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THE DEVELOPMENT OF FINGERPRINT SCANNER IN A LOG DEVICE FOR ESTABLISHMENTS: A DIGITALIZED SYSTEM FOR CONTACT TRACING RECORDS

A Capstone Design Project
Presented to the Faculty of College of Engineering

In partial fulfillment of the requirements
for the conferral of the degree
of Bachelor of Science in Electronics Engineering

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APPROVAL SHEET

In partial fulfillment of the requirements for the conferral of the degree of Bachelor of Science in Electronics and Communications Engineering, this Capstone Design Project entitled **"THE DEVELOPMENT OF FINGERPRINT SCANNER IN A LOG DEVICE FOR ESTABLISHMENTS: A DIGITALIZED SYSTEM FOR CONTACT TRACING RECORDS"**, prepared and submitted by Keirone Mcilvaine R. Bautista, Robin B. Ignacio and Ken Ralph A. Tenmatay is hereby recommended for final oral examination.

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ABSTRACT

This research study is about the implementation of fingerprint identification as an alternative form of contact tracing method which aims to solve the problems that coincide with the manual contact tracing. With countless papers that could cause environmental issues to avoiding breach in privacy. The system is designed to ensure that data privacy is heavily implemented. with the integration of Biometrics as the main form of communication between the user and the device, it ensures safe and efficient contact tracing method that manages to list all the basic information needed: (Name, Contact Number, Address, Gender). Lessening the hassle of manually filling up the forms and give them sense of ease with regards to their data being compromised. The device managed to gather data out of 80 persons recording the basic information as mentioned, with the addition of the time it takes for them to go through the whole process (Enrollment and Verification). With the data being provided on Chapter IV, it helped the proponents arrive in the conclusion that implementing the system could greatly help provide efficient means of contact tracing since the manual method is still being implemented. Observing the limitations that the whole system is designed to cater only one establishment at a time which resulted to limited access for every establishment database. second, The need of sanitation before interaction with the device. And lastly, the need of admin for the website. But despite all these limitations, the proponents were able to provide good implementation of the project. To conclude, the use of fingerprints was proven to be a good choice for the proponents to use as identification for each user in an establishment

DEDICATION

We first dedicate this paper to God Almighty our creator, our strong pillar, our source of inspiration, wisdom, knowledge, and understanding. He has been our source of strength throughout the entirety of this course and on his wings that we have soared.

This research is also dedicated to our parents who never failed to give us financial and moral support, for giving all our needs during the time we developed our system and for teaching us that even the largest task can be accomplished if it is done one step at a time.

We also dedicate this project to all the people who have helped us to gather all the necessary data that we need which contributed to the accomplishment of the work.

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CHAPTER 1: THE PROBLEM AND ITS BACKGROUND

1.1 Introduction

Contact tracing plays a vital role in fighting the spread of COVID-19. It is an integral part in detecting, recording, quarantining, and tracing the total extent of the spread of the virus. Contact tracing can be broken down into 3 basic steps; contact identification, contact listing, and contact follow up. Contact identification involves asking the person with a confirmed case of the virus his activities to identify the people he had contact or been with, like his family members, work colleagues, friends, or establishments he went to. Contact listing includes all people considered to have contact with the infected person. This people should be notified and be told about the importance of receiving early care and be given information about early prevention of the disease. Contact follow-up includes the monitoring of the people who have been in contact with the infected person to ensure that they are following the quarantine instructions and to track the development of any potential symptoms.

The research focuses on an establishment within a community where there are a lot of people and safety protocols that are strictly implemented. In these places, it is necessary to record the information of everyone. This information includes the contact details of the person which is the most important data that the contact tracers need. There are a lot of different approaches implemented on this recording of personal information these includes the use of paper forms or logbooks, and the use of QR code system.

The widely use QR code system seems effective, but the proponents saw a problem in the case of using smartphones as not everyone has the technological capability to use its features, especially the elderly population. Another thing to consider is the availability of internet connection that is needed to generate or scan QR codes. So, the proponents came up with a solution that an

individual will only need his own information and biometrics. By this approach, there is no need to bring a quarantine pass or generate a QR code as they enter the establishment.

The proponents applied biometrics as the technology to ease the recording of every information of everyone. The system employs biometrics in the form of fingerprints. Each individual needs to enroll their fingerprints in our system. There are two main processes for a fingerprint system, it is the Enrollment and Verification. It all starts with the enrollment process when they enter the establishment and then the next time that they enter the establishment is the verification process. When they enroll fingerprints, they need to type their contact details in a tablet. In the verification process, there is no need to type their contact details if they are verified which means that their information is already present in the database. The whole system consists of a Fingerprint Scanner, Graphical User Interface, Tablet, Website and Database. The source coding that we used for the scanner is Python because this is more suitable for our prototype. For the Website and Database, we build it through MySQL and HTML.

1.2 OBJECTIVE OF THE PROJECT

General Objective:

The aim of this research project is to ease filling up of contact tracing forms by developing a fingerprint scanning device that can be used to gather and store information from individuals entering an establishment.

Specific Objectives:

The proponents highlighted the step-by-step objectives, and these specific objectives are aligned with the problem and solution presented from the general objective.

- **Fingerprint Device Development**

The initial step is to build a fingerprint scanner device with a Wi-Fi module that can scan fingerprint and transmit the scanned minutiae along with name and location of the establishment where the device is installed and the time when the user entered and leave the establishment to the database. The acquiring of fingerprint data is done with the use of Raspberry Pi Computer Board which can perform complex processing of fingerprint images. The processing will be done by python.

After creating the logic of the device, a database needs to be established that will store and recognize all the fingerprint of all users of every establishment. It will also serve as a basis for every data log of every user in an establishment and the time in will also be registered. The SQLite will help us develop the database which we can integrate with our python modules.

The last thing is integrating the Graphical User Interface (GUI) which displays everything on our system. Our GUI has touchscreen display which provides user friendly interaction with the user. The parameters for the interface are all set in the python modules for GUI.

- **Project Testing**

The aim of this testing is to see how the data is being collected in every person. The proponents must choose an establishment where there are a lot of individuals entering.

- **Data Visualization**

Data collection is done not just by the device testing but also from the resources where we need comparative analysis. The need to support the claim by data sets must be included in the results and discussion part. Efficiency and Accuracy rate are two measurable parameters which will lead to comparison between "Digital contact tracing forms" and "Manual contact tracing form".

- **Evaluation of Results**

The aim is to make feedback through all the results which includes all the summaries, recommendation, and conclusion of the report.

1.3 Significance of the Project

Engineering profession – this study will provide motivation to innovate and integrate new technologies that not only will contribute to present knowledge, but also, pave way to developments in other disciplines of study.

Researchers – this study can be used by future innovators by taking into consideration the paper's findings in creating a more economical yet reliable device to utilize the potential of non-chemical processes like the use of ultraviolet light as disinfection technique.

Economy – the study is proposed in response to COVID-19 pandemic to avoid direct contact in filling up the registration form. This study utilized an up-to-date technology to create a low-cost device without compromising the accuracy and effectiveness of the device.

Law Enforcement Institution – this proposed system will be of great use to this institution in matching fingerprints left in the crime scene in our database, helping the investigators in solving the crime faster.

Other Institutions – The proposed system is not limited to Law enforcement institutions. It can also be used by other institutions such as Healthcare institutions, Academic Institutions, etc., for different purposes like attendance checking, validation.

1.4 Scope and Limitation of the Project

This study focuses on making a digital contact tracing method. The study will integrate certain technology and approaches to implement a system that will be used for an efficient digital contact tracing system. The study will eliminate the use of forms in contact tracing, which will greatly contribute to environmental sustainability by minimizing the use of paper, minimizing the indirect transmission of the virus, and saving time.

Typically, in a manual contact tracing, having false information in the forms will fall under limitations. However, the proponents will address this issue with the approach they will use in the proposed digital system.

Our contact tracing system, however, will only limit in obtaining minimal personal data such as Name, Address, Email Address, Gender, and Contact Number and will not include extensive personal details such as medical records and symptoms. The system will utilize the use of memory device, web server and database in which the data can only be altered by establishments and LGU's.

1.5 Definition of Terms

Aerosol – is a collection of microscopic particles, solid or liquid, suspended in gas. (Greenfacts, n.d.)

Arduino – refers to open-source electronics which is easy to use computer designed to run 1 program at a time. (Seedstudio, Yida, 2019)

Arduino IDE – is an open-source software, which is used to write and upload code to Arduino boards. (Javatpoint, n.d.)

Binary – is a base-2 numbering system that uses the numerals 0 and 1 for counting. It is used by digital computers to perform calculations from the simplest to the most complex (techopedia, 2018)

Biometric – A measurable physical characteristic or personal behavioral trait used to recognize the identity, or verify the claimed identity, of an applicant. (NIST, Nieles, 2017)

Central Processing Unit (CPU) – is the unit which performs most of the processing inside a computer. (Techopedia, Kottayil, 2020)

Charge-Coupled Device (CCD) – an electronic device used in imaging and signal processing, in which information is represented as packets of electric charge that are stored in an array of tiny closed spaced capacitors and can be moved from one capacitor to another in a controlled way. (Dictionary, n.d.)

Complementary Metal Oxide Semiconductor (CMOS) – it is a technology used to produce integrated circuits. (Techterms, Christensson, 2017)

Data – Information that may be in the form of text, documents, images, audio clips, software programs. may be processed by the computer's CPU and is stored in files and folders on the computer's hard disk. (Techterms, Christensson, 2006)

Database – is an organized collection of structured information, or data, typically stored electronically in a computer system. (Oracle, n.d.)

Debugger – is a software program tool used to test and find bugs (errors) in other programs. (Techopedia, 2017)

Device- An invention or contrivance, particularly one that is mechanical or electrical, that is made for a specific purpose. (Dictionary, n.d.)

Digital Log – Safe and secure place for a person to store information that only they can access and share information with other people. (Digitallogbook, n.d.)

Embedded system- is a collection of computer hardware and software that is designed to perform a specific task. Embedded systems can work as part of a larger system. (IoTAgenda, Lutkevich, 2020)

Ethereum – open access to digital money and data-friendly services. (Ethereum, n.d.)

Fingerprint scanner- it is a type of technology that identifies and authenticates the fingerprints of an individual in order to grant or deny access to a computer system of a physical facility. (Techopedia, 2016)

Firebase – is a Backend-as-a-Service (Baas). It provides developers with a variety of tools and services to help them develop quality apps, grow their user base, and earn profit which is built on google infrastructure. (Educative, n.d.)

Flask - a python module that lets you develop web applications easily. (PythonBasics, n.d.)

Framework – is a platform that provides a foundation for developing software applications. (CodeInstitute, n.d.)

Graphical Processing Unit (GPU) – a specialized processor originally designed to accelerate graphics rendering. (Intel, n.d.)

