	Good	Do not force it too much on the Ethernet hub, and once it is inserted, make sure it is locked.
1024x600 7 Inch LCD Display	This will serve as the monitor of the microcontroller to display all of the GUI's	Damaged One Time Cause: Lack of adhesive in the touch connector.	To prevent this problem, pick an LCD Display where all of the USB hub is soldered properly. Moreover, plug the connector slowly.
Speaker	The goal of the speaker is to play wav files whenever a function on the system is being executed.	Good	Future researchers can pick any type of speaker as long as it can run on Bluetooth.
Raspberry Pi Cam V2.1	The components provide an operation for capturing images and videos.	Good	Properly connect it to the Raspberry Pi 4B camera port. If it is not properly connected, the Pi camera will fail.
Push button Module	To record the time in and time out of the students and faculties.	Good	Insert it on the right GPIO pins; this will cause an electrical shortage if the positive and negative are not connected correctly.
Email Sender (YagMail)	It is a library from python where the user can send an automatic email to any recipient	Seldomly Fails Cause: Slow internet speed connection	The microcontroller's internet connection must be relentless and continuous. If not, the sending of an email might induce an error.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The testing phase is consisting of various methods that the developers applied in order to determine the accuracy and quickness of the prototype. Moreover, the developers also utilized different kinds of statistical formulations to establish a stable tolerance score that will increase the precision and recall of the prototype. Therefore, the outcome was immaculate since all of the objectives were accomplished throughout the testing. The core objectives of the study are face recognition, where it is indicated that the prototype must recognize the person and give a warning if the person is unfamiliar. Secondly, to notify the guardian for students and the head office for faculty members, the prototype will track the time of entry and egress of a particular person, and it will also send an email after the person enters the school. The email will be sent to the recipients that the person has chosen. Furthermore, since the last objective is increasing the parameters of security in the school, the prototype will also send an email to the chief officer or the supervisor of security once the person has not been recognized for the fifth time by the prototype. As a result, this prototype can assist the school improve its security and alleviate guardians' concerns about their child not attending school.

1. The accuracy of the model that was utilized by the researchers is equal to 97%, which denotes that the model is proficient enough to recognize known and unknown individuals. In addition, with a 95% confidence level, the accumulated tolerance points from each test subject have an interval of 0.353 to 0.393. Furthermore, the sampling distribution also suggested that 99.62% of the gathered tolerance points were less than 0.40; therefore, the researchers set the tolerance at 0.40.
2. In accordance to the sending email, the researchers find out that using wi-fi network is faster than the data connection. The wi-fi can recognize 30 persons with only 121.49 seconds or two minutes while data connection has longer time where it can recognize 30 persons for 147.63 second or approximately 2 minutes and 23 seconds. Furthermore, the developers also used simple linear regression to predict

on how many seconds will it take if there are 50 students and 100 students entering the school and the result on the wi-fi to the 50 students is 197.17 seconds or approximately 3 minutes while in 100 students is 394.17 seconds or approximately 6 minutes, on the other hand the data connection gave a result of 239.04 seconds or approximately 3 minutes for 50 students and 479.54 or approximately 8 minutes if there are a hundred students outside the school.

3. According to the survey, 98% of the guardians agreed that the prototype must have notification features since 54% were uncertain about their child attending their individual class. Furthermore, almost 80% of the guardians are informed about their child being idle before going to class.

Recommendations

The developers suggest that in order to enhance the device's functionality and capability, future researchers who would like to study it should take into account the addition of features and upgrades. The developers advice thinking about modifying or including the following in the prototype:

1. Use an updated Raspberry Pi 4 model. It must have 8 GB of RAM and 64 GB of memory for maximum performance and quicker identification.
2. This is an optional recommendation; future researchers can use different models like the LBPH (local binary patterns histogram). Using other models can increase the speed of fps on the webcam; however, this can be a complex algorithm unlike the face recognition made by Dlib.
3. Use a clearer and higher-resolution camera, such as the Raspberry Pi HQ camera. This camera contains a 12MP sensor and a 6mm 3MP wide angle lens. With this sort of specification in the camera, the accuracy and precision of the recognition may be improved.

4. Install numerous cameras on the Raspberry Pi 4, so that they may set another camera outside the hall and also add a night vision camera if the environment goes dark.

5. Attach a GSM Module on the prototype, this can be useful in the case the internet or the data connection fails.

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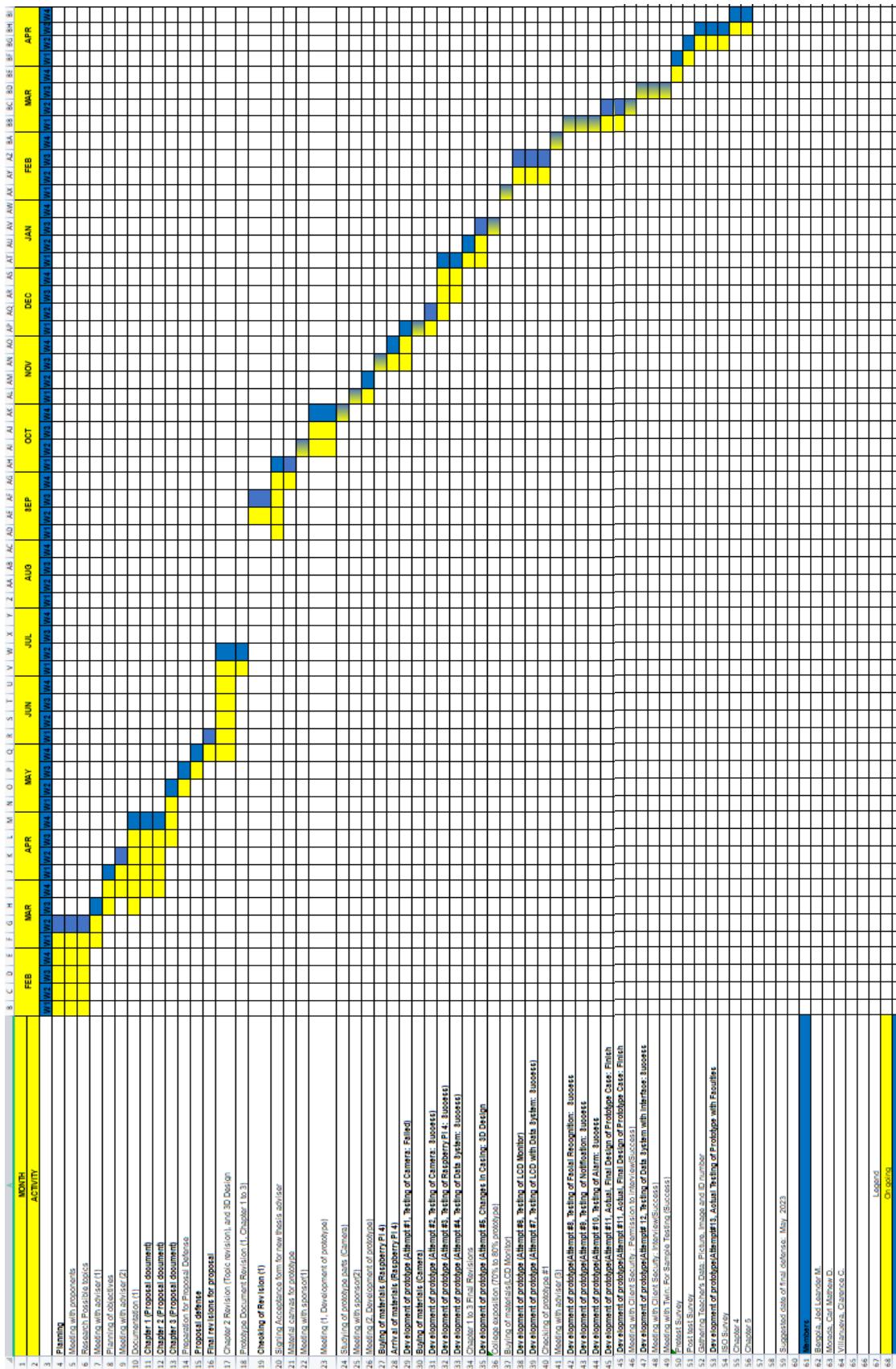
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APPENDICES

APPENDIX A. GANTT CHART



APPENDIX B. ACTUAL THESIS EXPENSES

THESIS EXPENSES

Quantity	Specifics	Approximate Cost	Actual Cost
1	Raspberry pi 4B	₱15,000	₱11,728.09
1	Memory Card	₱300	₱358
2	Pi Camera V2	₱3800	₱4,400
1	HDMI Cable	₱750	₱749
1	Power Button Switch	₱500	₱600
1	Bluetooth Speaker	₱600	₱580
1	7inc Raspberry Pi LCD Monitor	₱3000	₱2500
1	RJ45	₱320	₱350
1	USB Card Reader	₱350	₱359
1	Raspberry pi 4B Power Supply	₱400	₱500
		Total Cost:	₱22,124.09

Prepared by:

Jed Leander M. Bergola

Carl Mathew D. Morada

Clarence C. Villanueva

Noted by:

Cherish M. Bergola

Stephanie D. Morada

Fatima C. Villanueva

Approved by:

Marvic M. Espiritu, ECE

Marvic M. Espiritu, ECE

APPENDIX C. USER'S MANUAL

Appendix C. User's Manual

User's Manual

Nurturing the microcontroller

1. Power Supply of the Device

Use a power supply that produces 3A and 5V on the Raspberry Pi 4B; any power supply that doesn't meet the demand will result in the ruin of the microcontroller. Use a type C USB connector.



2. Temperature of the Environment.

Don't put the raspberry pi 4 in a place that has a temperature of more than 70 degrees. Make sure to keep it cool at all times.



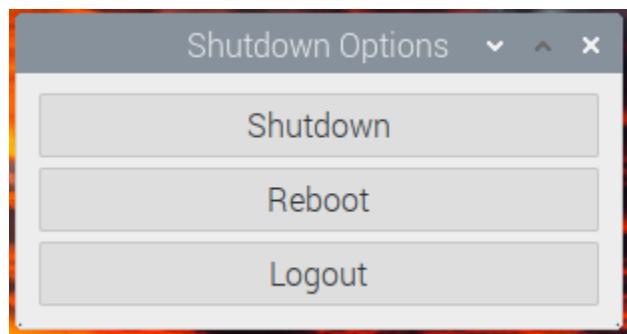
3. Avoidance on metals and conductive.

Don't place it on top of any metal surface or any conductive materials because it can cause electrical shorts or interfere with the operation of the board.



4. Shut down appropriately.

Properly shut it down: Always shut down the Raspberry Pi 4 properly before disconnecting power. This helps prevent corruption of the SD card and other data loss issues.



Before powering it on

1. Wirings and Peripherals Connection.

Check connections: Check all the connections to the Raspberry Pi 4, including the HDMI cable, power cable, and any other peripherals, to ensure they are properly connected.



2. Wi-Fi and Ethernet Connection.

Connect to the network: If a user plans to connect to a network, make sure that the Ethernet cable or WiFi dongle is properly connected.

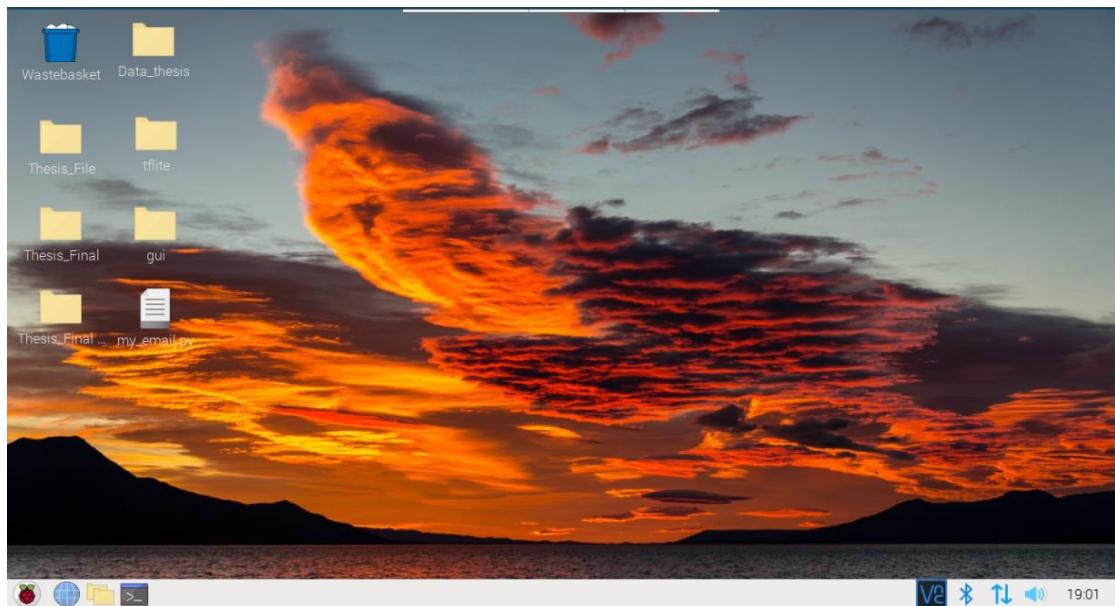


Connected to Wi-Fi



Not Yet Connected to any Wi-Fi

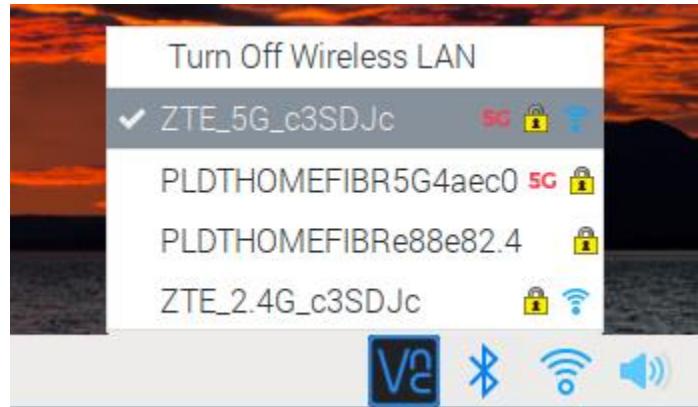
To connect the Raspberry Pi 4B in Wi-Fi



Click what the arrow sign is pointing out.



After Clicking it, Click the “Turn On Wireless LAN”



Choose the preferred Wi-Fi connection.

3. Optional: Adding peripherals on Raspberry Pi 4B

If a user wants to add connections like a mouse, keyboard, etc., make sure that they are connected properly.



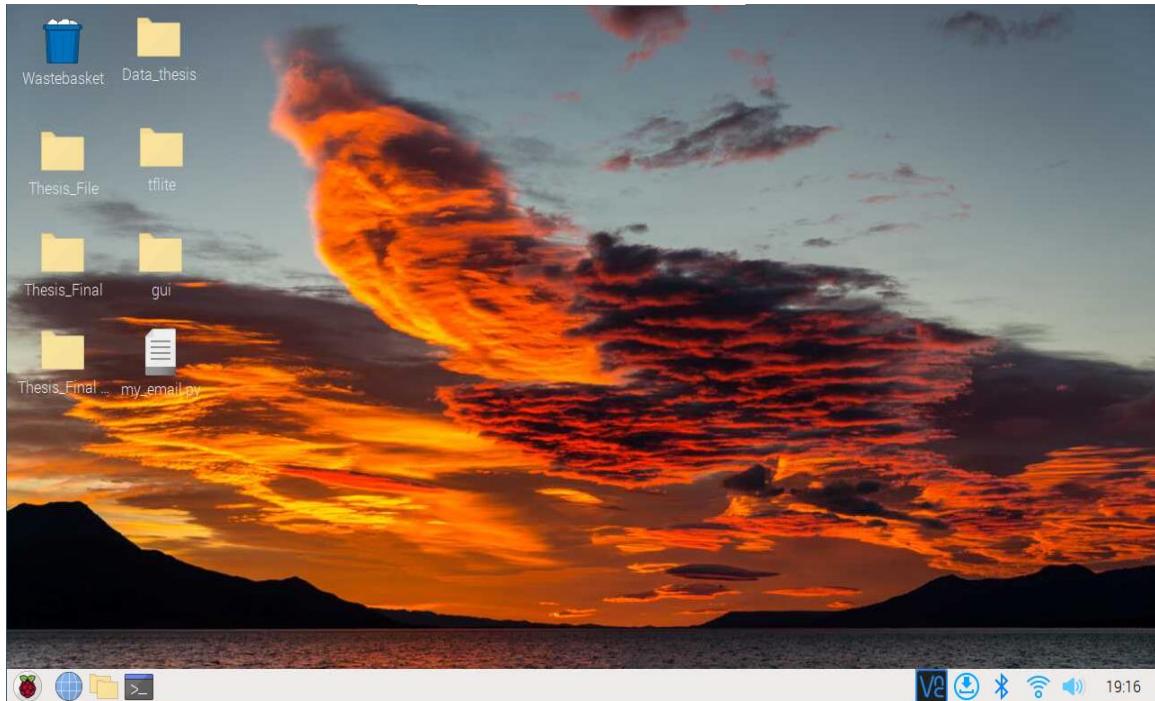
4. Powering it up

Wait for boot: wait for the Raspberry Pi 4 to boot up and for the operating system to load. This may take a few minutes, depending on the operating system and any installed applications. Be patient.

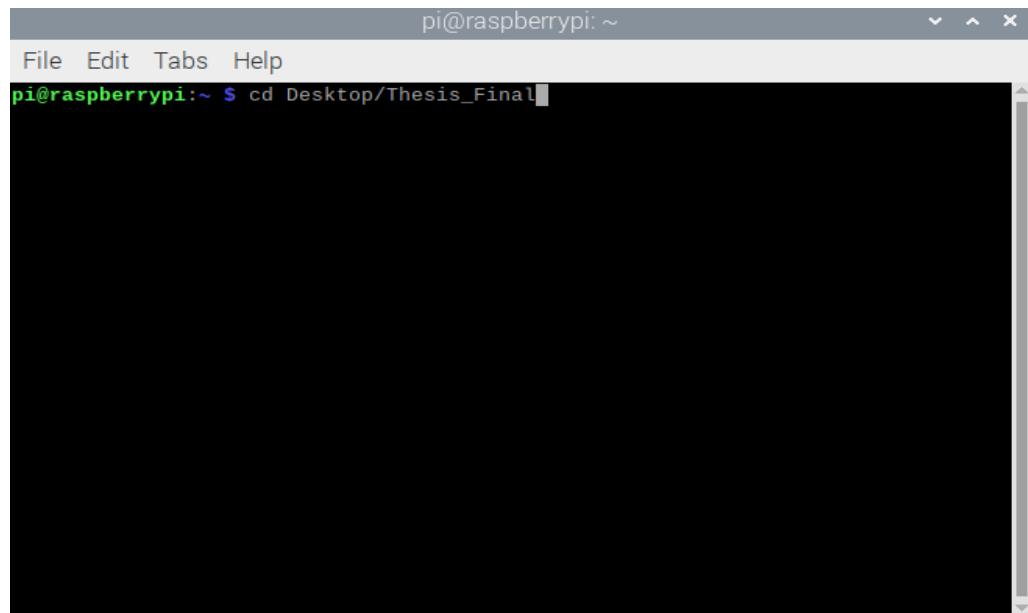


Running the Face Recognition

1. Open the terminal as the arrow sign point out.

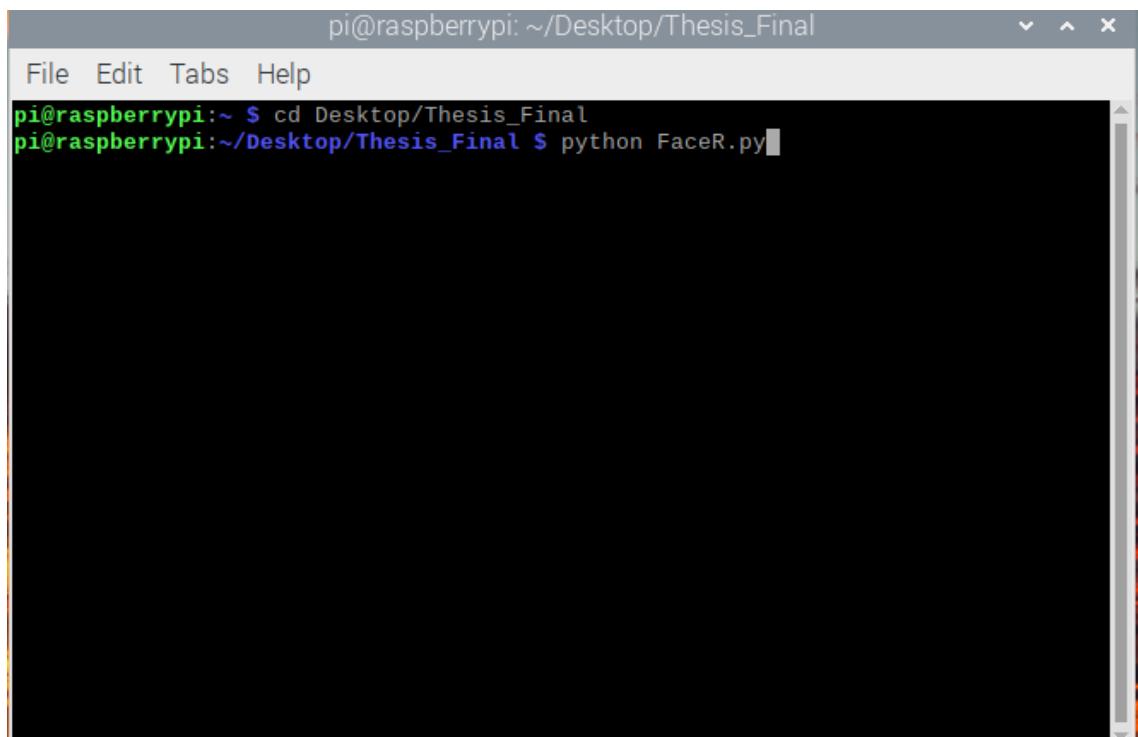


- After clicking it, type on the terminal “*cd Desktop/Thesis_Final*”.



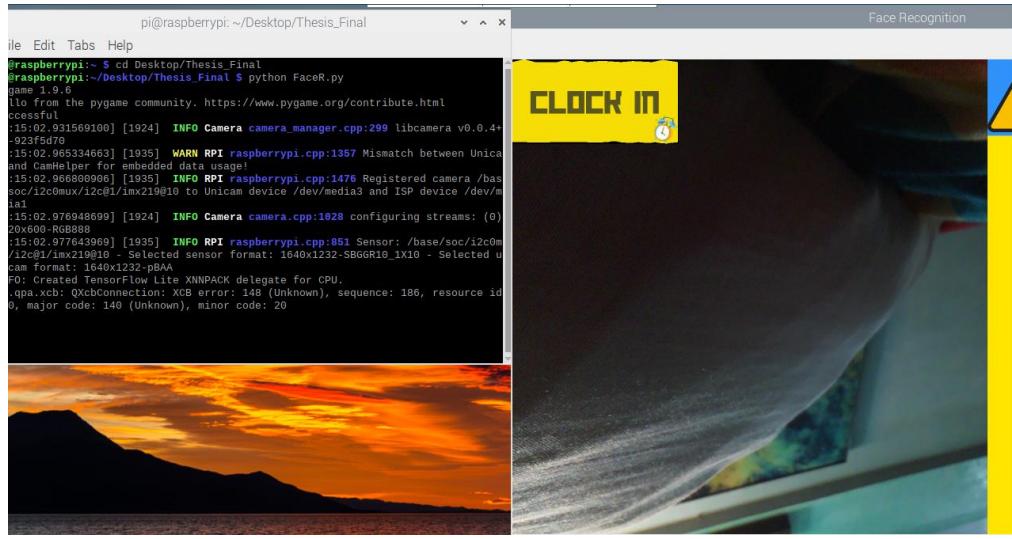
```
pi@raspberrypi: ~
File Edit Tabs Help
pi@raspberrypi:~ $ cd Desktop/Thesis_Final
```

After typing the command on the terminal, the user must type next “*python*

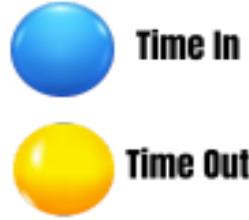


```
pi@raspberrypi: ~/Desktop/Thesis_Final
File Edit Tabs Help
pi@raspberrypi:~ $ cd Desktop/Thesis_Final
pi@raspberrypi:~/Desktop/Thesis_Final $ python FaceR.py
```

This will execute the system. Note: this may take a few minutes to open up, therefore the user must wait so it won't generate any error.



3. The buttons on the prototype represent the recording of the exact time and date of every person who enters the school. The blue color indicates the time of entry, while the yellow color indicates the time of exit. The user can store their attendance by clicking the buttons.



5. To stop the program, the user can click the "q" button to exit the system or minimize the application and press the exit on the terminal. In case the user encounters an error while using the system, they can also just click the exit button on the terminal to stop the program.



6. To enable the notification function of the prototype the user must open the terminal and type the “*cd Desktop/Thesis_Final*”. Next is to execute the program by typing the “*python email_sender.py*”, wait for it to run successfully, it will show a message “*Ready to use*”.

```
pi@raspberrypi:~/Desktop/Thesis_Final $ python email_sender.py
Ready To use
Email Sent
Successful
pi@raspberrypi:~ $ cd Desktop/Thesis_Final
pi@raspberrypi:~/Desktop/Thesis_Final $ python email.sender.py
```

During the operation of the system

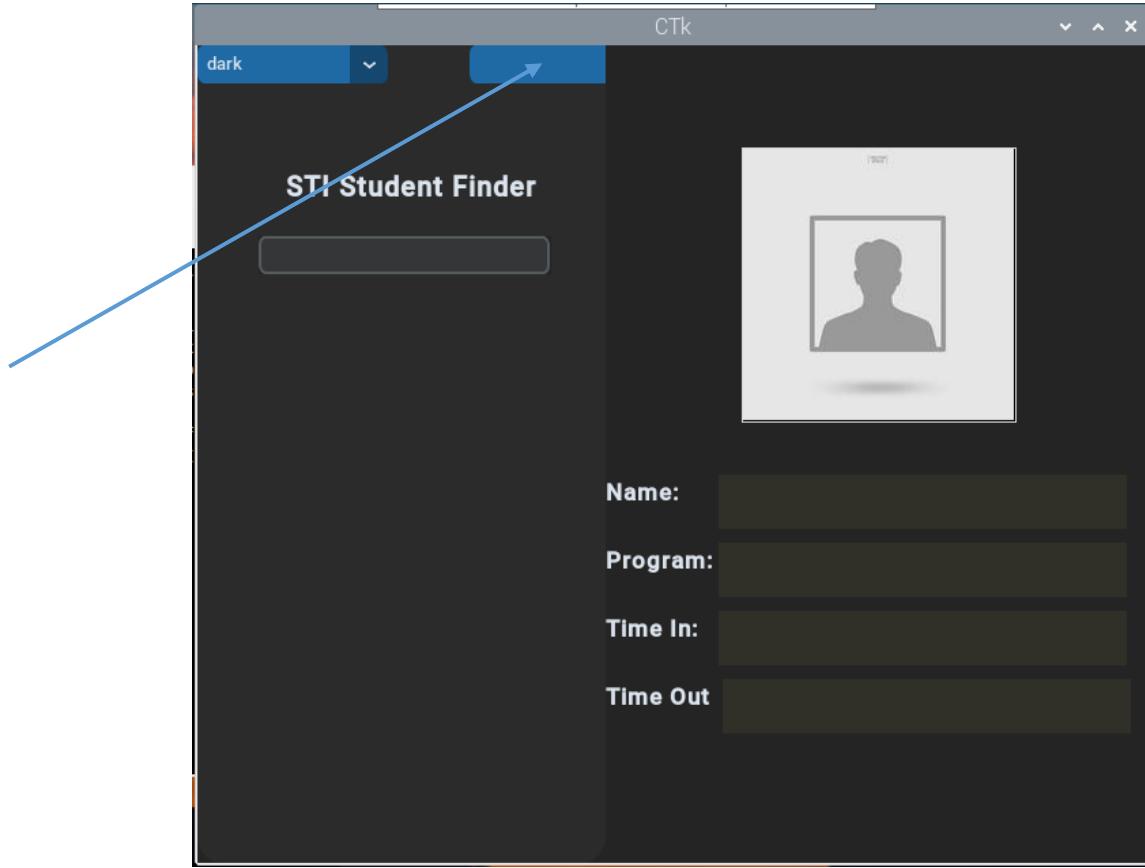
1. Avoid placing the lens of the camera in a bright environment; this can cause the camera to become vague that result a low accuracy on the face recognition system.
2. It is necessary that the fan be turned on since the model requires a lot of computational power to perform its task.
3. Always put it on a cool environment.