Graphical User Interface (GUI) – is a user interface that includes graphical elements, such as windows, icons, and buttons. (Techterms, Christensson, 2006)

Hypertext Markup Language (HTML) – is a markup language for the web that defines the structure of webpages (Freecodecamp, Kolade, 2021)

Java – is a general-purpose, class-based, object-oriented programming language designed for having lesser implementation dependencies. (guru99, Hartman, 2021)

Project Jupyter – is a web-based interactive computing platform. The notebook combines live codes, equations, narrative text, visualizations. (Jupyter, n.d.)

Light Emitting Diode (LED) – an electronic device that emits light when an electrical current is passed through it. (Techterms, Christensson, 2009)

Memory – refers to any information or data, often in binary format, that a machine or technology can recall or use. (Techopedia, 2015)

Minutiae - refer to certain small features of a fingerprint image to identify an individual for access. (Techopedia, n.d.)

MongoDB – is a document-oriented NoSQL database used for high volume data storage. (Guru99, Taylor, 2022)

MySQL – is a full-featured relational database management system based on structured query language. (Techtarget, Moore, 2018)

Networkx – is a python package for the creation, manipulation, and study of the structure, dynamics, and functions of complex networks. (Networkx, n.d.)

Organic Light Emitting Diode (OLED) – a display technology that offers rich colors, high contrast, deep blacks, wide viewing angle, low power, and fast response time for action scenes. (PcMag, n.d.)

Operating System – software that allows a user to run other applications on a computing device. (Techopedia, 2020)

Python – is an interpreted, object-oriented, high-level programming language with dynamic semantics. (Python, n.d.)

Quick Response Code (QR) – is a type of barcode that can be read easily by a digital device and which stores information as series of pixels in a square-shaped grid. (Investopedia, Hayes, 2021)

Raspberry Pi – is a low cost, credit-card sized computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing. (RaspberryPi, n.d.)

Server - is a computer or system that provides resources, data, services, or programs to other computers, known as clients, over a network. (Paessler, n.d.)

Source Code – is the set of instructions and statements written by a programmer using a computer programming language. (Techopedia, 2017)

SQLite – is an in-process library that implements a self-contained, serverless, zero-configuration, transactional SQL database engine. (SQlite, n.d.)

Terminal – a command line interface on a Unix-based computer. (PcMag, n.d.)

Transmitter – is an electronic device used in telecommunications to produce radio waves to transmit or send data with the aid of an antenna. (Techopedia, 2016)

Web application - is a computer program that utilizes web browsers and web technology to perform tasks over the internet. (Stackpath, Gibb, 2016)

Web Server - includes several parts that control how web users access hosted files. (Mozilla, n.d.)

Wi-Fi Module- a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. Capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. (WIA, n.d.)

CHAPTER 2: LITERATURE REVIEW AND FRAMEWORK OF THE PROJECT

2.1 Introduction to Literature Review

In this chapter, we will present the concepts that support the feasibility of our system and the claims about the problem. We will make use of the definitions and references that will guide the proponents to create a solution to the problem presented. The results of review of related literature focuses more on the latest studies about the technology used as reference for our Digital log device and how this may be efficient than use of papers as manual recording of health declaration forms. We will also highlight some of the latest studies about using RaspberryPi technology for fingerprint system.

Conceptual Literature

We reviewed related studies for the following parts of our system including the problems address in this study. The first idea that we want to tackle is about the digital log of every individual in an establishment. We will state the current claim about the data privacy of every individual when they are filling up their contact details. Gathering this from a reliable source, this includes articles that support the claim.

For the system that we are proposing, we will divide its parts of every working principle and how the data is being processed. The proponents also explain the working principle of fingerprint scanner as well as its data acquisition. The pieces of research for building this device will be presented and analyzed. We will refer to the current trends on how to store the fingerprint scanner data in the database. Furthermore, an integral part of our system is the communication protocol that will be implemented for the wireless communication of the Digital log device and the database.

2.2 Result of Literature Review

The aim of contact tracing with COVID-19 is to determine people who have been infected—or may have been infected—and isolate them from others. Since COVID-19 is spread by infectious droplets in coughs and sneezes, exposure is characterized as spending at least 15 minutes within 2 meters of a probable or confirmed case. As a result, contacts are people who meet these requirements. Contacts are traced by asking people who have been marked as index cases to remember their contacts during a period associated with a high risk of infection, such as two days before symptom onset before they are isolated (Centers for Disease Control and Prevention, 2020).

We have a limited number of weapons in the fight for COVID-19, and contact tracing is one of the most powerful among them. Indeed, epidemiological models that combine rates of transmission, infection, and initiation of symptoms with the pace and effectiveness of contact tracing indicate that contact tracing could monitor majority of outbreaks if done rapidly but efficiently (Hellewell et al., 2020). Many countries have adapted to this method, along with social distancing protocol, but only a few countries have succeeded in mitigating the spread of the virus-including South Korea, Vietnam, Japan, and Taiwan (Lewis, 2020).

According to the study conducted by Biswas et al., (2020), contact tracing is not new to epidemiologists; however, it has traditionally relied on time-consuming, expensive, and inefficient manual or semi-manual methods. Although scalability is a major challenge in dealing with pandemics, as it primarily relies on human memory. The unparalleled health and socioeconomic consequences prompted researchers and practitioners around the world to look for technology-based solutions that could be scaled and delivered quickly. Because of their high prevalence and versatility, smartphones and related emerging innovations could have a better approach. While data-driven solutions are extremely effective, people are concerned that information such as

location or proximity, when combined with other personal data, may be used by governments to impose surveillance.

According to (Barrat A. et al. 2021). Contact tracing is traditionally carried out via interviews of identified cases, followed by phone calls to the identified contacts to warn them and ask them to go to quarantine. Such 'Manual' Contact Tracing (MCT) is labour intensive, it can be slow, and it critically relies on the ability of the individuals to remember and identify their contacts. The actual ability to recall and identify close-range proximity contacts is known to be limited. Retrospective surveys have found that brief contacts have a lower probability of being recalled and that contact durations are overestimated. In important contexts such as establishments, public transportation, with the proximity of unknown persons. In such cases, digital proxies for close-range proximity are currently viewed as a complementary and scalable approach, known as digital contact tracing (DCT), that could overcome the above limitations.

APP BASED CONTACT TRACING

(Altmann, et al. 2020) The main advantage of the app over traditional (manual) forms of contact tracing is that it allows for instantaneous notification of contacts, which is an important factor in the effectiveness of COVID-19 case isolation and contact tracing strategies. Other advantages include the ease with which automatic contact recording scales up and the avoidance of information loss due to patients' recall bias and/or imperfect knowledge of the people with whom they have had contact.

(Mcarthy, et al. 2020), Manual contact tracing is too slow to reach people before they transmit, whereas the scalability and speed of a digital approach, using proximity sensors of smartphone devices, is theoretically fast enough to stop the epidemic.

PAPER BASED CONTACT TRACING

According to the study conducted about paper-based contact tracing during the time of Ebola virus. (Sacks JA, Zehe E, Redick C, Bah A, Cowger K, Camara M, et al. 2015) The current paper-based system works like this: contact tracers use paper forms based on internationally recognized templates to record relevant information on the contacts they track daily. They then submit these forms to supervisors/field epidemiologists, who compile the information and enter it into an Excel database.

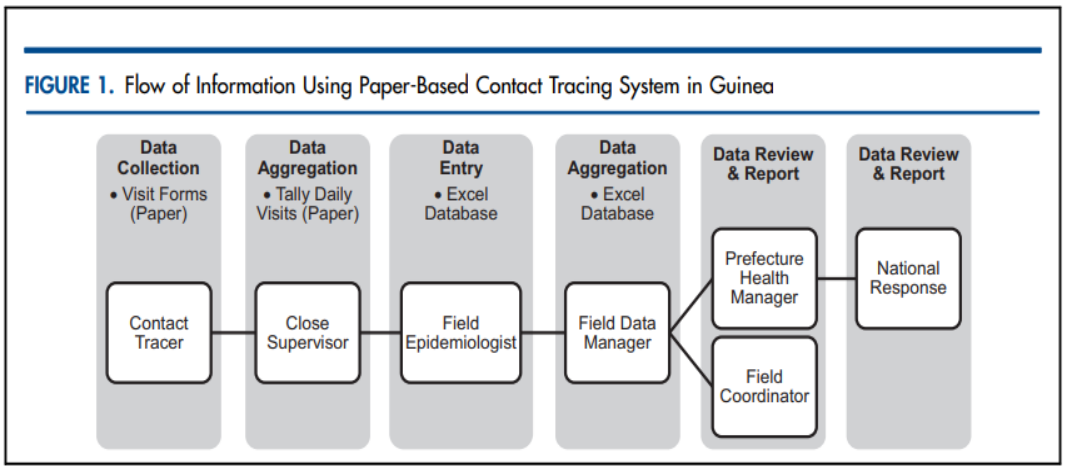


Fig. 2.1 Flow of information using Paper-based Contact Tracing system in Guinea

(Sacks JA, Zehe E, Redick C, Bah A, Cowger K, Camara M, et al. 2015) Introduction of Mobile Health Tools to Support Ebola Surveillance and Contact Tracing in Guinea

TABLE 1. Limitations of Paper-Based Contact Tracing System

Limitation		Process Impact
Paper-based contact tracing system creates delays between data collection and consumption.	→	Impedes rapid response and decision making around contact tracing strategy.
Human error is common with data entry, as is misunderstanding of data and communication gaps.	→	Data become unreliable, out of date, and inconsistent.
Efforts for data cleaning, data entry, and data compilation are time-intensive.	→	Takes away from time and resources needed for data analysis and troubleshooting.

Fig. 2.2 Flow of information using Paper-based Contact Tracing system in Guinea

(Sacks JA, Zehe E, Redick C, Bah A, Cowger K, Camara M, et al. 2015) Introduction of Mobile Health Tools to Support Ebola Surveillance and Contact Tracing in Guinea

According to Sacks et Al., based on Table 1, the paper-based system and the time-intensive effort required for entering, collating, and cleaning data pose several limitations. First, there is a time lag of 2 to 3 days for data collected by contact tracers to be processed and available for managers to use. Second, it is difficult to identify points at which mistakes may have been introduced during any step of the process. Third, this process requires significant time and energy by response teams devoted solely to data entry, drawing resources away from analyzing and acting on the issues presented.

In a study that was published in The International Journal of Tuberculosis and Lung diseases by Nadol, P. et al.