Using the Student Finder GUI

1. Type in the terminal “*cd Desktop/gui*” afterwards is run the script by typing “*python gui.py*”.

```
pi@raspberrypi:~ $ cd Desktop/gui
pi@raspberrypi:~/Desktop/gui $ python gui.py
```

2. After entering the command in the terminal wait for the GUI to start up. And click the Option Box on the on the upper right and click the program of the who the person wants to find.



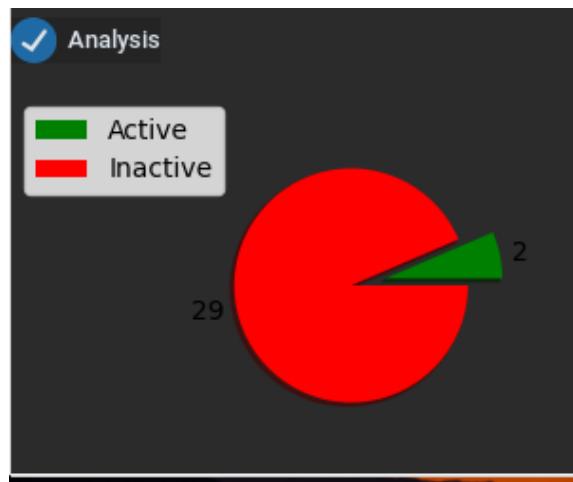
3. The person needs to type the surname of the person, and click the button that has a named find.



4. Select the person who the user intended to find, and the click the search button to show up the information of the right side.



5. The user can also put a check mark on the analysis to know how many are active students and inactive students on the specified programs.



Before shutting it down

1.Close all the running applications.

The User must first shutdown all of the applications that is running actively.



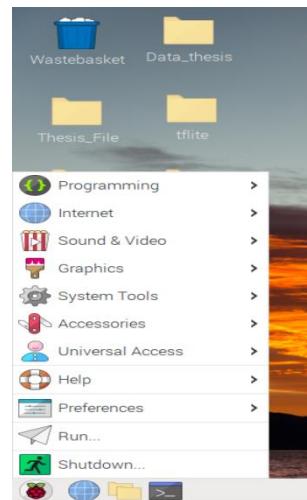
2. Shutting Down on the Terminal

The user can shut down the Raspberry Pi 4 using the command line by typing "sudo shutdown -h now."

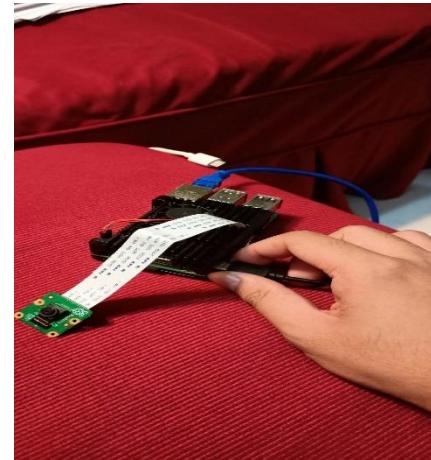
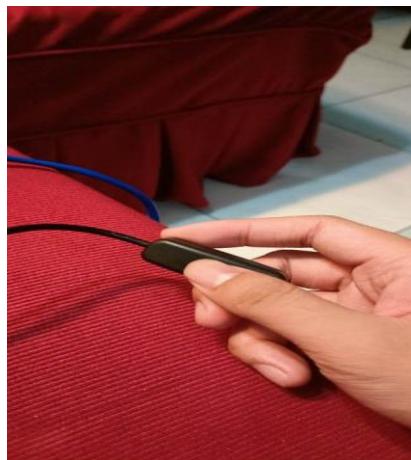
A screenshot of a terminal window titled "pi@raspberrypi: ~". The window has a menu bar with "File", "Edit", "Tabs", and "Help". The main area shows a command line prompt: "pi@raspberrypi:~ \$ sudo shutdown -h now". The terminal is black with green text.

3. Shutting down on the desktop environment.

If the user is using the desktop environment, click on the "Shutdown" button in the menu to initiate the shutdown process.



4. Wait for the Raspberry Pi 4 to complete the shutdown process before disconnecting the power supply.
5. Once the Raspberry Pi 4 has completely powered down, you can safely disconnect the power supply by clicking the button on the power supply and removing the USB connector.



Note it's necessary to do a proper shutdown on the raspberry to prevent any data corruption and damage on the operating system.

Maintenance for the Raspberry pi 4 and system

- Clean the board on a regular basis with a soft, dry cloth to remove any dust or dirt that has gathered. Any liquid cleansers should be avoided since they might harm the components.



- Maintain software updates and libraries update: To guarantee best performance and security, keep your Raspberry Pi 4's operating system and software up to date.



- Check for hardware concerns: Check for any indicators of hardware difficulties, such as loose connections or broken components, on a regular basis. Address any concerns as soon as possible to avoid additional damage.



- Delete the image and information of all the old students on the data because this can cause a lag on the system if the old students are still included on the data.



All of the tips listed above can ensure reliable operation and prolong the life of the Raspberry Pi 4

APPENDIX D. TECHNICAL MANUAL

Technical Manual:

Setting up the system:

1. Ensure all the libraries are updated.
2. Debug the system in case of encountering any error.

Inserting data on the system

1. Take a picture of the chosen person, jpeg format is preferable.

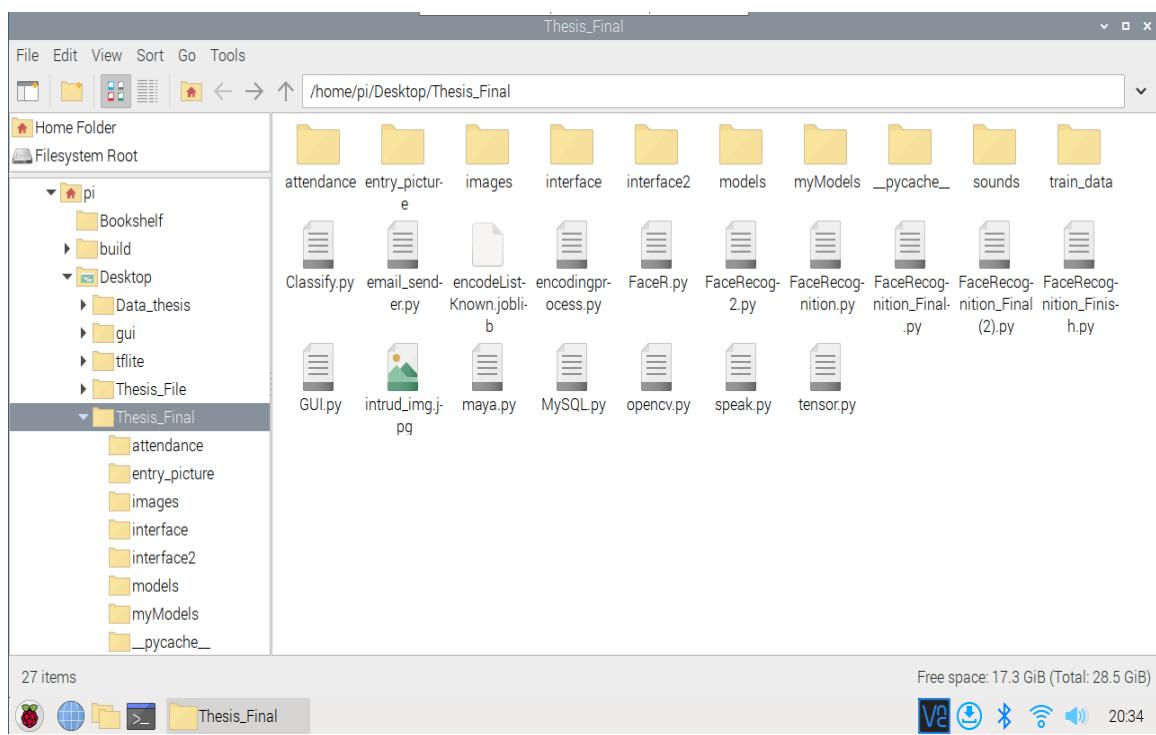


2. Make sure that the picture is in high resolution to increase the accuracy of the system.
One picture is enough.

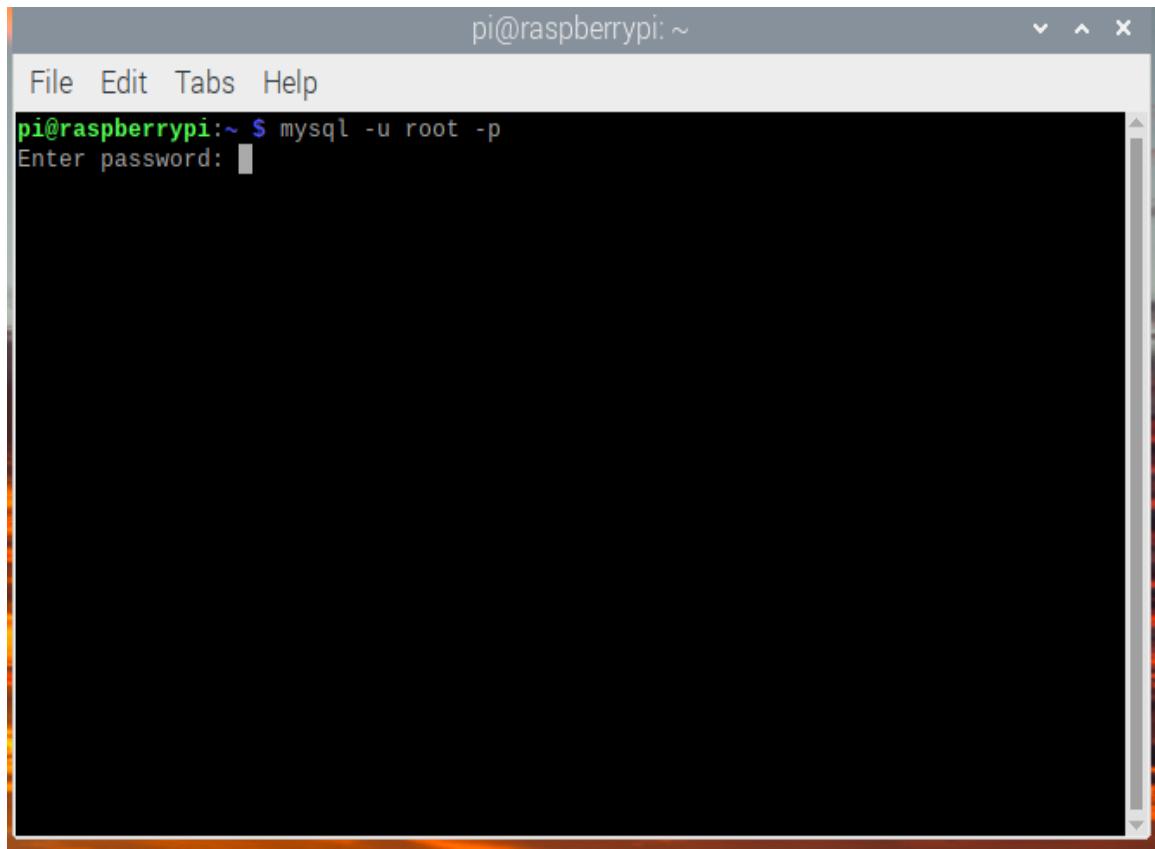
3.



4. Put the picture in the images and train_data folder that can be found in the Face Recognition Directory.



5. Input the information about the person into the database of the system. The system uses MariaDB, which can be acquired by opening the bash command and typing the following command: mv MariaDB. mysql -u root -p" Click enter afterwards, and type this password: "123456789".



A screenshot of a terminal window titled "pi@raspberrypi: ~". The window has a menu bar with "File", "Edit", "Tabs", and "Help". The main area shows the command "pi@raspberrypi:~ \$ mysql -u root -p" followed by the prompt "Enter password: [REDACTED]". The terminal window is set against a background of a red and orange abstract pattern.

```
pi@raspberrypi:~ $ mysql -u root -p
Enter password: [REDACTED]
```

The user may experience that the password is not showing on the terminal. It's part of the OS since the raspberry pi 4B uses Linux in order to make the system more secured. The user must continue typing this and ensure that the user didn't type the wrong password because this might result an error.