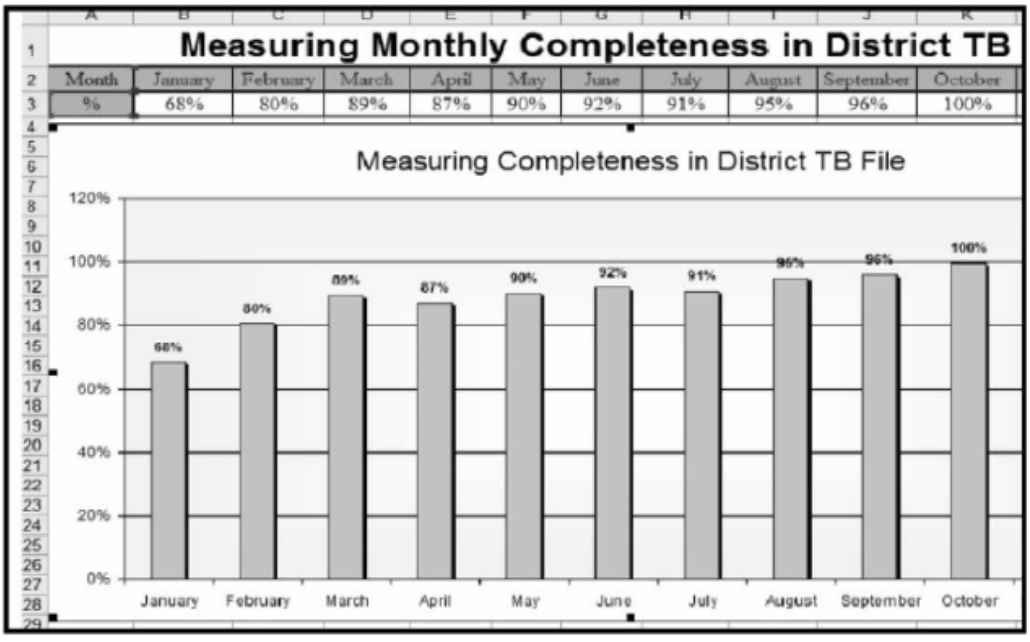


Fig. 2.3 ENRS monthly supervisory report indicating the proportion of TB registers that are complete for a specific district. ENRS = Electronic Nominal TB Registration System. (Nadol, P. et al., 2008) Electronic tuberculosis surveillance systems: a tool for managing today's TB programs.

(Nadol, P., et al.) In a completely paper-based system, a designated TB coordinator must personally visit all TB points of service and manually review and transfer data from the lower level (e.g., facility) to the higher level (district, province, and national). Standardized reports must be calculated by hand, which is time consuming and prone to error.

They also conclude on their paper that, (Nadol, P., et al.) While the success of electronic systems is dependent on individual settings, they provide the opportunity to simplify data entry, improve data accuracy and completeness, increase data confidentiality and security, and quickly produce more complex analyses in areas such as TB-HIV integration.

According also to (Melo, S. 2019) The manual filling up of forms has a lot of challenges including Lack of Storage Space, Security issues, Prone to damage, Document Transportation, Editing Problems and High Cost. These are related to the forms that are managed by the private or public sector.

Other claims supporting the ineffectiveness of paper forms in terms of gathering data is highlighted in the blog of (Cheatam, M. 2021) “There are no analytics. There is no simple way to analyze data in a paper form without re-entering it into a spreadsheet or a separate system. How can you make effective management decisions without trend data?” and about the transmission of that paper form data was also highlighted.

According to two cohort studies conducted by (Andrew Anglemyer et al. 2020). Contact tracers found digital systems simpler to use and generally preferred them over paper systems; they saved personnel time, repeatedly improved accuracy with large data sets, and were easier to transport compared with paper forms.

(Cheatam, M. 2021) Transferring form data to a computer is difficult. It is difficult to analyze. When your company receives a paper form, transferring the information into a computer is difficult. Even with scanners, you must inspect each form to ensure that the information was correctly transmitted.

So, with this we can conclude that the use of forms really provides lots of work that needs to be done. Ultimately, in the case of contact tracing where time and productivity are valuable.

In another study conducted by Galliher et al. where there was a comparison between the Paper-based forms and PDA forms. PDA stands for Personal Digital Assistants.

(Galliher et al. 2008) "We compared the completeness of data collection using paper forms and using electronic forms loaded on handheld computers in an office-based patient interview survey conducted within the American Academy of Family Physicians National Research Network." *(Data collection outcomes comparing paper forms with PDA forms in an office-based patient survey. Annals of family medicine, 6(2), 154–160.)*

RESULTS:

Table 1.

Returned Forms with Any Errors of Omission, by Site and Type of Form

Site	Paper No. (%)	Electronic No. (%)
Paper-first group		
A	3/30 (10)	2/22 (9)
D	2/30 (7)	1/30 (3)
E	10/30 (33)	2/20 (10)

Site		Paper No. (%)	Electronic No. (%)
	F	6/30 (20)	1/28 (4)
	H	9/30 (30)	0/30 (0)
	J	20/29 (69)	0/4 (0)
	O	3/30 (10)	2/29 (7)
	P	1/30 (3)	1/31 (3)
	R	30/30 (100)	1/25 (4)
	S	6/30 (20)	1/32 (3)
	Total	90/299 (30)	11/251 (4)
Electronic-first group			
	B	4/30 (13)	0/30 (0)
	C	18/32 (56)	NA[a]
	G	30/30 (100)	0/30 (0)
	I	17/24 (71)	1/28 (4)
	K	NA[b]	0/32 (0)
	L	8/30 (27)	0/32 (0)

Site	Paper No. (%)	Electronic No. (%)
M	2/30 (7)	2/33 (6)
N	11/30 (37)	NA[c]
Q	6/32 (19)	1/30 (3)
Total	96/238 (40)	4/215 (2)
Overall total	186/537 (35)	15/466 (3)

NA = not applicable.

Note: Not all sites returned 60 forms as specified in the protocol.

[a] Handheld computer was lost/stolen before data collection.

[b] No paper forms were returned because of staffing difficulties.

[c] Handheld computer was lost/stolen after data collection.

Table 2.

Returned Form Items with Errors of Omission, by Site and Type of Form

Site	Paper No. (%)	Electronic No. (%)
Paper-first group		
A	3/727 (0.4)	6/547 (1.1)
D	6/760 (0.8)	2/740 (0.3)
E	14/737 (1.9)	6/522 (1.1)

Site		Paper No. (%)	Electronic No. (%)
	F	12/760 (1.6)	1/714 (0.1)
	H	27/767 (3.5)	0/781 (0.0)
	J	55/764 (7.2)	0/121 (0.0)
	O	3/808 (0.4)	2/735 (0.3)
	P	2/752 (0.3)	6/774 (0.8)
	R	34/757 (4.5)	5/604 (0.8)
	S	14/777 (1.8)	2/876 (0.2)
	Total	170/7,609 (2.2)	30/6,414 (0.5)
Electronic-first group			
	B	10/777 (1.3)	0/771 (0.0)
	C	67/774 (8.7)	NA[a]
	G	100/670 (14.9)	0/689 (0.0)
	I	81/585 (13.8)	5/699 (0.7)
	K	NA[b]	0/800 (0.0)
	L	9/750 (1.2)	0/799 (0.0)

Site		Paper No. (%)	Electronic No. (%)
	M	6/806 (0.7)	6/864 (0.7)
	N	20/764 (2.6)	NA[c]
	Q	6/823 (0.7)	2/799 (0.3)
	Total	299/5,949 (5.0)	13/5,421 (0.2)
Overall total		469/13,558 (3.5)	43/11,835 (0.4)

NA = not applicable.

Note: Not all sites returned 60 forms as specified in the protocol, and the number of items per form varied because of skip patterns.

[a] Handheld computer was lost/stolen before data collection.

[b] No paper forms were returned because of staffing difficulties.

[c] Handheld computer was lost/stolen after data collection.

SOURCE: (Galliher, J. M., Stewart, T. V., Pathak, P. K., Werner, J. J., Dickinson, L. M., & Hickner, J. M. (2008). Data collection outcomes comparing paper forms with PDA forms in an office-based patient survey. Annals of family medicine, 6(2), 154–160.) https://doi.org/10.1370/afm.762

SECURITY OF INFORMATION

(Owusu, P. 2020), despite the promise of digital approach for global health, there is still a need of precautions in the case of collecting data. The authorities had already considered the data privacy of every individual. Governing body need to ensure that policy frameworks include strong protections for the privacy of users. By the same token, international or national laws

should guarantee that data collected in the interest of public health are not revealed and can only be used for retaliatory or surveillance purposes.

Based on the study conducted by Wassem, D. and Chen. J. (2020), There have been reports that some restaurant staff keeps on harassing female customers after getting their information from contact tracing form. Several restaurant goers have complained that their contact details can be seen by other customers. There have also been cases of people receiving scam text messages which involve track-and-trace of a person. All of which makes it unsurprising that some people are giving out false contact details. Trust is obviously an integral part of the problem here. For contact tracing to work effectively – for what might be many years to come – customers need to trust that establishments will look after their data the right way.

DEVELOPMENT OF FINGERPRINT SCANNER

Woodford (2020), in a study entitled “Biometric Fingerprint Scanners”, stated that it is obvious why we have fingerprints, the tiny friction ridges on the ends of our fingers and thumbs make it easier to grip things. These ridges increase the force of friction between our hands and the objects we hold by making our fingers rougher, making it harder to drop things. The research area that is dealing with fingerprints is called dactyloscopy. It is a science of the papillary lines on the inside of human fingers. The shapes of the papillary lines, their course and direction, are very different for every person. The fingerprints appeared on human even before birth. In fact, fingerprints are completely formed by the time you are seven months old in the womb. Unless you suffered accidents with your hands, your fingerprints remain the same throughout your life.

Currently, there are two separate stages involved in using a system like this. The first process is called enrollment, where the system learns about all the people it will have to recognize each day. In this stage, each person's fingerprints are scanned, analyzed, and then stored in a coded form on a secure database. Typically, it takes less than a half second to store a

person's prints and the system works for over 99 percent of typical users. Once enrollment is complete, the system is ready to use—and this is the second stage, known as verification. In an establishment set-up anyone who wants to gain access must put their finger on a scanner

The scanner takes their fingerprint, checks it against all the prints in the database stored during enrollment, and decides whether the person's fingerprint belongs, or it needs to register. Sophisticated fingerprint systems can verify and match up to 40,000 prints per second.

During enrollment or verification stage, each print is analyzed for very specific features called minutiae, where the lines in your fingerprint split in two or terminate. Measuring the distances and angles between these features is done by a computer—a bit like drawing lines between them—and then uses an algorithm (mathematical process) to turn this information into a unique numeric code. Comparing fingerprints is then simply a matter of comparing their unique codes. If the codes match, the prints match.