6. Once the database is accessed, type "USE Students" on the terminal and use the insert function to store data.

```
MariaDB [(none)]> USE Students;
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A
```

```
Database changed
```

```
MariaDB [Students]>
```

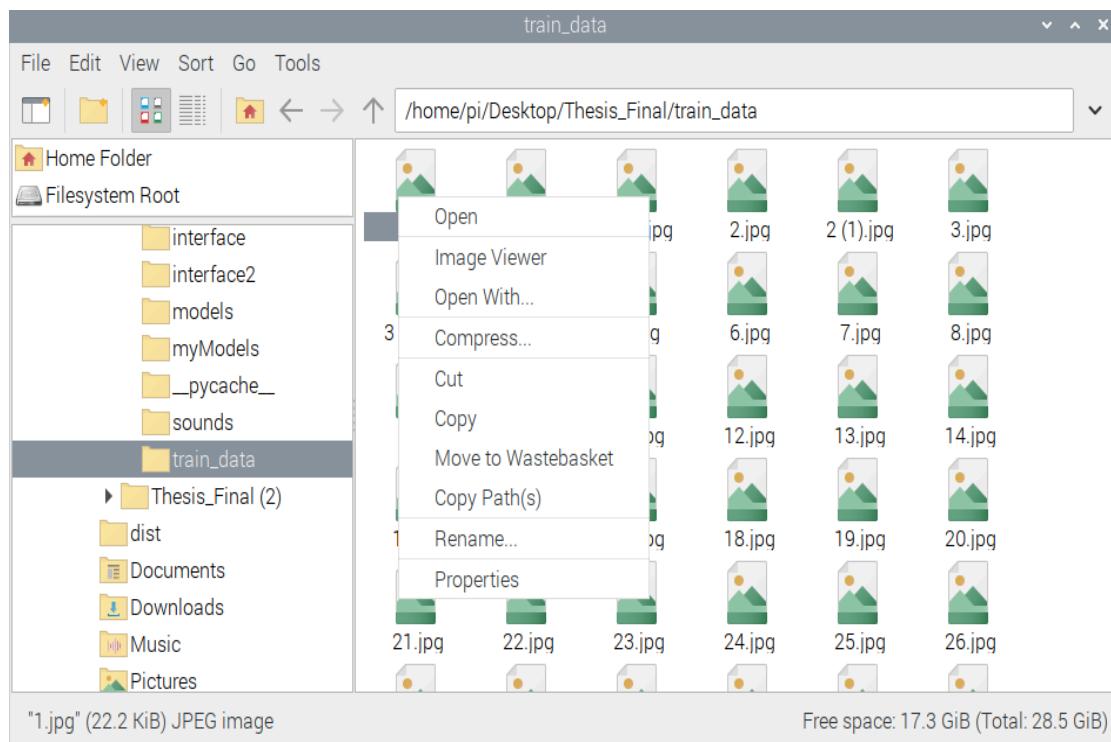
```
MariaDB [Students]> INSERT INTO Students VALUES(ID, Student_ID,Last Name, First Name, Program, Contact Number, Email);
```

7. Finally, after storing the image and information of the person, run the encodingprocess.py to encode the picture of the person on the system.

```
pi@raspberrypi:~ $ cd Desktop/Thesis_Final
pi@raspberrypi:~/Desktop/Thesis_Final $ python encodingprocess.py
```

Removing data on the system

1. Delete the picture of the former students and faculties in the image folder.



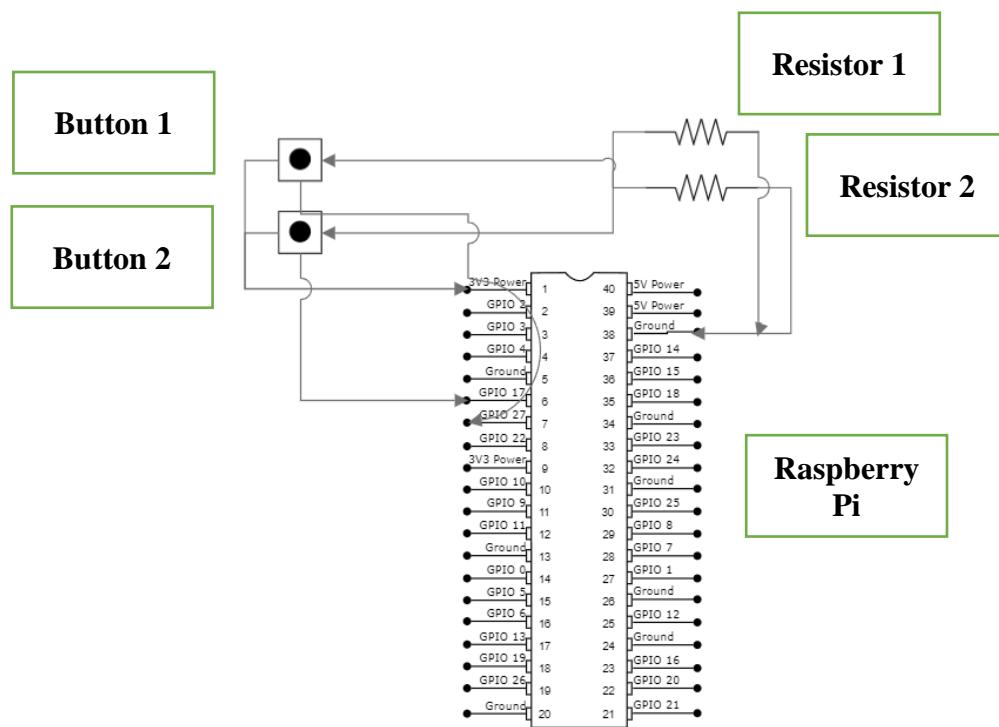
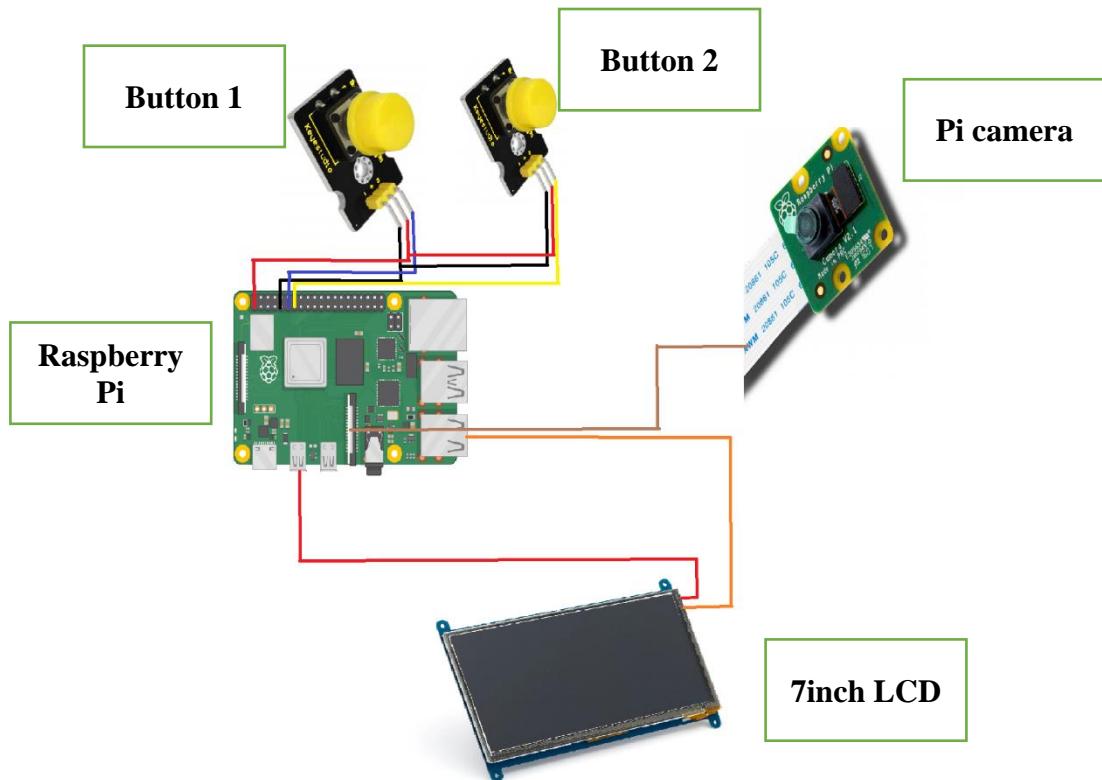
2. Access the database and use the delete function of mysql in order to remove the existing data.

```
MariaDB [Students]> DELETE FROM Students WHERE ID = Id Num;
```

3. Run the encodeprocess.py to update the data.

```
pi@raspberrypi:~ $ cd Desktop/Thesis_Final  
pi@raspberrypi:~/Desktop/Thesis_Final $ python encodingprocess.py
```

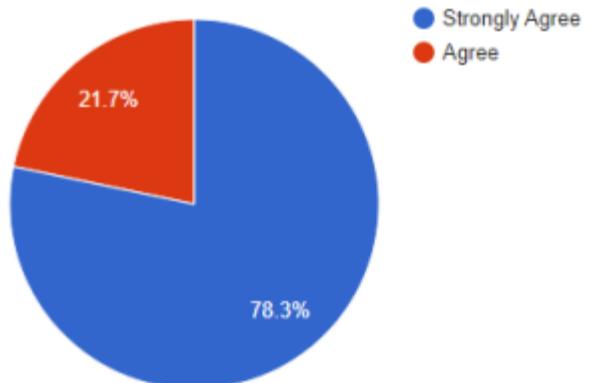
APPENDIX E. SCHEMATIC DESIGN



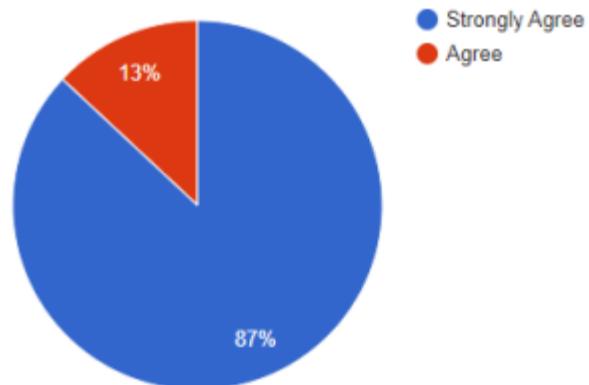
APPENDIX F. EVALUATION RESULTS

FUNCTIONALITY

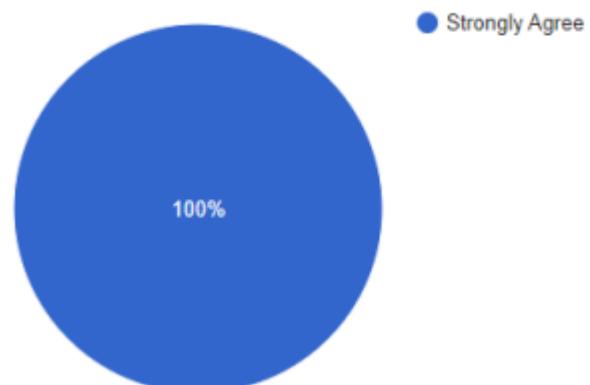
Completeness: The device can produce a complete output.



Correctness: The device operates in accordance with its intended purpose

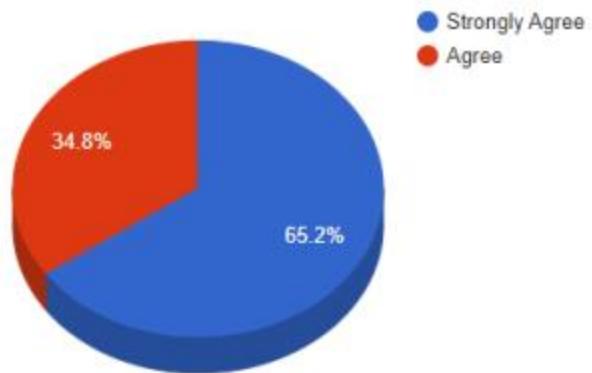


Appropriateness: The device produces the proper output based on its correct method.

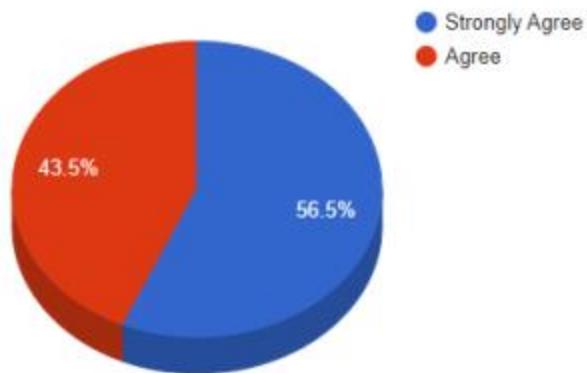


RELIABILITY

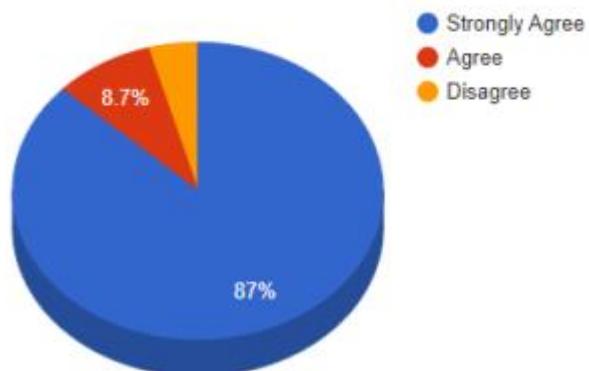
Maturity: After the final implementation, the device is completely functioning.



Availability: When needed, the device is functioning and accessible

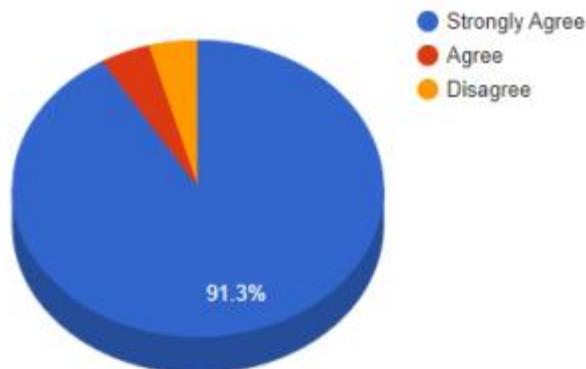


Recoverability: In the case of an interruption or breakdown, the device can restore the desired state of the system.

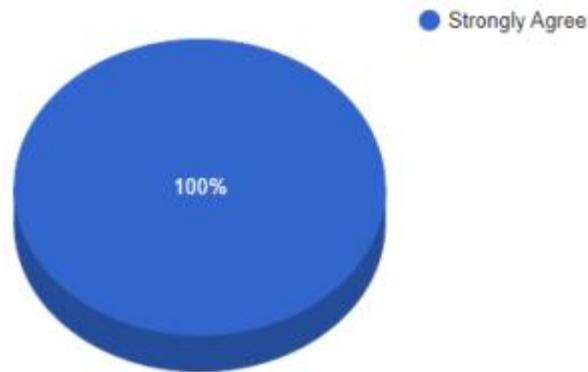


USABILITY

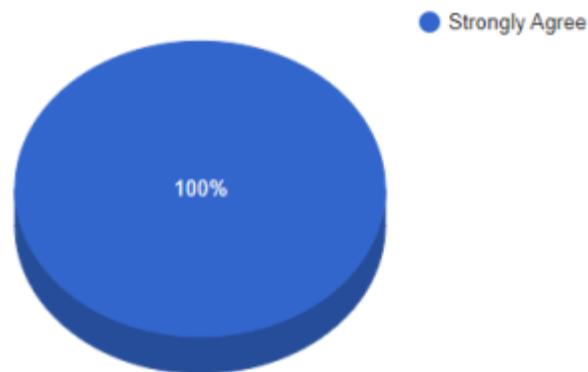
Operability: The device contains features that make it simple to use and control



Learnability: The device may be utilized by certain users to achieve specific goals such as learning how to use the product effectively.

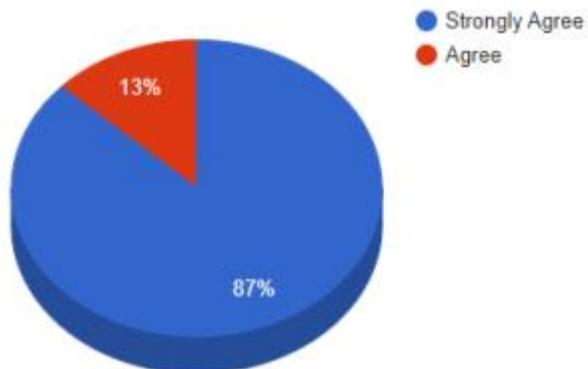


Accessibility: The device is used by persons with a wide range of characteristics and abilities.

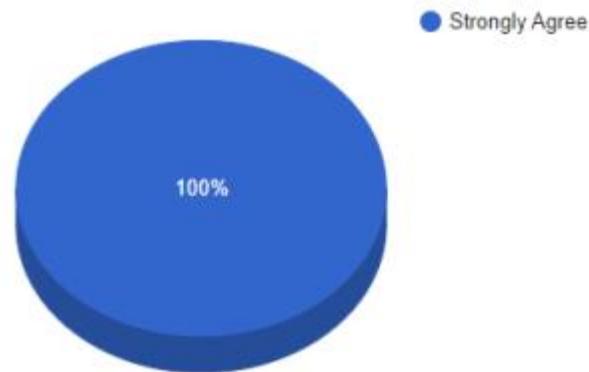


PERFORMANCE EFFICIENCY

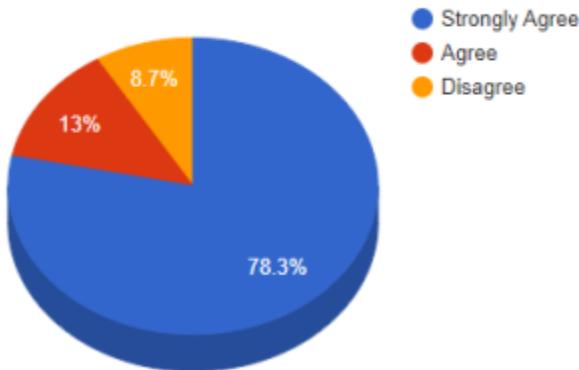
Capacity: The device satisfies the maximum limit parameter criteria.



Time behavior: Based on the device needs, the machine processing time responds well.

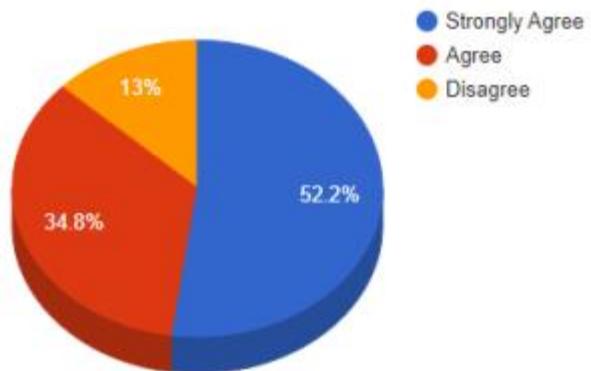


Resource utilization: To satisfy the right performance of the functions, the device can utilized the appropriate quantity and kind of resources.

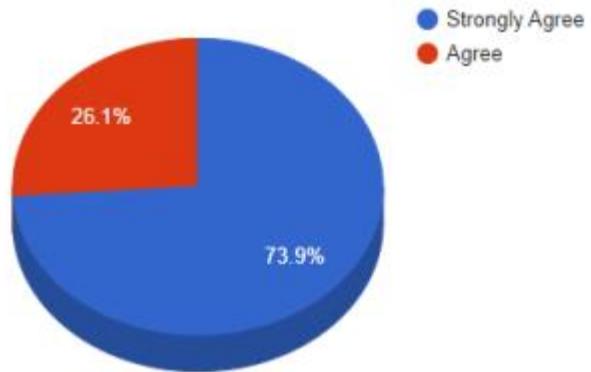


MAINTAINABILITY

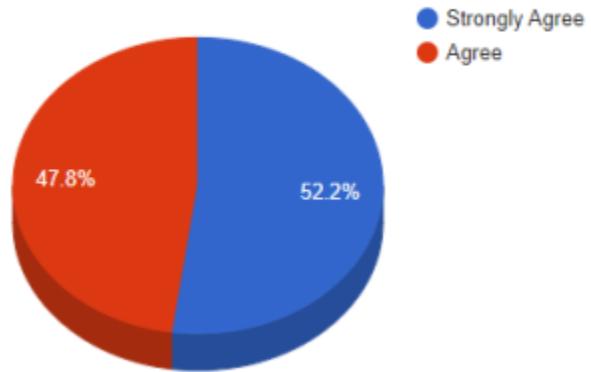
Reusability: The device may be utilized in a variety of industries.



Modifiability: The device may be updated without causing flaws or lowering the quality of the present product.

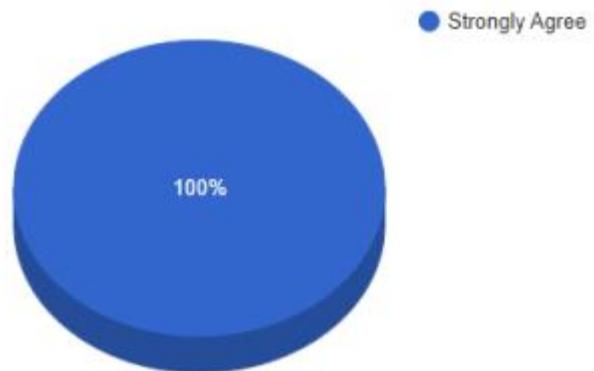


Modularity: The device is made up of components that may be swapped out with minimum influence on other components.

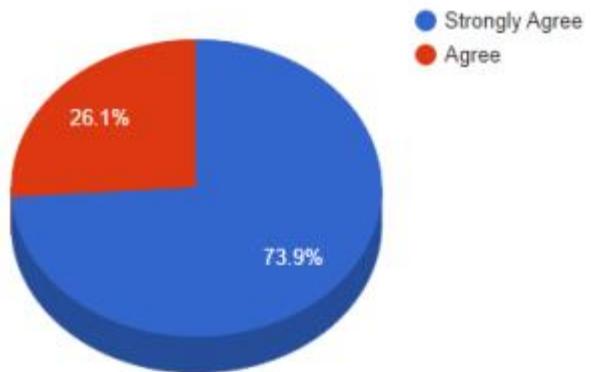


PORATABILITY

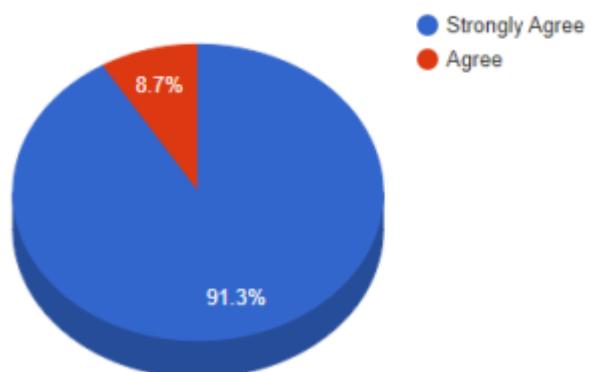
Adaptability: The device may be successfully customized for new or changing hardware.



Installable: In the appropriate environment, the device can be successfully installed and/or removed.

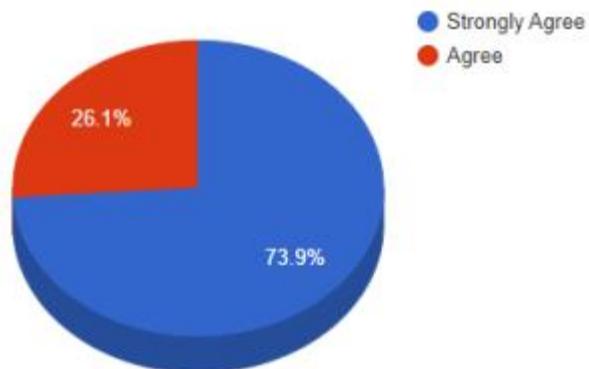


Replaceability: In the same environment, the device can be replaced with another specified part for the same purpose.

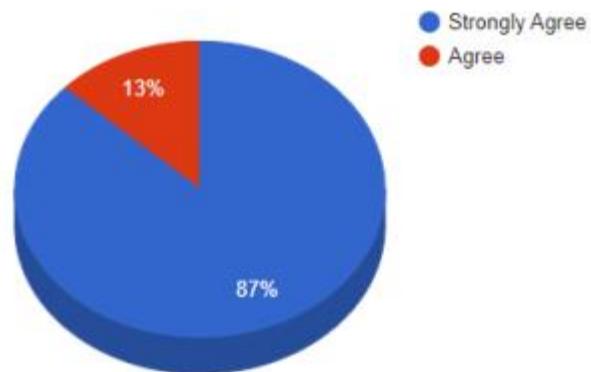


SECURITY

Confidentiality: In the same environment, the device can be replaced with another specified part for the same purpose.



Authenticity: The asserted device identity and resources may be proven.



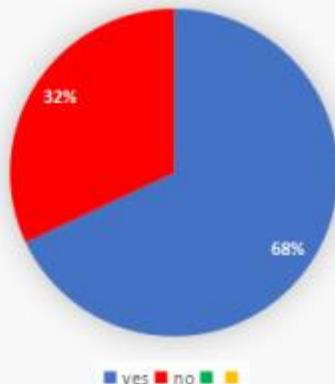
Accountability: The device can track the user's actions while utilizing each function.



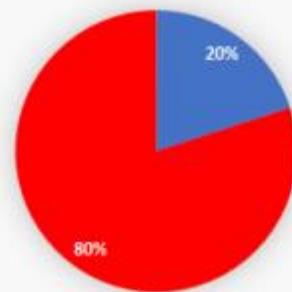
APPENDIX G. SURVEY RESULTS

Pre-test Result 1.1 for Parents

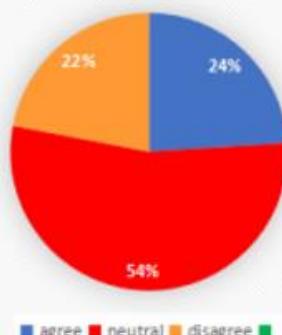
Are you aware about the time entry of your child in his/her school?



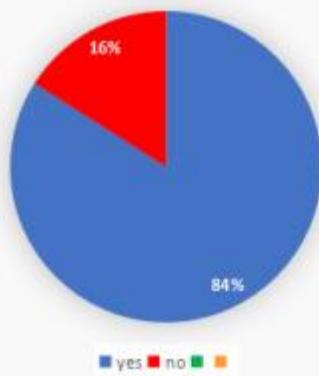
Are you once informed by the teacher that your child is inactive in terms of his/her attendance?



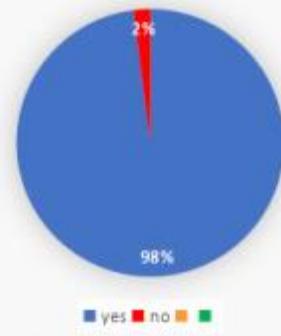
Every time your child goes to school, are you certain that they will attend their individual class?



Can you say that your child is safe inside the school?



Do you agree on generating a system where it can notify you about the time entry of your child?



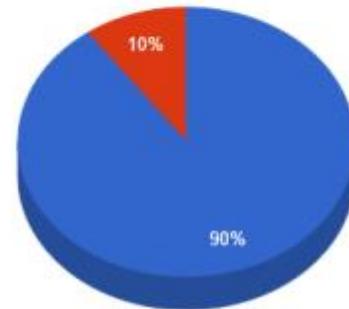
Post-test Result 1.2 for Parents

After using the device, are you aware about the time entry of your child in his/her school?



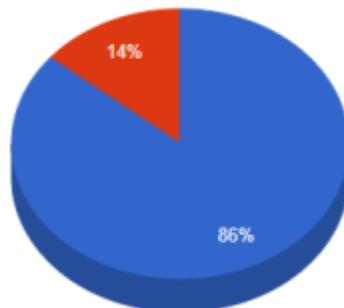
● Yes

After using the device, are you satisfied that you received an email if your child is active in term of his/her attendance?



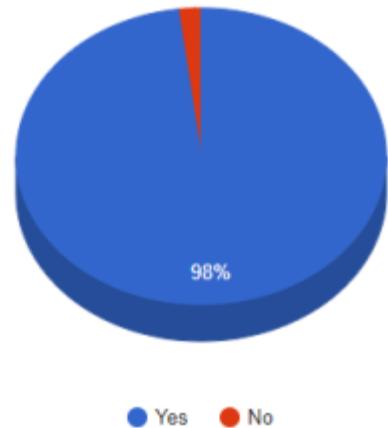
● Yes ● No

After using the device, can you say that your child is safe inside the school?



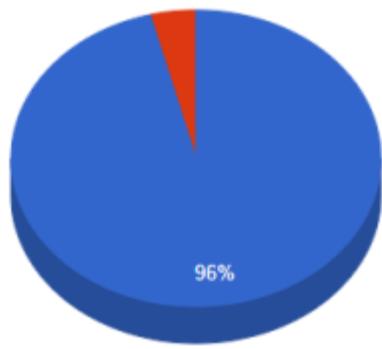
● Yes ● No

Implementing the prototype in school will increase the security and safeness of students.



● Yes ● No

After using the device, do you think it necessary to send an email for time in and time out of the student?

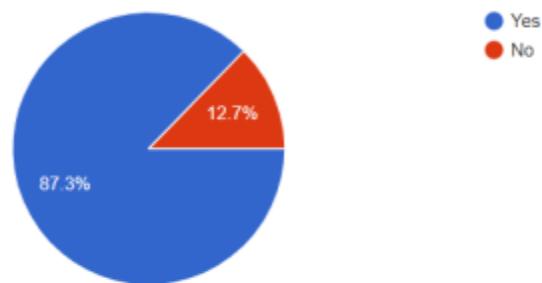


● Yes ● No

Pre-test Result for Student 1.1

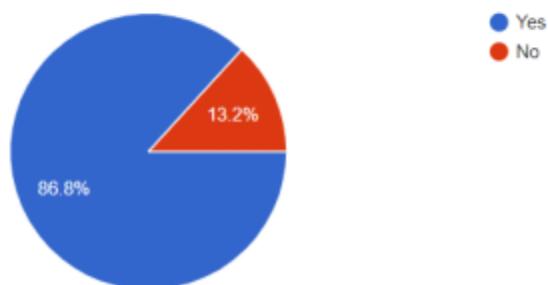
Is attendance important to you?