According to Wate (2019), there are 3 types of fingerprint scanner. These are optical, capacitive, and ultrasound fingerprint scanners. An optical scanner, as the name implies, uses optics (light) to capture and scan fingerprints on a screen. Basically, the scanner takes a digital photograph of the fingerprint and then uses algorithms to find unique patterns of lines and ridges that are scattered through the image's lighter and darker regions. This digital photograph is a 2D representation of the various patterns of ridges and lines found on the finger, and since it includes information in the darker areas of the image, it is lit up with a light source, usually an LED, to capture a detailed image. Capacitive scanner measures your fingerprint electrically. How this works is that when your finger rests on a surface, the ridges on your fingerprints touch the surface while the hollows between the ridges slight clear of it. To sum up, it builds up a picture of your fingerprint by measuring distance between each part of your finger and the surface below it. With this, capacitive scanner works efficiently than optical ones since they do not work well in moisture and can be damaged by static electricity. The third one is called an ultrasonic scanner, because it uses high-frequency sound waves this is known as ultrasound, to "map" your finger

instead of light. If you have a new Samsung smartphone, you will probably find it has one of these built under the display, which you can use to unlock the phone or secure access to your apps and data.

Quality Control is a major element in finger scanning. Since fingerprint is a viable tool in criminal trial as evidence which could help identify the perpetrator. The Fingerprints scanned should be accurate to the extent wherein it should be captured exactly to the right amount of detail—brightness and contrast—so that the individual ridges and other details in the fingerprint can be accurately matched to scans taken previously.

According to Woodward et al. (2020), there is a simple process on how optical fingerprint sensor work.

1.) A row of LEDs scans bright light onto the glass (or plastic) surface on which your finger is pressing (sometimes called the platen).

2.) The pressing determines the quality of the image, considering also how clean or greasy your fingers are, how clean the scanning surface is, the light level in the room, and so on.

3.) Reflected light bounces back from your finger, through the glass, onto a CCD or CMOS image sensor.

4.) The brighter the image formed on the image sensor, the longer this image-capture process takes.

5.) If the image is too bright, areas of the fingerprint (including important details) may be washed out completely this is the same as like an indoor digital photo where the flash is too close or too bright. If it's too dark, the whole image will look black, and details will be invisible for the opposite reason.

6.) An algorithm tests whether the image is too light or too dark; if so, an audible beep or LED indicator alerts the operator, and we go back to step 1 to try again.

7.) If the image is roughly acceptable, another algorithm tests the level of detail, typically by counting the number of ridges and making sure there are alternate light and dark areas (as you would expect to find in a decent fingerprint image). If the image fails this test, we go back to step 1 and try again.

8.) Providing the image passes these two tests, the scanner signals that the image is OK to the operator (again, either by beeping or with a different LED indicator). The image is stored as an acceptable scan in flash memory, ready to be transmitted (by USB cable, wireless, Bluetooth, or some similar method) to a "host" computer where it can be processed further. Typically,

images captured this way are 512×512 pixels (the dimensions used by the FBI), and the standard image is 2.5cm (1 inch) square, 500 dots per inch, and 256 shades of gray.

9.) The host computer can either store the image on a database (temporarily or indefinitely) or automatically compare it against one or many other fingerprints to find a match.

In the study conducted in University of Zambia by Kalunga, J. and Sembo T. (2016), fingerprint scanner is an Optical electronic device utilized to capture fingerprint picture from a live human finger. The research utilized U 4500 Reader checking innovation for its superior picture quality and product reliability. This is because minutiae based unique finger impression biometric framework require high quality fingerprint image.

According to Petkovich, J.C. (2011), it is useful to precisely define the requirements and the components of a fingerprint recognition system. These components represent different phases of the fingerprint matching process, each of which plays an integral role in the accurate matching of fingerprints. The components include raw data collection, fingerprint image

enhancement, feature extraction, and feature enhancement. In the raw data collection, the component should be able to produce either an image of the rolled or referred to as a fingerprint image ‘I’ pressed impression of the finger. ‘I’ is often a simple array of pixel intensities. In the fingerprint image enhancement, the component should be able to generate an enhanced fingerprint image, ‘E,' from image I. For the purposes of fingerprint matching, this picture may be enhanced. Contrast adjustment and ridge thinning, as well as ridge recovery via Gabor filtering, are common enhancements. Feature Extraction is the process of converting the enhanced fingerprint image, E, into quantitative data about its ridge features. This information is normally linked to locations, which are referred to as minutiae. The word "minutiae" refers to small ridge information found in fingerprints; they are most commonly a collection of characterizing points identified on ridge structures. The part should produce a collection of minutiae or similar features,

denoted by the letter ‘M,' which is also known as a second template. Feature matching includes the matching phase. It concerns itself with the fingerprint matching problem. This is a most complex part because of pattern that needs to be process by the computer.

Based on the study of Mayhew, S. (2012), verification systems are designed to address the question, "Is this individual who they claim to be?" An entity presents himself or herself as a particular person in a verification framework. To find a match, the machine compares his or her biometric to one that already exists in the database linked to that person's file. Since the system attempts to match the biometric provided by the user against a standard biometric already on file, verification systems are commonly referred to as 1-to-1 matching systems.

According to Murad, M. (2020), locating an unknown person’s name or details by comparing his or her live biometric samples with potentially hundreds of thousands of templates previously

stored in a system’s database is the goal of the identification system. This is often referred to as one-to-many matching. An example might be a border patrol agent looking to identify a suspect by looking for a match among existing templates.

(Asabere, P. et al. 2019), Database administration framework may be a program bundle for making and managing databases. Numerous distinctive sorts of database frameworks exist based on how they manage the database structure. In this venture, MySQL was utilized. MySQL is an Oracle-backed open-source social database administration framework (RDBMS) based on Structured Query Dialect (SQL). MySQL runs on essentially all stages, counting Linux, Mac OS and Windows.

(Alonzo-Fernandez et al. 2008), Investigation in biometrics significantly depends on the accessibility of detected information. The development that the field has experienced over the

past two decades has driven to the appearance of expanding numbers of biometric databases, either monomodal (one biometric characteristic detected) or multimodal (two or more biometric characteristics detected).

According to Martin Magdin (2018), the information storage for the confirmation framework, we chose the database. When choosing a database framework, we had taken after the taking after criteria that the database framework had to meet 4 criteria, relational database system, support for transactional processing, low hardware requirements, and low purchase price, ideal free database system. Based on these necessities we chose database framework MySQL that's accessible with license GPL. The database structure was at that point outlined utilizing the MySQL Workbench improvement tool.

In the study conducted in University of Zambia by Sembo, T. et al. (2016), the design components of their proposed fingerprint system. An integrated design component contains fingerprint scanner, client interfacing and social database. User Interfaces are separated further into information input forms and codes. The backend database design was implemented using MySQL social database. The program was coded in CSharp(c#) object-oriented programming language.

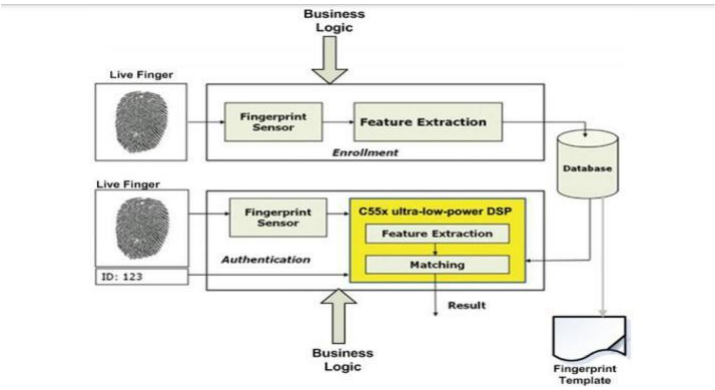


Figure 2.1. Architectural Design for fingerprint biometrics verification

(Kalunga J. Sembo T. 2016)

Another figure of the same concept of fingerprint system:

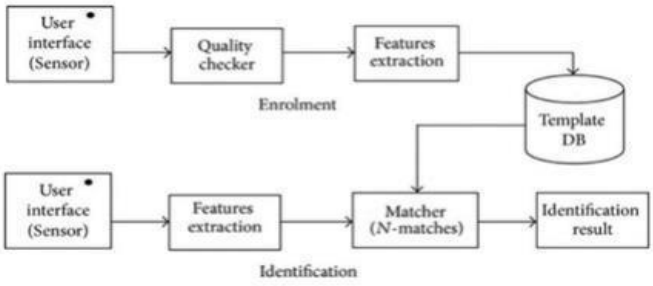


Figure 2.2. Flow Diagram for enrollment and identification of biometric authentication system

(Asabere P. et al. 2019)

Based on Jolles J. (2021), The Raspberry Pi is a low-cost SBC developed by the Raspberry Pi Foundation (Raspberrypi.org), with several generations of Raspberry Pi, each features a system-on-a-chip that consists of an integrated CPU (Central Processing Unit) and on chip GPU (Graphics Processing Unit), on-board memory and a power input of 5V DC. As well as an array of input/output (GPIO) pins that can be used to communicate with a wide range of electronics.

The Raspberry Pi has been purposefully built as a highly flexible and powerful computer at a fraction of costs of a traditional PC to be used by anyone to solve problems creatively. Its large number of assets easily outweigh its limitations making it a great research tool which can be used extensively throughout any research.

Figure 2.3. Raspberri Pi Model 4B

(Jolle J. 2021)

Spec	Raspberry Pi 4B // Zero W
Type	Single-board Computer
Operating system	Multiple operating systems possible
Dimensions	85.6 mm x 56.6 mm // 65 x 30 mm
Weight	46 g // 9 g
Price	40 (2 GB) – €85 (8 GB) // €12
Multitasking	Yes
Setting up required	Yes
Processor	64-bit // 32-bit
Memory	up to 8 GB // 512 MB
Clock speed	4× 1.5 GHz // 1 GHz
Ethernet	Gigabit // Adapter needed
Wi-Fi	Yes
Bluetooth	Yes
USB	2× USB 2 & 3 // micro-USB
Camera port	Yes
Audio port	Yes // No
HDMI	2× // 1× micro-HDMI
Input voltage	5 V
GPIO Ports	40 pins: 5 V, 3.3 V, Ground Digital I/O
Shut down required	Yes
Storage	MicroSD card (up to 1 TB)
Desktop interface	Yes
Power consumption (idle)	3,000 mW // 750 mW

Figure 2.4. Raspberry Pi Model 4B Specs

(Jolle J. 2021)

Based on Lathifah A. et al (2021), in their paper, Implementation of Python was used to process synthetic data amongst Indonesians who are suspected to have covid. The main advantage of their research was to evaluate contact tracing in real life based on Social Network Analysis Calculation. The Synthetic data is being calculated by graph degree, the betweenness centrality, and Page Rank. The visualizations of the data will be presented using Python Library of NetworkX running on Jupyter Notebook.