197 responses



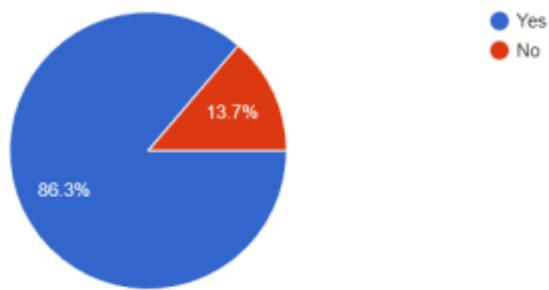
Does attendance affect your grades?

197 responses



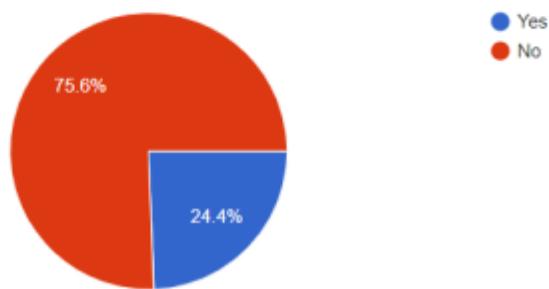
Do you let your parents know about your school schedule?

197 responses



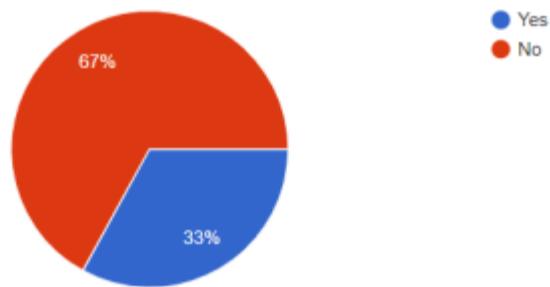
Do your parents ask if you've already entered into school?

197 responses



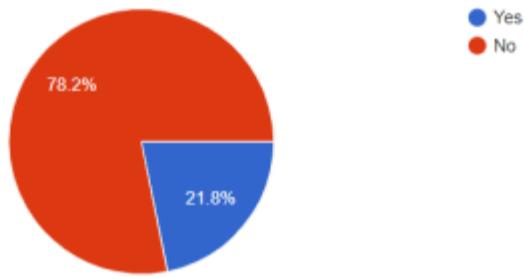
Do your parents know the exact time of your school entry?

197 responses



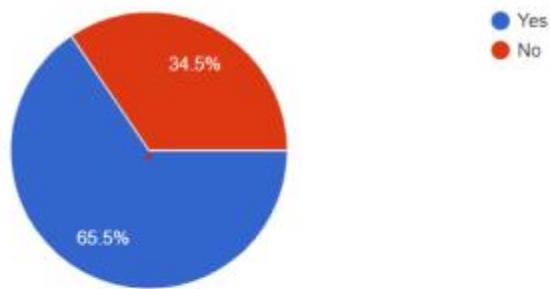
Do you ever think that whenever there are outsiders in school, there might be a chance of chaos or trouble occurring?

197 responses



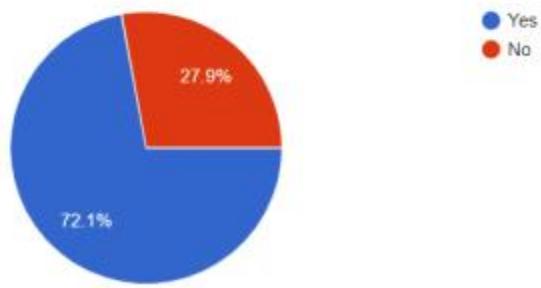
Do you go straight home when you leave school?

197 responses



Would you agree to have a device that will inform your parents of your arrival and departure from school, including a picture of you?

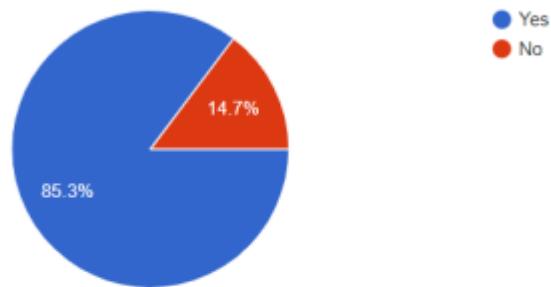
197 responses



Post-test Result for Student 1.2

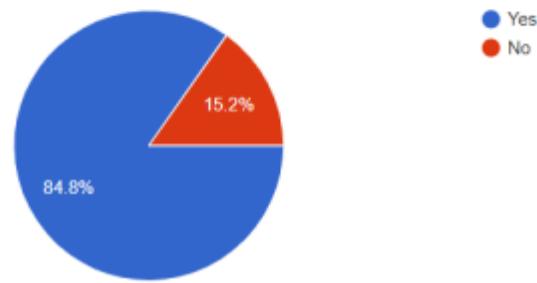
Will the device help to speed up the process of taking your attendance?

197 responses



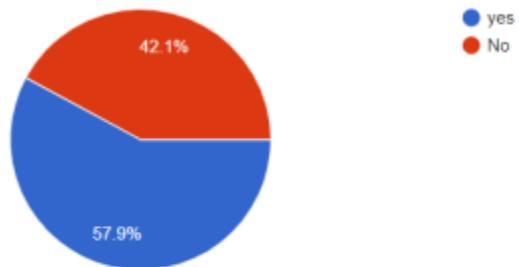
After using the device, do you think it helped in informing your parents about your school attendance?

197 responses



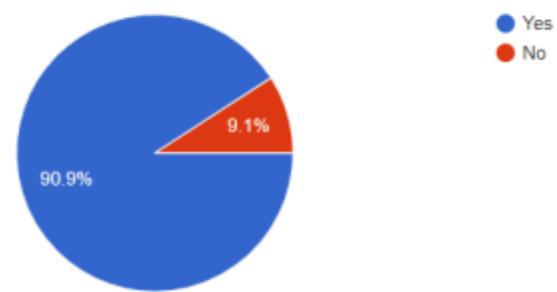
After using the device, do you think it is okay if your parents received a picture of you every time you enter and exit into school?

197 responses

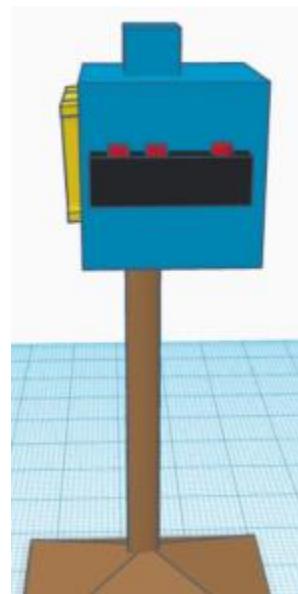
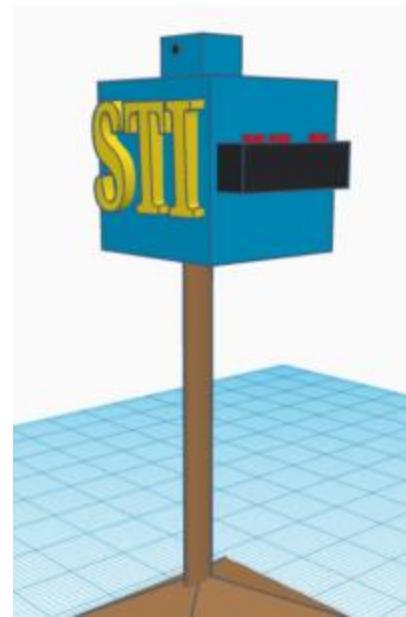


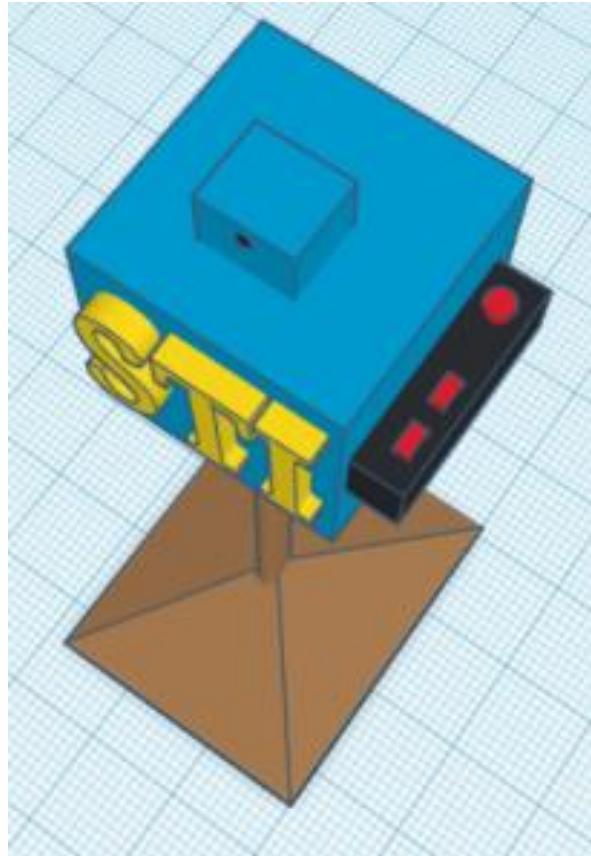
After using the device, Do you think this will help enhance the security of STI?

197 responses



APPENDIX H. ARCHITECTURAL DESIGN







ACTUAL IMAGE OF PROTOTYPE



APPENDIX I. PROGRAM CODE

```
import cv2
import cvzone
import face_recognition
from picamera2 import Picamera2
import numpy as np
import mysql.connector
from mysql.connector import Error
import tensorflow as tf
import tensorflow.lite as lite
import os
from datetime import datetime,date,time,timedelta
import yagmail
import pygame
import RPi.GPIO as GPIO
import pandas as pd
from joblib import load
```

#-----MySQL Commads-----

```
host_name, user_name, password, database= ("localhost" , "root", "12345908527",
"Students")
```

```
def my_connection(host_name, user_name, password, database):
    connection = None
    try:
```

```

connection = mysql.connector.connect(
    host = host_name,
    user = user_name,
    passwd = password,
    db = database
)
print("Successful")

except Error as err:
    print(f"Error: {err}")

return connection

def read_query(connection, query):
    cursor = connection.cursor()
    result = None
    try:
        cursor.execute(query)
        results = cursor.fetchall()
        return results
    except Error as err:
        print(f"Error : {err}")

def execute_query(connection, query):
    cursor = connection.cursor()
    try:

```

```
        cursor.execute(query)

        connection.commit()

        print("Successfully Executed")

    except Error as err:

        print(f"Error {err}")

connection = my_connection(host_name, user_name, password, database)
```

```
#-----
#-----Anti-Spoofing-----
```

```
class ClassifierLite:

    def __init__(self, model, labels):

        self.interpreter = tf.lite.Interpreter(model_path=model)

        self.interpreter.allocate_tensors()

        self.input_details = self.interpreter.get_input_details()

        self.output_details = self.interpreter.get_output_details()
```

```
with open(labels, "r") as f:

    self.labels = [line.strip() for line in f.readlines()]

    self.true_labels = [label.split(" ")[1] for label in self.labels]
```

```
def get_prediction(self, img):
```

```

img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

img = cv2.resize(img, (224, 224))

img = np.asarray(img, dtype=np.uint8)

self.input_data = np.expand_dims(img, axis=0)

self.interpreter.set_tensor(self.input_details[0]['index'], self.input_data)

self.interpreter.invoke()

self.output_data = self.interpreter.get_tensor(self.output_details[0]['index'])

self.predicted_class = self.true_labels[np.argmax(self.output_data)]

return self.predicted_class

#-----
#-----Play Audio-----
class playAudio:

    def __init__(self, file):

        self.sound = file

        pygame.mixer.init()

        sound_file = pygame.mixer.Sound(self.sound)

        sound_file.play()

#-----
#-----TIME MODE-----
time_in_picture = cv2.imread("interface2/TIME IN.png")

time_out_picture = cv2.imread("interface2/TIME OUT.png")

cutting_picture = cv2.imread("interface2/Cutting.png")

GPIO.setmode(GPIO.BCM)

```

```

time_in_pin = 17
time_out_pin = 27
GPIO.setup(time_in_pin, GPIO.IN)
GPIO.setup(time_out_pin, GPIO.IN)
value_state1 = 0
value_state2 = 1
time_in_option = 1
time_out_option = 0
#-----
def email_sender_parents(email, lastname, firstname, image):
    yag = yagmail.SMTP("calambasti5@gmail.com", "oeyoxzeqgwqvuyyv")
    yag.send(to=email, subject="Student Attendace", contents=f"""<h1>{lastname}, {firstname} is now inside the school.</h1>
Kindly Check if the person in the image is your son/daugther.
Have a good day.
Aim High With STI.
""", attachments=image)
    print("Email Sent")

def email_sender_security(email, lastname, firstname, image):
    yag = yagmail.SMTP("calambasti5@gmail.com", "oeyoxzeqgwqvuyyv")
    yag.send(to=email, subject="Student Attendace", contents=f"""<h1>{lastname} {firstname} an anonymous person is trying to enter the school.</h1>
Please verify if the person in the picture is allowed to enter the school.
Have a good day.
""")