Name	Person ID	Health Status	Respiratory Problem	Age
LUP	32	sick	1	14
MIH	16	healthy	1	61
WAGP	18	sick	1	39
MIF	26	sick	0	69
CAKM	81	healthy	1	29
MUHL	23	healthy	1	38
PAK	99	healthy	0	25
NAVM	9	sick	1	57
SAWP	27	healthy	0	78
WUU	89	sick	0	57

Figure 2.5. Detail Information Data

(Lathifal A. et al. 2021)

Rank	Name	Graph Degree	Between-ness Centrality	Page Rank Value
1	LUP	8	0.01543	0.01235
2	MIH	8	0.01813	0.01203
3	WAGP	7	0.00957	0.01182
4	MIF	7	0.03219	0.01181
5	CAKM	8	0.01579	0.01180
6	MUHL	8	0.01715	0.01176
7	PAK	8	0.01594	0.01171
8	NAVM	8	0.00908	0.01169
9	SAWP	7	0.01656	0.01168
10	WUU	23	0.08365	0.01165

Figure 2.6. Visualization Result Data

(Lathifal A. et al. 2021)

The tables above represent how a person interacts with other people. The highest rank along with the highest Page Rank score in the table greatly represents that the person did not limit his/her interaction. Thus, a high-value point of result means the person may transmit the disease if already had COVID-19.

According to Soroush O. et al (2020), in their paper, Cloud-based architecture is developed. Having three layers (Data Collection, Cloud Data Storage and Management, and Visualization). All user-related contexts in offline mode are stored internally in a smartphone's database using SQLite.

Thus, whenever the users are willing to share their movement trajectory, a bulk data transfer mechanism is applied to share all stored trajectory points with a cloud server.

According to Afnan B. et al. (2020), They proposed a low-cost IoT-enabled COVID-19 standard operating procedure compliance system that utilizes Raspberry Pi Specifically model 4 which counts the number of people entering and leaving a vicinity, ensures physical distancing, monitors body temperature and warns attendees and managers of violations. The system comprises of multiple sensors that communicates with a centralized server. The data which are stored can be used for compliance auditing, real-time monitoring, and planning purposes.

According to a paper proposed by Mohamed T. et al (2021), The greatest challenge that most governments are currently facing is the lack of precise, accurate, and automated mechanism for detecting and tracking new COVID-19 cases. Their proposed solution is to create a first blockchain-based system for their implementation of the CCTS, utilizing different software tools such as Ethereum, Java and firebase, and lastly, Python and MongoDB. The present study was designed to further investigate the feasibility of utilizing blockchain technology to detect and track cases of COVID-19 and their contacts. The proposed system can assist governments and health authorities in making critical decisions based on transparent data provided by the blockchain.

According to A.J. Mansfield et al (2002), the successive attempt for each user may vary due to increased familiarity with the device or feedback of their authentication results. Averaging over the multiple attempts can significantly help the case. However, alteration and the pattern of attempts per user may affect the error rates. Error rates in the collection process may easily increase than those of the biometric device. For this reason, extreme care must be taken during collection phase to ensure efficient and accurate data.

According to Hsu D (2016), Biometrics is a technology focusing on human's biological features, such as facial, fingerprint, retina, DNA and other characteristics to verify a person's identification and authorize specific actions. Of all of them, Fingerprint analysis technology is most mature and has the widest acceptance. Fingerprint patterns are first captured either using an optical sensor of a capacitive sensor:

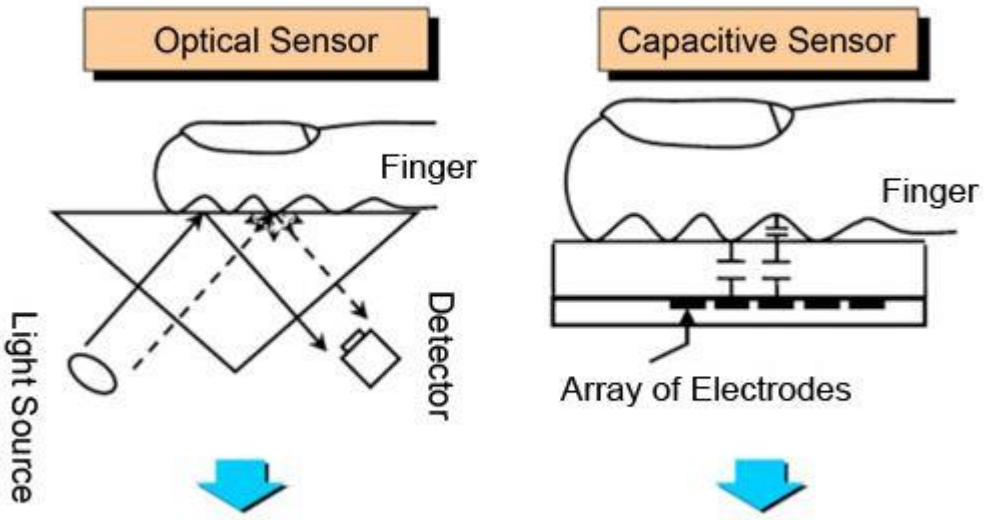


Figure 2.7. Fingerprint Analysis Theory

(Hsu D. 2016)

A pattern of minutiae points is stored on a database as a representation of the data. In essence, the minutiae are the one being stored in the memory and not the fingerprint itself.

Memory media storing of such important data should have high security strength against hacking. It is suggested to utilize multi-factor and multi-modal authentication in relation to fingerprint analysis. Devices such as smartphones, wearables, RFID cards can be used as means of co-authentication.

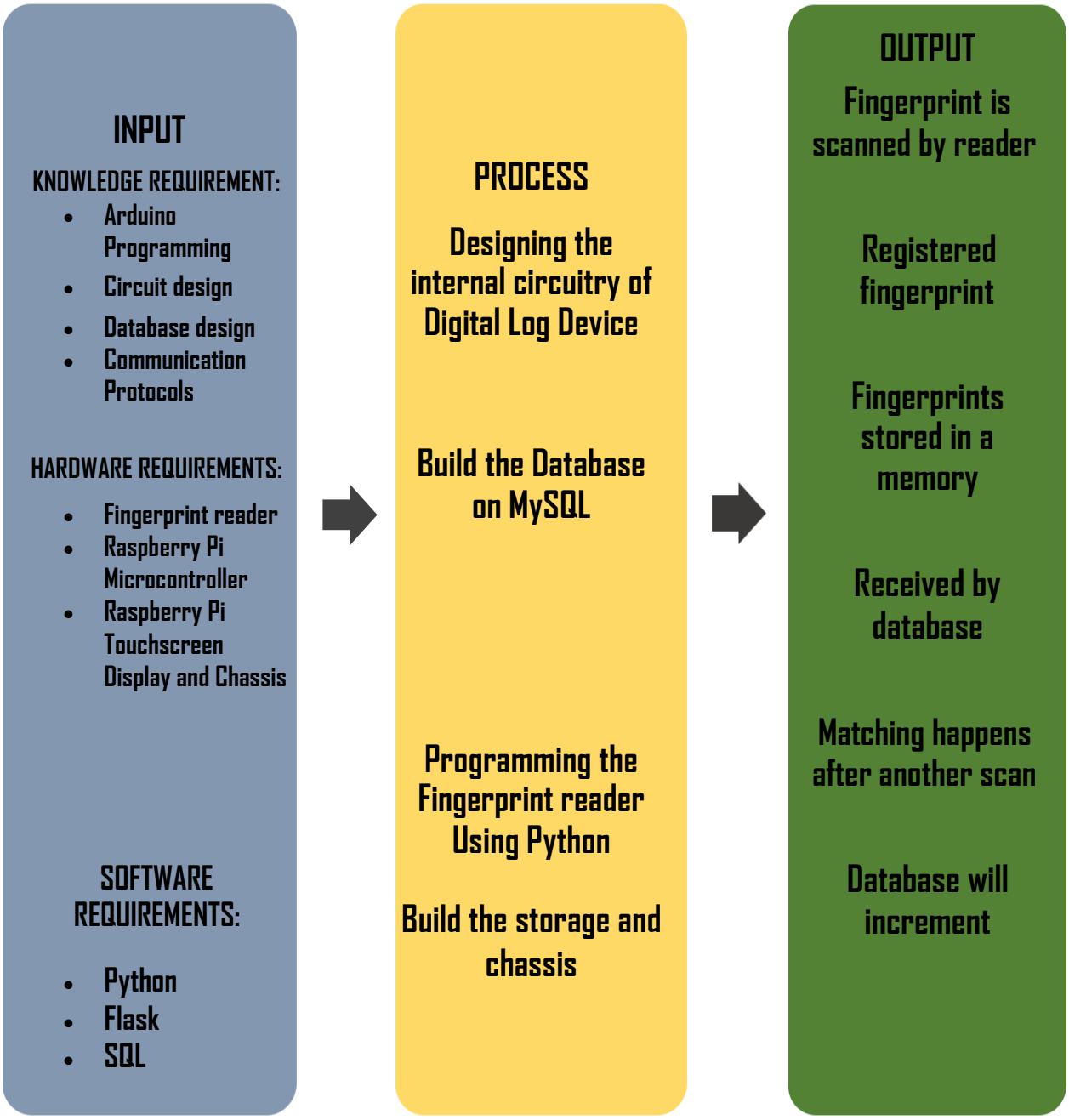


Figure 2.8. Conceptual Framework of the Project

2.3 Conclusion and Framework of the Project

The Project requires the familiarity of the proponents along with the software and hardware requirements. Python Programming is critical as it is required for the device to work on its function. The first step of our testing is to enroll fingerprints which will be integrated to a database. The device is intended to read and store along with fingerprint. the fingerprint reader will notify the user if fingerprint is already registered with the device.

The circuit design needs hardware components which involves the sensor for fingerprint, the microcontroller, Raspberry Pi Touchscreen LCD and Chassis. The proponents maximized the use of python along with flask and SQL for our database.

The expected output is essentially ease contact tracing which is the function of the device from scanning of the fingerprint through a reader, enrolled fingerprint will then be stored in a database where matching of fingerprint will take place. Data generated will then be integrated to the database and should reflect on the website.

CHAPTER 3: PROJECT DESIGN AND METHODOLOGY

This chapter presents the project design, project development, operation, and testing procedure, as well as the evaluating procedure to guide the proponents in implementing the design project.

3.1 Project Design

The proponents of this research highlight the design of the whole system in this sub chapter. This will include all the block diagrams, the logical flowchart of the fingerprint system, design tradeoff and constraints of the system. The industry standards used we'll be our guide on the project development.

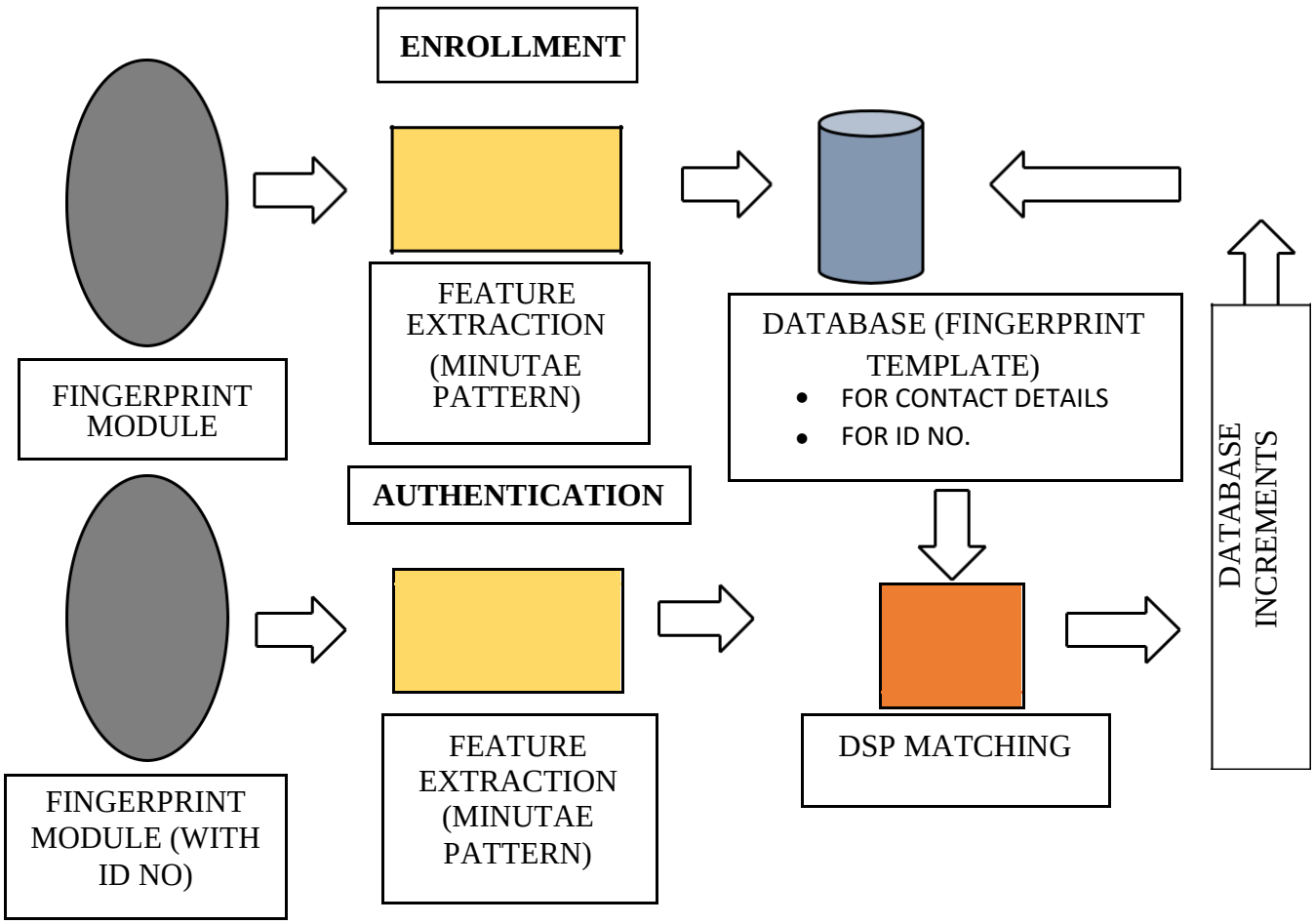


Figure 3.1. Block Diagram of the system

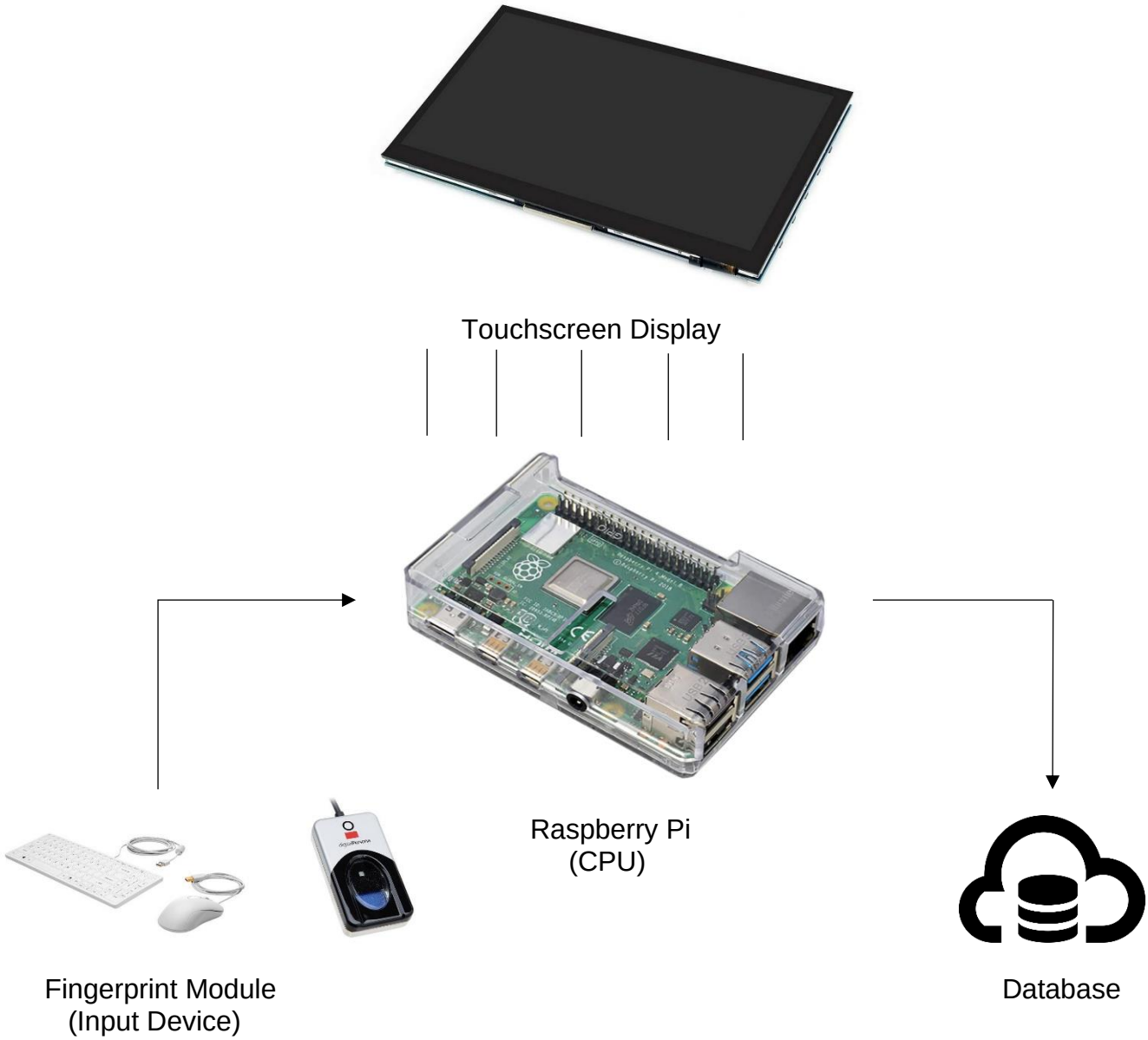


Figure 3.2. Project Setup

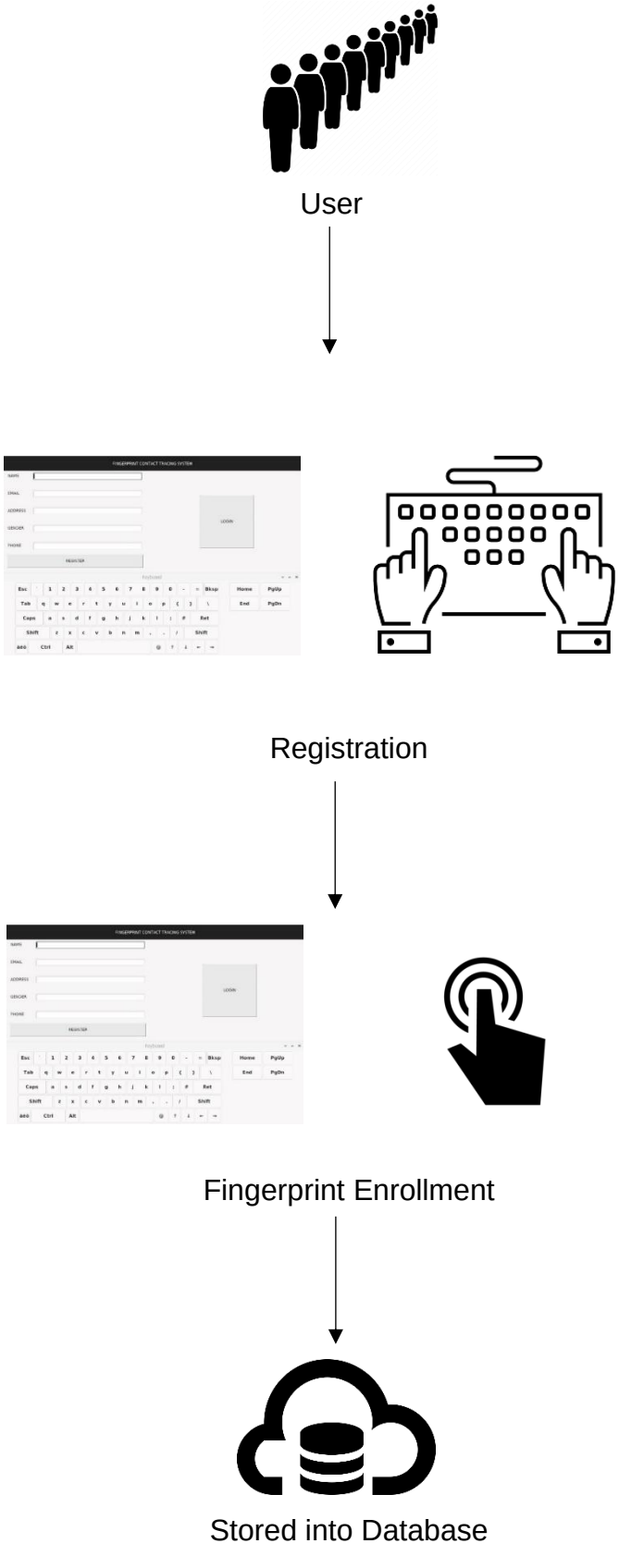


Figure 3.3. Enrollment Process

User

Fingerprint Verification

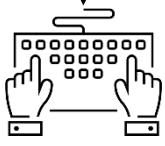
Fingerprint Matching

Fingerprint Matched

Stored into Database

Failed Match

Retry Authentication



Retry Enrollment

Figure 3.4. Verification Process

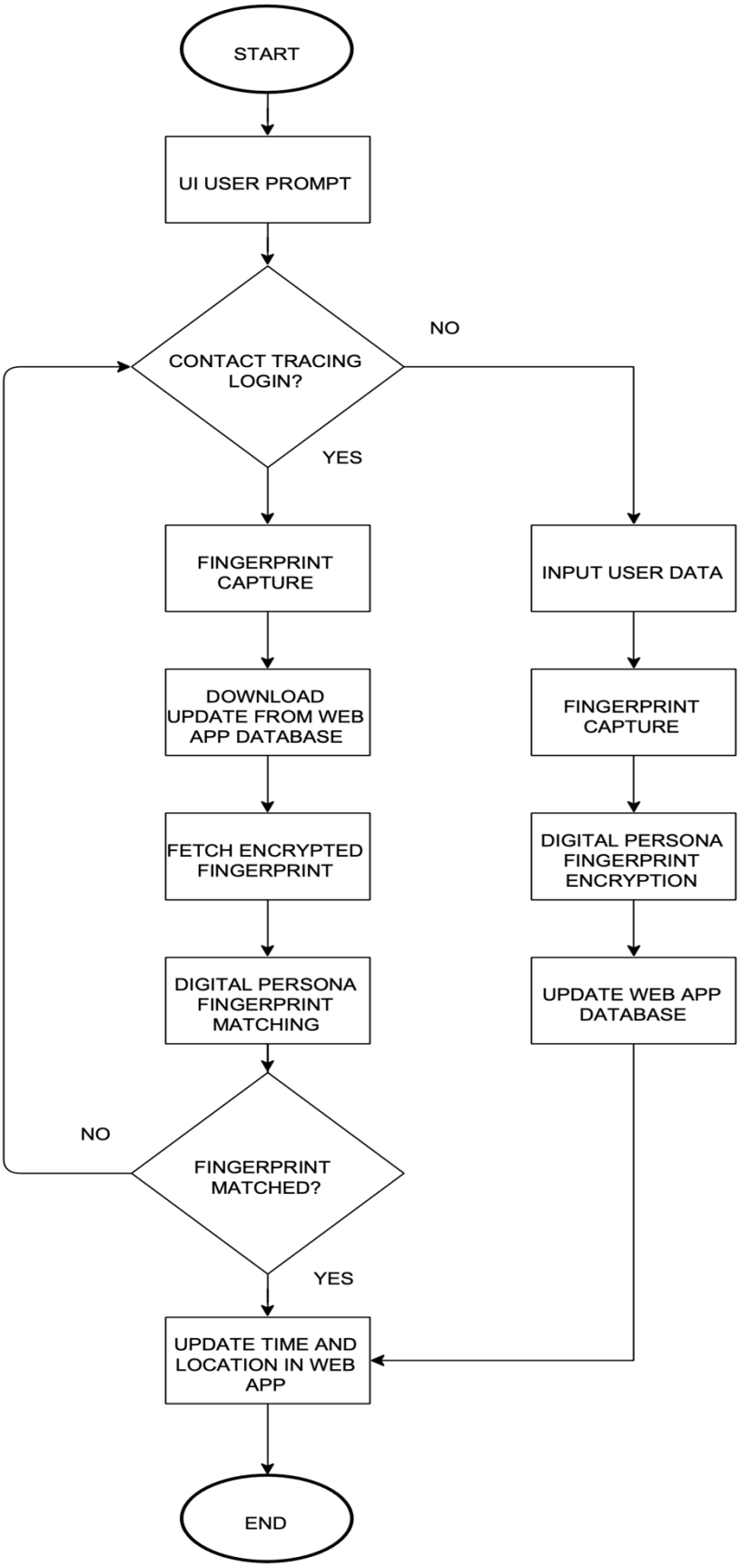


Figure 3.5. Flowchart for the system

The whole process is highlighted in the flowchart that can be seen on Fig. 3.5; it all starts with a prompt that is displayed on the interface. The user will be given an option to register first or proceed to login. On both ways, the user data will be directed into the database. There are two process which the user will undergo after the first prompt these are, Enrollment and Verification process.

ENROLLMENT PROCESS

This is the rundown of the enrollment process. First, the user will have to click on "Login" on our interface, then a prompt will pop up asking the user to place his thumb on the fingerprint scanner. Once the user taps, the raspberry will process the matching by finding the same extracted features in the database. The scanner will not recognize the scanned fingerprint otherwise the interface will display the "Welcome (name)" message indicating complete scan. So, the user will need to input his details first and then need to tap five times to indicate the registration. After that, the database will now store the new information.

VERIFICATION PROCESS

The verification starts at the user will need to click on "Login" and then tap the fingerprint one time and it will find a match on the database. If there is a matched fingerprint, then it will display "Welcome (name)". The database will now increment the user's registered data.

3.1.1 Industry Standards Used

These are the following that we considered in making this project. Reliability, programmability, accuracy, and cost.

Reliability- Degree or extent of the accuracy of data if given certain conditions as to how it will provide same repeated results by measuring something more than once.

Programmability- refers to how the hardware and software will change, by accepting new sets of instructions which can alter its behavior.

Accuracy- refers to the closeness of the measured value to its real, true or actual value.

Cost- The cost of every component must be considered which the market will offer best.

Time- The time it took to read fingerprints that would make the system efficient.

3.1.2 Design Constraints

Design Criteria	**Design Constraints**
Security	Can be prone to attacks but guided by the data privacy act
Accuracy	Device Error in the matching of fingerprints
Scope	Limited to establishments only