```

Aim High With STI.

```
"""", attachments=image)
```

```
print("Email Sent")
```

```
#-----CAMERA SETTINGS-----
```

```
piCam = Picamera2()
```

```
piCam.preview_configuration.main.size=(720, 600)
```

```
piCam.preview_configuration.main.format="RGB888"
```

```
piCam.preview_configuration.controls.FrameRate = 60
```

```
piCam.configure("preview")
```

```
piCam.start()
```

```
#-----
```

```
#-----ALL OF THE CLASSES-----
```

```
myModel = ClassifierLite(model="models/model.tflite", labels="models/labels.txt")
```

```
#-----
```

```
#-----INTERFACE OF THE FINAL PROJECT-----
```

```
path2 = "interface"
```

```
guiList = os.listdir(path2)
```

```
guiInterFace = []
```

```
for img in guiList:
```

```
    gui = cv2.imread(f"{path2}/{img}")
```

```
guiInterFace.append(gui)

webcam = guiInterFace[2]

#-----ENCODING THE TRAIN DATA-----
path = "train_data"

images_path ="images"
imageList = os.listdir(path)

images_gui = os.listdir(images_path)

images_text = []

images = []

img_for_gui = []

id_numbers = []

for img in images_gui:

    curImg = cv2.imread(f"{path}/{img}")

    curImg2 = cv2.resize(curImg, (245, 215))

    img_for_gui.append(curImg2)

    image_num = os.path.splitext(img)[0]

    images_text.append(int(image_num))

for img in imageList:
```

```

id = os.path.splitext(img)[0]

real_id = id.split(" ")[0]

id_numbers.append(int(real_id))

encodeKnown = load(filename = "encodeListKnown.joblib")

#-----TIME-----


now = datetime.now()

current_time = now.strftime("%H:%M:%S")

result_time = datetime.combine(date.today(),time(int(current_time[:2]),

                                         int(current_time[3:5]),

                                         int(current_time[6:8]))) + timedelta(seconds=5)

now2 = datetime.now()

current_time2 = now2.strftime("%H:%M:%S")

result_time2 = datetime.combine(date.today(),time(int(current_time2[:2]),

                                                 int(current_time2[3:5]),

                                                 int(current_time2[6:8]))) + timedelta(seconds=5)

now3 = datetime.now()

current_time3 = now3.strftime("%H:%M:%S")

result_time3 = datetime.combine(date.today(),time(int(current_time3[:2]),

                                                 int(current_time3[3:5]),

                                                 int(current_time3[6:8]))) + timedelta(seconds=5)

now4 = datetime.now()

```

```

current_time4 = now4.strftime("%H:%M:%S")

result_time4 = datetime.combine(date.today(),time(int(current_time4[:2]),
                                             
                                              int(current_time4[3:5]),
                                             
                                              int(current_time4[6:8]))) + timedelta(seconds=5)

#-----  

intruder_attack = 0

#-----CSV DATA-----  

Student_ids = []  

names_of_students = []  

time_of_entries = []  

time_of_out = []  

data = None  

string_date_now = now.strftime("%Y-%m-%d")  

#-----  

while True:  

    curTime = datetime.now()  

    curTime_string = curTime.strftime("%H:%M:%S")  

    if curTime_string == "20:12:00":  

        result_for_attendees = read_query(connection, f"""SELECT Student_ID,  

CONCAT>Last_Name, ", ", "", First_Name), Time_In, Time_Out  

FROM StudentAttendance LEFT JOIN Students USING(ID) """)  

        for id in result_for_attendees:

```

```

Student_ids.append(id[0])

names_of_students.append(id[1])

time_of_entries.append(id[2])

time_of_out.append(id[3])

print(Student_ids, names_of_students, time_of_entries, time_of_out)

data = pd.DataFrame({

    "Name of Students": names_of_students,

    "Time of entry": time_of_entries,

    "Time of out": time_of_out

}, index= Student_ids)

data.to_csv(f"attendance/{string_date_now}.csv")

execute_query(connection, "TRUNCATE TABLE StudentAttendance")

value_state1 = GPIO.input(time_in_pin)

value_state2 = GPIO.input(time_out_pin)

img = piCam.capture_array()

image = img.copy()

class_name = myModel.get_prediction(img)

webcam[0:600, 0:720] = image

webcam[0:600, 600: 424 + 600] = guiInterFace[0]

if value_state1 == 1:

    time_in_option = 1

    time_out_option =0

```

```

        elif value_state2 == 1:

            time_in_option = 0

            time_out_option = 1


        if time_in_option == 1:

            webcam[0:107, 0:210] = time_in_picture

        elif time_in_option == 0:

            webcam[0:107, 0:210] = time_out_picture


    if class_name == "Face":

        imgS = cv2.resize(image, (0,0), None, 0.25, 0.25)

        imgRgb = cv2.cvtColor(imgS, cv2.COLOR_BGR2RGB)

        curFaceLoc = face_recognition.face_locations(imgRgb)

        curEncoding = face_recognition.face_encodings(imgRgb,
curFaceLoc,num_jitters=0,model="small")

        for encodFace, faceLoc in zip(curEncoding, curFaceLoc):

            matches = face_recognition.compare_faces(encodeKnown, encodFace, tolerance=
0.40)

            faceDis = face_recognition.face_distance(encodeKnown, encodFace)

            y1,x2,y2,x1 = faceLoc

            y1,x2,y2,x1 = y1 *4, x2 * 4, y2*4,x1*4

            time_in = read_query(connection, "SELECT * FROM StudentAttendance ")

            inside = [id[0] for id in time_in]

```

```

bbox = x1, y1, x2-x1, y2-y1

if time_in_option== 1 and time_out_option == 0:

    try:

        _ = matches.index(True)

        num_index = np.argmin(faceDis)

        student_id = id_numbers[num_index]

        StudentsInfo = read_query(connection, f"SELECT * FROM Students
WHERE ID = {student_id}" )[0]

        _, Student_Id, LastName, FirstName, Program, Attendance_Count,
Contanct_Number, Email = StudentsInfo

if student_id not in inside:

    playAudio("sounds/Face_Recognized_voice.wav")

    enter_attendance = f"""INSERT INTO StudentAttendance(ID)
VALUES({student_id})"""

    execute_query(connection, enter_attendance)

    intruder_attack = 0

    try:

        img_path = f"entry_picture/{student_id}_in_img.jpg"

        cv2.imwrite(img_path, image)

        #

        email_sender_parents(Email, LastName, FirstName, img_path)

        #

        os.remove(img_path)

except:

    print("No internet")

```

```

else:

    webcam[0:600, 600:424 + 600]= guiInterFace[5]

    student_img = images_text.index(student_id)

    webcam[135:215 + 135, 688:245 + 688] = img_for_gui[student_img]

    cv2.putText(webcam,f" {LastName} ",(680, 412),
cv2.FONT_HERSHEY_COMPLEX_SMALL, 1.2, (255,255,255), 2)

    cv2.putText(webcam,f" {Student_Id} ",(680, 485),
cv2.FONT_HERSHEY_COMPLEX_SMALL, 1.6, (255,255,255), 2)

    cv2.putText(webcam,f" {Program} ",(680, 560),
cv2.FONT_HERSHEY_COMPLEX_SMALL, 1.6, (255,255,255), 2)

intruder_attack = 0

```

```

except:

    cvzone.cornerRect(webcam, bbox, rt=0, colorC=(255, 0, 0))

    webcam[0:600, 601:423 + 601] = guiInterFace[3]

    if curTime > result_time:

        playAudio("sounds/Warning_voice.wav")

        now = datetime.now()

        current_time = now.strftime("%H:%M:%S")

        result_time = datetime.combine(date.today(),time(int(current_time[:2]),
int(current_time[3:5]),

int(current_time[6:8]))))

timedelta(seconds=5)

intruder_attack += 1

```

```

if intruder_attack == 5:

    intrud_img = "intrud_img.jpg"

    cv2.imwrite(intrud_img, image)

    email_sender_security("moradacar12711@gmail.com", "High Officer", "Security",
intrud_img)

    os.remove(intrud_img)

    intruder_attack == 0


else:

    cvzone.cornerRect(webcam, bbox, rt=0)

    cvzone.putTextRect(webcam,f"FirstName}", (x2 -130, y2 + 70),
thickness=3, scale = 2)

elif time_in_option == 0 and time_out_option == 1:

    try:

        _ = matches.index(True)

        record_curTime = datetime.now()

        num_index = np.argmin(faceDis)

        student_id = id_numbers[num_index]

        StudentsInfo = read_query(connection, f"""SELECT * FROM Students
LEFT JOIN
StudentAttendance
USING(ID)
WHERE ID = {student_id}""") [0]

```

```
_ , Student_Id, LastName, FirstName, Program, Attendance_Count,  
Contanct_Number, Email, Time_In, Time_Out, time_in_email, time_out_email=  
StudentsInfo
```

```
if Time_Out == None:  
  
    if _ not in inside and curTime > result_time3:  
  
        playAudio("sounds/Not in.wav")  
  
        now3 = datetime.now()  
  
        current_time3 = now3.strftime("%H:%M:%S")  
  
        result_time3 =  
datetime.combine(date.today(),time(int(current_time2[:2]),  
  
                           int(current_time3[3:5]),  
  
                           int(current_time3[6:8]))) + timedelta(seconds=5)  
  
  
elif _ in inside:  
  
    my_now = datetime.now()  
  
    day_of_week = my_now.weekday()  
  
    if day_of_week == 0:  
  
        monday_query = f"SELECT * FROM Schedule WHERE ID =  
{student_id}"  
  
        my_result_date = str(read_query(connection,  
monday_query)[0][1])  
  
        print(my_result_date)  
  
        my_result_date = time(hour=int(my_result_date[:2]), minute  
=int(my_result_date[3:5]), second=int(my_result_date[6:]))  
  
        time_now = now.time()  
  
        if time_now > my_result_date:
```

APPENDIX J. LETTER FOR STI COLLEGE CALAMBA

April 17, 2023
Fe Dalangin Yedra, MAITE, LPT
Academic Head
STI College Calamba
Brgy. Uno, National Highway
Calamba City, Laguna

Dear Ms. Yedra,

We are student of Bachelor of Science in Computer Engineering at STI College Calamba. We are currently doing the capstone 2 entitled Facial Recognition System of Students and Faculties for STI College Calamba. With this letter, we would like to invite all of faculty members for prototype testing of our capstone and 15 minutes interview. Please find the below more information on the study and the interview setting:

Subject:

Our capstone goal is to establish a Facial Recognition Attendance System that based on Facial Recognition with student and faculty profile, attendance and queuing system for the user's convenience in terms of time, effort, and increased safety by removing direct contact with undesired objects.

Scope:

The focus of this prototype pertains to attendance and queuing system where it processes student's information entering the school premises and handling the people lining on a specific appointment in school.

Preparation:

As small preparation for the interview, please think of the way Facial Recognition System.

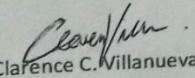
Duration:

This interview will take around 15 minutes and will be recorded for data analysis purposes.

Privacy and anonymity:

The recording will only be available to the interviewer and the direct supervisors of STI College Calamba and will in no way be used other than for the analysis of this research. In the resulting thesis, your participation will be anonymized by default, unless you specifically mention that this is not necessary. In that case, permission may be requested at a later stage to use one or more direct quotes.

Sincerely Yours,


Clarence C. Villanueva

Developer

Prototype Testing : Apr 17 - May 22
Attendance Fms

Checked by:


Marvic M. Espiritu

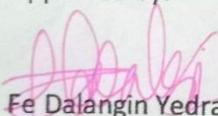
Thesis Adviser

Noted by:


Jocelyn Llanderol, MIT

Program Head

Approved by:


Fe Dalangin Yedra, MAITE, LPT

Academic Head

Date: March 13, 2023

To:

Head of Security
Brgy Uno, Calamba, Laguna
4027

Subject: Request Letter

Dear Corporal Nardito,

We are the student in Bachelor of Science in Computer Engineering at STI College Calamba. We are currently doing research study on Facial Recognition of Students and Faculties for STI College Calamba. With this letter, we would like to invite you for a 30 minutes interview on the subject. Please find the below more information on the study and the interview setting:

Subject:

Our research goal is to innovate a prototype that will enhance the quality in terms of security and expand security measures inside the school of STI.

Scope:

The focus of this research pertains to attendance and queuing system where it processes student's information entering the school premises and handling the people lining on a specific appointment in school.

Preparation:

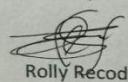
As small preparation for the interview, please think of the way Facial Recognition System

Duration:

This interview will take around 30 minutes and will be recorded for data analysis purposes.

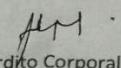
Privacy and anonymity:

The recording will only be available to the interviewer and the direct supervisors of STI College Calamba and will in no way be used other than for the analysis of this research. In the resulting thesis, your participation will be anonymized by default, unless you specifically mention that this is not necessary. In that case, permission may be requested at a later stage to use one or more direct quotes.



Rolly Recodig

Security In Charge



Nardito Corporal

Officer In Charge

April 18, 2023

Fe Dalangin Yedra, MAITE, LPT

Academic Head

STI College Calamba

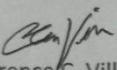
Brgy. Uno, National Highway

Calamba City, Laguna

Dear Ms. Yedra,

We are student of Bachelor of Science in Computer Engineering at STI College Calamba. We are currently doing the capstone 2 entitled Facial Recognition System of Students and Faculties for STI College Calamba. With this letter, we would like to request to bring our prototype inside the school. So that, we can start to test our prototype with faculty members.

Sincerely Yours,


Clarence C. Villanueva

Developer

Checked by:


Marvic M. Espiritu

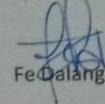
Thesis Adviser

Noted by:


Jocelyn Llanderal, MIT

Program Head

Approved by:


Fe Dalangin Yedra, MAITE, LPT
Academic Head

May 8, 2023

Fe Dalangin Yedra, MAITE LPT

Academic Head

STI College Calamba

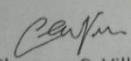
Brgy. Uno, National Highway

Calamba City, Laguna

Dear Ms. Yedra,

We are student of Bachelor of Science in Computer Engineering at STI College Calamba who is currently developing capstone 2 entitled Facial Recognition System of Students and Faculties for STI College Calamba. With this letter, we would like to invite among the selected respondents in STI College Calamba to test our prototype and conduct a survey. The survey will be conducted on May 8-10, 2023.

Sincerely Yours,


Clarence C. Villanueva

Developer

Checked by:


Marvic M. Espiritu

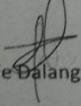
Thesis Adviser

Noted by:


Jocelyn Llanderal, MIT

Program Head

Approved by:


Fe Dalangin Yedra, MAITE, LPT
Academic Head

APPENDIX K. INTERVIEW

Interview from a research participant

The developers conducted an interview from Officer In Charge of STI College Calamba to know the past issues regarding the safety of students and faculty inside the school, through this method, the proponents will determine if the prototype will be effective in the school. An interview is a formal conversation between two or more people, where one person (the interviewer) asks questions and the other person (the interviewee) provides answers. Interviews are often conducted for the purpose of gathering information, assessing qualifications or suitability for a job, or for media or research purposes.

Below is transcript of the interview:

Interviewee: "Do they often encounter strangers who enter STI?"

Officer In Charge: "Particularly during events, a significant number of individuals visit this location. However, as security guards who have been stationed here for a considerable period, we have observed that the majority of those who attempt to enter are not real students in here. We prevent their entry as we are capable of recognizing the students and distinguishing non-affiliated persons based on their facial expressions. While we do not grant them immediate entry, we maintain courteous communication with them to avoid any misconceptions, regardless of their admission status."