As shown in the table, the information is secured if there will be no breach of the database system. To compensate, the data privacy act has guidelines to support the alteration of data. In the accuracy, the errors are inevitable so to lessen the errors it may take time to recognize the enrolled

prints. Our scope targets only the establishments in a community where people come and go that they only need to enroll once per establishment. If they register to establishment 1, they also need to enroll to establishment 2, so that wherever city they will go, their information will be recorded.

3.1.3 Design Tradeoffs

Matching Speed Conflicts Accuracy

When designing a fingerprint identification or verification framework, there's always a trade-off between speed and accuracy. As the speed requirements of the system increases, one should give up more accuracy to achieve that working speed. Conversely, as the accuracy of the framework increases, the longer it'll take for it to perform identification/authentication.

Redesigning the algorithm to be various leveled in order to tune the speed and accuracy of a biometric framework to the required level, is very common. For the most part, the operation of these hierarchical methodologies progress by first running less exact but faster algorithms to reduce the number of candidates, and after that by iteratively conjuring slower but more segregating algorithms until an edge number of candidates is reached.

3.2 Project Development and Implementation

The development of our system focuses on hardware and software parts. In this subchapter, the working principle of every component are explained. The specifications of every component are reviewed to full details and how it may help the overall system specifically, the device itself.

A. Main Hardware

Digital Persona Fingerprint Sensor

Fingerprint recognition and authentication will be an ease with the Digital Persona Fingerprint Sensor. The image rendering, measurement, feature-finding, and searching are all done by optical fingerprint scanning technology with silicone coating to achieve excellent image quality, a large capture area and superior reliability. Allowing it to read a wide range of fingerprints accurately and rapidly regardless of placement angle.

Figure 3.6. Digital Persona Fingerprint Sensor

Raspberry Pi 4 Model B (8GB Ram)

Raspberry Pi Model B is the most powerful yet in the line of the Raspberry Pi Single-Board Computers. With its major increase in processing power, enhanced video output and peripheral connectivity. It can also accommodate both Wired and Wireless Connection that wasn't present on the previous models of the Single-Board Computers.

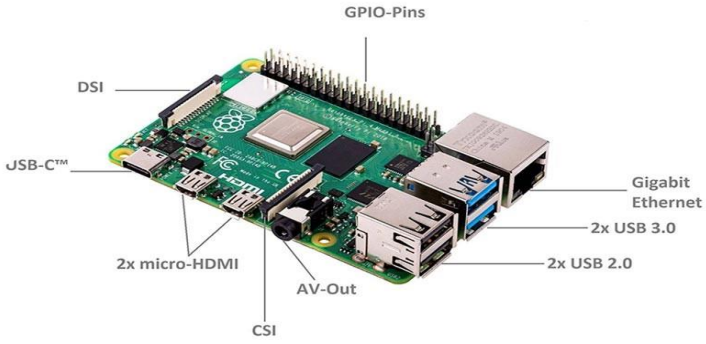


Figure 3.7. Raspberry Pi 4 Model B

Capacitive Touch Screen Display

Capacitive Touch Screen is a control display that uses conductive touch or specialized device for input. It is more efficient than resistive or surface wave panels since it requires capacitive touch of a human finger or special capacitive pen or glove to produce input to the device.