Interviewee: "If strangers are going inside the school, do they still need permission to enter?"

Officer In Charge: Yes, permission is required to enter. If someone has been approved by the head of STI, we allow them entry. Often, individuals who are not students but have connections with someone here, such as a friend, sibling, or cousin, attempt to enter, and we make sure to inform the authorities before granting them access. However, if they have proper identification and approval from the head, we permit them to enter.

Interviewee: "Are there any strangers who suddenly enter without permission?"

Officer In Charge: "There are a lot of people who suddenly come in without notice. We usually notice them when they are already inside the premises, especially during events or services. Some people seem to know the drill and take advantage of a busy guard to sneak in. However, we are quick to catch on and follow up. There are also individuals who come on motorcycles or in cars and have connections here, but they fail to inform us beforehand."

Interviewee: "Has there been any recorded accident inside STI due to the entry of an unknown person?"

Officer In Charge: "No, not really, except for some former students who occasionally drop by for confrontations. They usually have some personal issues or grievances that they want to settle, and they only come to campus for that purpose. Other than that, there haven't been any significant incidents of people entering the premises without permission."

Interviewee: "What about the latest issue regarding the reported loss of items?"

Officer In Charge: "The equipment used by unauthorized individuals is usually borrowed from their fellow students. Unfortunately, there are some people who come in and act like shoplifters, making it hard for us to prevent them from entering the premises. They pretend to have complete IDs and documentation and even claim that they will pay their tuition fees. However, despite their dubious behavior, they still have the right to enter the campus."

Interviewee: "On a scale of 1-10, how secure do you think the security of the STI is?"

Officer In Charge: "In my opinion, if I were to rate our situation, it wouldn't be perfect because we're understaffed. At the moment, we only have around 7 guards, and that's not enough to cover the whole campus. However, if we were to have more personnel, I believe we could achieve a perfect rating. Currently, I can't give it a 10 because we still have a long

way to go. Having just one guard on patrol inside the campus makes it difficult to ensure everyone's safety.”

Interviewee: “In your opinion, what alternative security measures do you think can be implemented here in STI aside from just writing down one’s name and contact number?”

Officer In Charge: “As security personnel here, we only follow the rules of STI security. We take the name, capture the image, and get the ID. We can't go beyond the rules of STI.

Interview for several of the faculty members

The developers used convenience sampling to interrogate some of the faculty members in regards to one of the functions of the prototype, which is to send an email that contains a picture of them to the supervisors. Based on the accumulated data, 10 out of 15 faculty members stated that it's okay for them to implement a notification to supervisors about their time of entry. Furthermore, several faculty members corroborated that it is acceptable to include a picture of them in the email.

**APPENDIX L. ACTUAL TESTING OF PROTOTYPE IN STI COLLEGE
CALAMBA**



OPPO A94





FT

OPPO A94

APPENDIX M. ADVISERS ACCEPTANCE FORM

ADVISER'S ACCEPTANCE FORM

NAME OF PROPONENTS: Clarence C. Villanueva
 Carl Mathew D. Morada
 Jed Leander M. Bergola

APPROVED RESEARCH TITLE: The Utilization of Smart Electric Bill Reader to the selected residents of Brgy. Mahipon, Cavinti, Laguna

AREA OF STUDY: Embedded Systems and Microelectronics

CONFORME:


Marvic Espiritu
Adviser

APPROVED BY:

Jocelyn G. Llanderal Date: 11 March, 2022 Project Coordinator

NOTED BY:

Jester Emann E. Peñaranda, MIT Program
Head

ADVISER'S ACCEPTANCE FORM

NAME OF PROPONENTS: Clarence C. Villanueva
Carl Mathew D. Morada
Jed Leander M. Bergola

APPROVED RESEARCH TITLE: The Process of Implementing the Automated Door Access based on RFID for the entrance in STI
College Calamba

AREA OF STUDY: Embedded Systems and Microelectronics

CONFORME:



Marvin Espiritu
Adviser

APPROVED BY:

Jocelyn G. Llanderal Date: 11 March, 2022 Project Coordinator

NOTED BY:

Jester Emann E. Peñaranda, MIT
Program Head

ADVISER'S ACCEPTANCE FORM

NAME OF PROPONENTS: Clarence C. Villanueva
Carl Mathew D. Morada
Jed Leander M. Bergola

APPROVED RESEARCH TITLE: Air Powered Mobile Phone Charger

AREA OF STUDY: Embedded Systems and Microelectronics

CONFORME:


Marvic Espiritu
Adviser

APPROVED BY:

Jocelyn G. Llanderal Date: 11 March, 2022 Project Coordinator

NOTED BY:

Jester Emann E. Peñaranda, MIT
Program Head

APPENDIX N. THESIS PROPOSAL EVALUATION FORM

THESIS PROPOSAL EVALUATION FORM

THESSIS ADVISER	STI SCHOOL	SCHOOL YEAR/TERM
Engr. Marvic M. Espiritu	CALAMBA	2021-2022 / 2ND
THESSIS TITLE		
DEVELOPMENT OF FACIAL RECOGNITION SYSTEM OF STUDENTS AND FACULTY FOR STI COLLEGE CALAMBA		
NAME OF GROUP MEMBERS		
Jed Leander M. Bergola	Clarence C. Villanueva	
Carl Mathew D. Morada		

INSTRUCTIONS:

Fill-out the form by checking the appropriate box that needs to be revised by the thesis group. Write your comments/suggestions/recommendations if necessary.

RECOMMENDATION:

- Thesis proposal is *approved with no revisions*.
- Thesis proposal is *approved with revisions**. (Ensure that all revisions are met to be accepted as thesis)

***CORRECTIONS/REVISONS:**

- Inappropriate thesis title.
- The study was already conducted.
- Incompleteness or incorrectness of written research problems and objectives in any of the following (*Indicate reasons*):
 - Inappropriate statement of the research problems (form).
 - Problems incorrectly state what must be solved by the study.
 - Objectives state the incorrect solutions to the problem(s).
 - Objectives of the study do not conform to S-M-A-R-T (Specific, Measurable, Attainable, Realistic, and Time-bounded) criteria.
 - The specific objectives do not state precise and definite details about the project.
 - The criteria cannot be quantified for measuring the accomplishment(s).
 - The goals set by the proponents are not achievable through available means.
 - The proposed solution is not complex enough to justify a thesis.
 - It is not possible to time-bound the objectives.
 - Other (Please specify):
- Scope discusses all important modules or features of the study which were essential in the development of the project.
- Limitations of the study are incorrectly identified which make the contents of the document inconsistent to what has to be covered. (**Should provide justifications on the limitations**)
- Discussions which are not the original ideas are not properly cited and the bibliographical listing contains inadequate amount of references. (**Do not simply copy from sources**)

THESIS PROPOSAL EVALUATION FORM

Title:

Remove the phrase "development of" and add terms which will highlight what your project can do and/or auxiliary components worth of a thesis project.

Background of the problem:

It is good that all problem statements are backed up by research. However, it could have been better if an actual interview with STI Calamba Faculty Members and/or school staff was conducted. It will also localize your problem statements. Instead of pointing out general issues experienced by schools, since you already mentioned STI Calamba in your title, why not focus on local problems. Data gathered in this manner will be a lot more impactful in establishing problems. This will also make it easier for you when you are already working on Chapter 4 (Testing) since you already have contact people whom you can gather data with. Getting data to establish problems from the same group of people who will also test the project once completed will be the perfect conditions in establishing a successful project.

Objectives of the Study:

Objectives should be aligned with the problem statements. You had 4 specific problem statements. Therefore, there should be 4 specific objective statements. Its either you add an objective, or you reduce your problems.

Specific Objective #1 statement seem to be a solution to problem #1 but the discussion implies that this also covers problem #3. Be very specific and avoid covering multiple problems with one objective only. It also implies that attendance is taken right at the turnstile entrance to the campus (since you mentioned about long queues going into the campus). That is a wrong idea which may have avoided if only an actual interview is conducted with teachers. You can ask any teacher, attendance is only recorded if a student is inside the classroom, not inside the campus.

Problem #2 did not mention about parents/guardians but Specific Objective #2, suddenly mentions about them. Again, alignment should be observed. To which group of people are you really proposing a project for? The parents or the teachers? Or the students? Focus on this so you would not get confused or you do not get your readers confused.

Who is unauthorized to enter? Objective #3 discussion did not dwell on this. The term "unauthorized" should be properly defined since schools, whether we like it or not, receives visitors all the time: walk-in inquiry, parents for consultation, students from other schools conducting a study, graduates processing documents, former employees processing separation, etc.

For all three objectives, there is one common comment: A full discussion should be given as to how the objective will be accomplished, what hardware/software will be used, technology which will be integrated, and if applicable, how success rate will be measured eventually.

Limitations of the Study:

Some limitations are avoidable. Like accuracy only in broad daylight. If that is the case, why not add a ring light to your system? It won't cause much. At the same time, it makes your project more efficient.

Others:

Grammatical lapses were observed. Specifically, subject and verb agreements.

Note: Please provide a copy of this form in your Project Implementation documentation.

APPENDIX O. THESIS PROPOSAL APPROVAL FORM

THESIS PROPOSAL APPROVAL FORM

THESSIS ADVISER	STI SCHOOL	SCHOOL YEAR/TERM
Marvic M. Espiritu	Calamba	2021-2022 / 2nd Term
THESSIS TITLE		
FACIAL RECOGNITION SYSTEM OF STUDENTS AND FACULTY FOR STI COLLEGE CALAMBA		
NAME OF GROUP MEMBERS		
Jed Leander M. Bergola	Clarence C. Villanueva	
Carl Mathew D. Morada		

RECOMMENDATION:

- Thesis proposal is **approved with no revisions**.
Thesis Proposal is approved if all the necessary comments/revisions/suggestions are met based on the Thesis Proposal Evaluation Results.

Remarks:

Click or tap to enter remarks.

- Thesis proposal is **for revisions**.
Thesis Proposal is for revision if the given comments/revisions/suggestions are not met based on the Thesis Proposal Evaluation Results.

Remarks:

Click or tap to enter remarks.

Note: Please provide a copy of this form in your Project Implementation documentation.

APPENDIX P. ADVISER CONSULTATION FORM

ACCOMPLISHMENT AND CONSULTATION FORM

INSTRUCTION: List all the activities, improvements or accomplishments that has been made in your Thesis Documentation and System/Prototype. This form may be reproduced as you go along with your thesis. This form should be submitted to your Thesis Adviser every week.

Thesis Title: Facial Recognition System of Student and Faculty for STI College Calamba

Week Number: 2

ACTIVITY/ ACCOMPLISHMENT	REMARKS/ COMMENTS/ SUGGESTIONS/ DELIVERABLES and DUE DATE
1. Meeting the objectives. 2. Testing of System(If can recognize and identify the images of persons). 3. Testing of email notification. 4. Checking of Gantt Chart. 5. Testing of Alarm(security Alert). 6. Checking the design of prototype.	1. The objectives is achieved. 2. Try to test in twins. 3. Try to use SMS for receiving notification. 4. Add alarm in prototype. 5. Gantt chart updated. 6. Documentation from chapter 1 to 5 should be checked 1 week after the testing of prototype.
Prepared by: Jed Leander M. Bergola Carl Mathew D. Morada	Clarence C. Villanueva
Checked by:  Engr. Marvic Espiritu Thesis Adviser	Noted by:  Engr. Marvic Espiritu Thesis Coordinator

APPENDIX Q. CURRICULUM VITAE OF RESEARCHES

Curriculum Vitae of
Jed Leander M. Bergola
B9 Lot 49 San Isidro Heights Banlic, Cabuyao, Laguna
jedleander@gmail.com
09230892293



EDUCATIONAL BACKGROUND

Level	Inclusive Dates	Name of school/ Institution
Tertiary	2016-present	STI College Calamba
TechVoc		
High School	2012-2016	Infant Jesus Montessori Center
Elementary	2006-2012	Paulinian Learning School

SKILLS

SKILLS	Level of Competency	Date Acquired
Computer related	Beginner	2019
Programming	Proficient	2018
Microsoft Office Suite	Proficient	2017

TRAININGS, SEMINARS OR WORKSHOP ATTENDED

Inclusive Dates	Title of Training, Seminar or Workshop
March 2019	23 rd STI national Youth Convention

Curriculum Vitae of
Carl Mathew D. Morada
Blk 13 Lot 4b San Isidro Heights Banlic, Cabuyao, Laguna
Moradacarl2711@gmail.com
09085278728



EDUCATIONAL BACKGROUND

Level	Inclusive Dates	Name of school/ Institution
Tertiary	2019-present	STI College Calamba
TechVoc		
High School	2013-2017	Saint Matthew Montessori and Science High School
Elementary	2010-2013	Saint Matthew Montessori and Science High School

SKILLS

SKILLS	Level of Competency	Date Acquired
Computer Literate	Beginner	2019
Analytical Skills	Normal	2018
Statistics	Newbie	2017

TRAININGS, SEMINARS OR WORKSHOP ATTENDED

Inclusive Dates	Title of Training, Seminar or Workshop
March 2019	23 rd STI national Youth Convention

Curriculum Vitae of
Clarence C. Villanueva
Brgy. Lumot Mahipon, Cavinti, Laguna
chivillanueva784@gmail.com
09062850609



EDUCATIONAL BACKGROUND

Level	Inclusive Dates	Name of school/ Institution
Tertiary	2019-present	STI College Calamba
TechVoc		
High School	2013-2017	Lumot National High School
Elementary	2010-2013	Lumot Elementary School

PROFESSIONAL OR VOLUNTEER EXPERIENCE

Inclusive Dates	Nature of Experience/ Job Title	Name and Address of Company or Organization
2019	Volunteer	Brgy. Real Hall
2018	Work Immersion	Construction Depot

SKILLS

SKILLS	Level of Competency	Date Acquired
Computer related	Beginner	2019
Java Script	Foundational	2019
Statistics	Proficient	2019
Microsoft Office Suite	Foundational	2018

TRAININGS, SEMINARS OR WORKSHOP ATTENDED

Inclusive Dates	Title of Training, Seminar or Workshop
2021	Huawei ICT Competition Philippines 2021 Summit
2021	Hello World: Decoding the Windows of Opportunities Webinar
2020	TESDA: Receiving and Responding to Workplace Communication
2019	Current Trends and Issues in Computer Engineering Industry Seminar
2019	National Youth Convention 2019