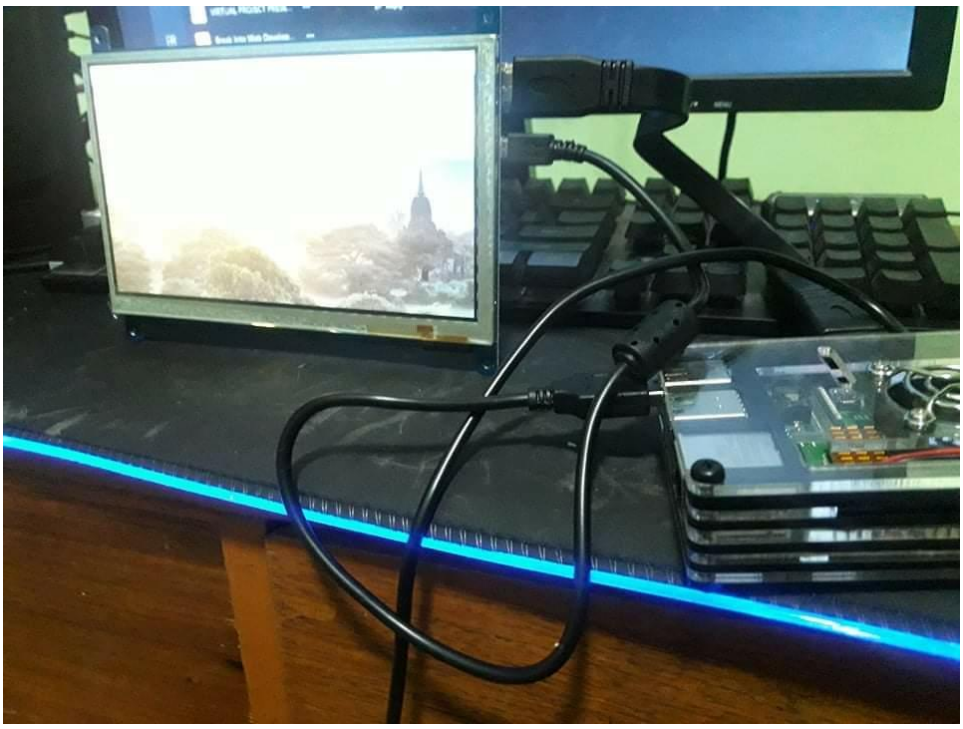


Figure 3.8. Capacitive Touch Screen Display

B. SOFTWARE

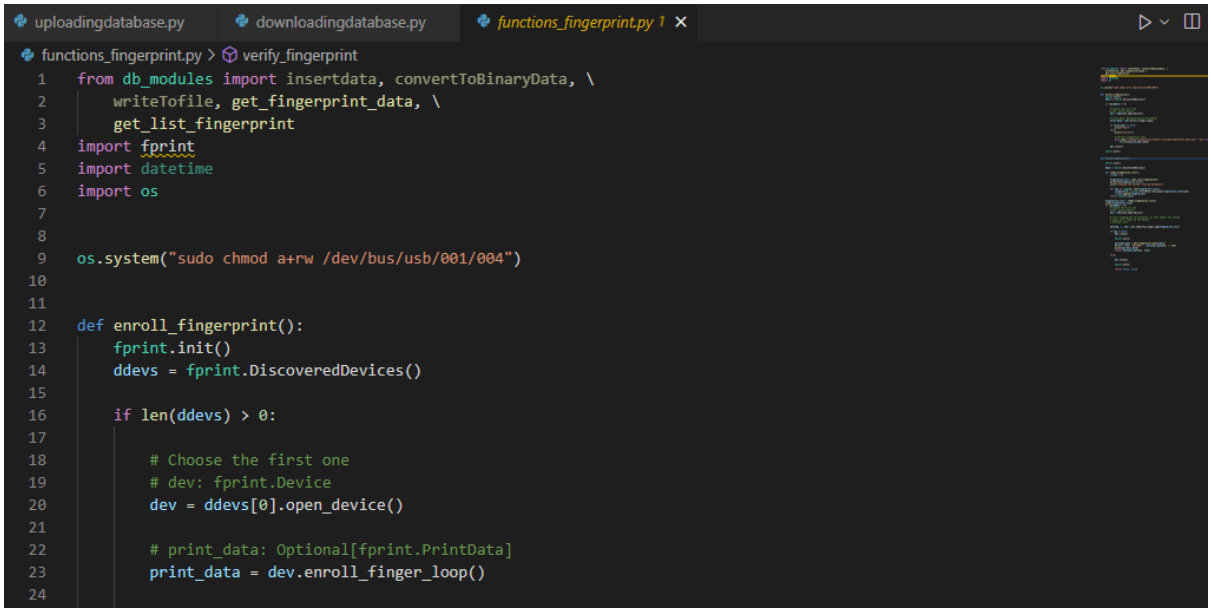
List of Software:

PYTHON AND FLASK INTEGRATION

The logic behind our system is integrated with Python language together with Flask for building the webapp. Using the database and python we can create the functionality of our system. In this part of the paper, we will highlight the codes that was used. All these modules can be accessed using GitHub account of one of the proponents

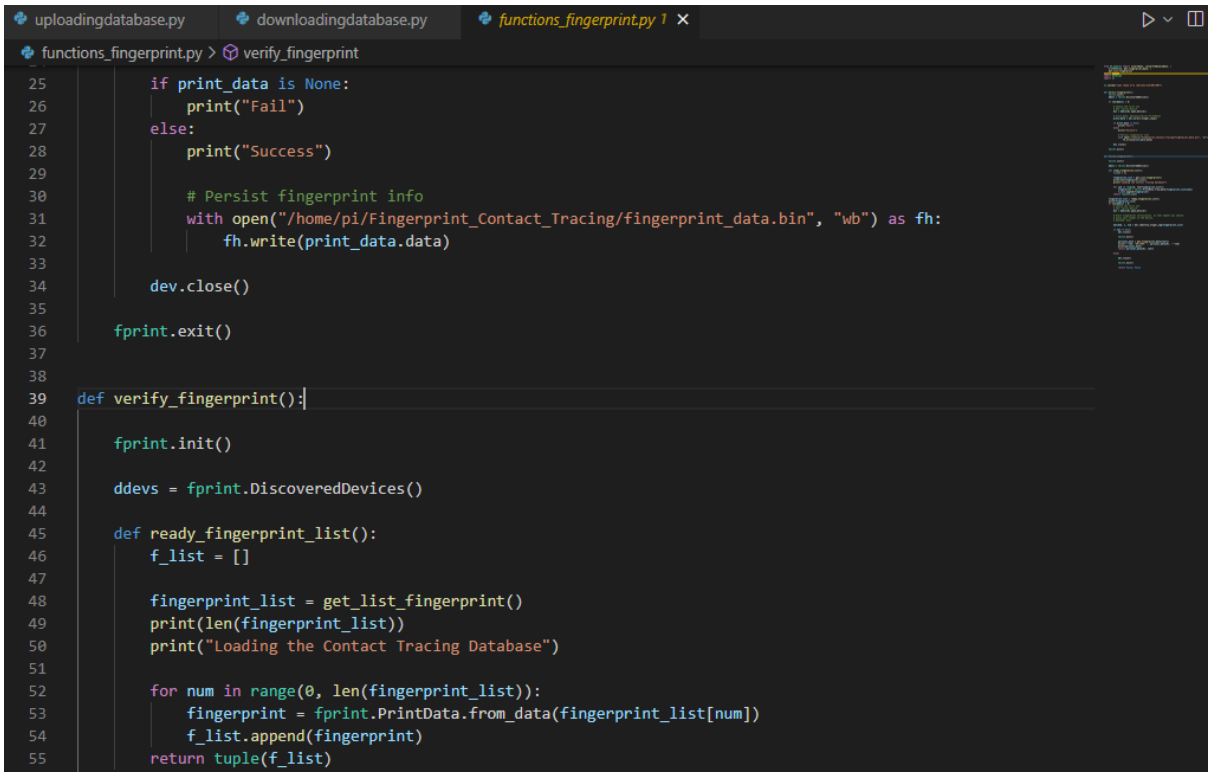
For the fingerprint module, “function_fingerprint.py”

THE FINGERPRINT SCANNER



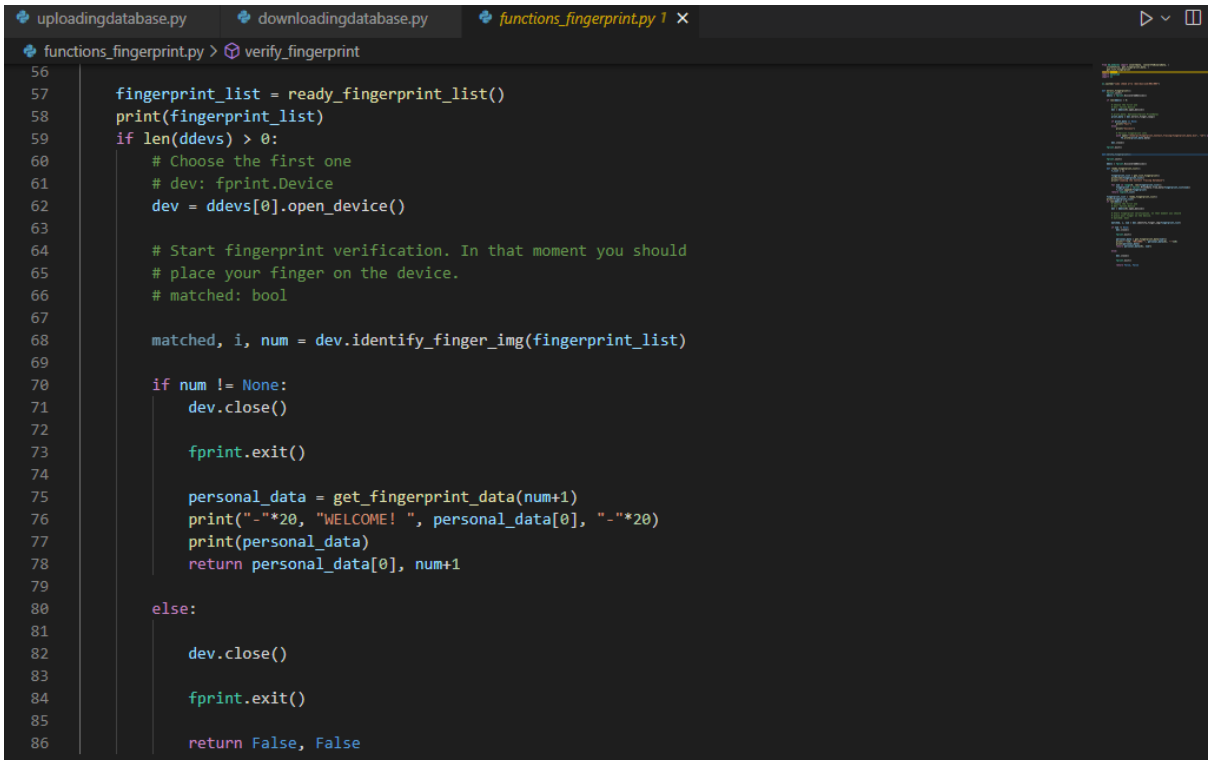
```python
from db_modules import insertdata, convertToBinaryData, \
    writeTofile, get_fingerprint_data, \
    get_list_fingerprint
import fprint
import datetime
import os


os.system("sudo chmod a+rw /dev/bus/usb/001/004")


def enroll_fingerprint():
    fprint.init()
    ddevs = fprint.DiscoveredDevices()

    if len(ddevs) > 0:

        # Choose the first one
        # dev: fprint.Device
        dev = ddevs[0].open_device()

        # print_data: Optional[fprint.PrintData]
        print_data = dev.enroll_finger_loop()
```

Here you can see the “import fprint” which let us access the fingerprint module and read it. The “import datetime” is for establishing recording of time a person enter a establishment. The “import os” loads the operating system of raspberry pi.



```python
        if print_data is None:
            print("Fail")
        else:
            print("Success")

            # Persist fingerprint info
            with open("/home/pi/Fingerprint_Contact_Tracing/fingerprint_data.bin", "wb") as fh:
                fh.write(print_data.data)

        dev.close()

    fprint.exit()


def verify_fingerprint():

    fprint.init()

    ddevs = fprint.DiscoveredDevices()

    def ready_fingerprint_list():
        f_list = []

        fingerprint_list = get_list_fingerprint()
        print(len(fingerprint_list))
        print("Loading the Contact Tracing Database")

        for num in range(0, len(fingerprint_list)):
            fingerprint = fprint.PrintData.from_data(fingerprint_list[num])
            f_list.append(fingerprint)
        return tuple(f_list)
```

We created various functions for the logic of our fingerprint system.

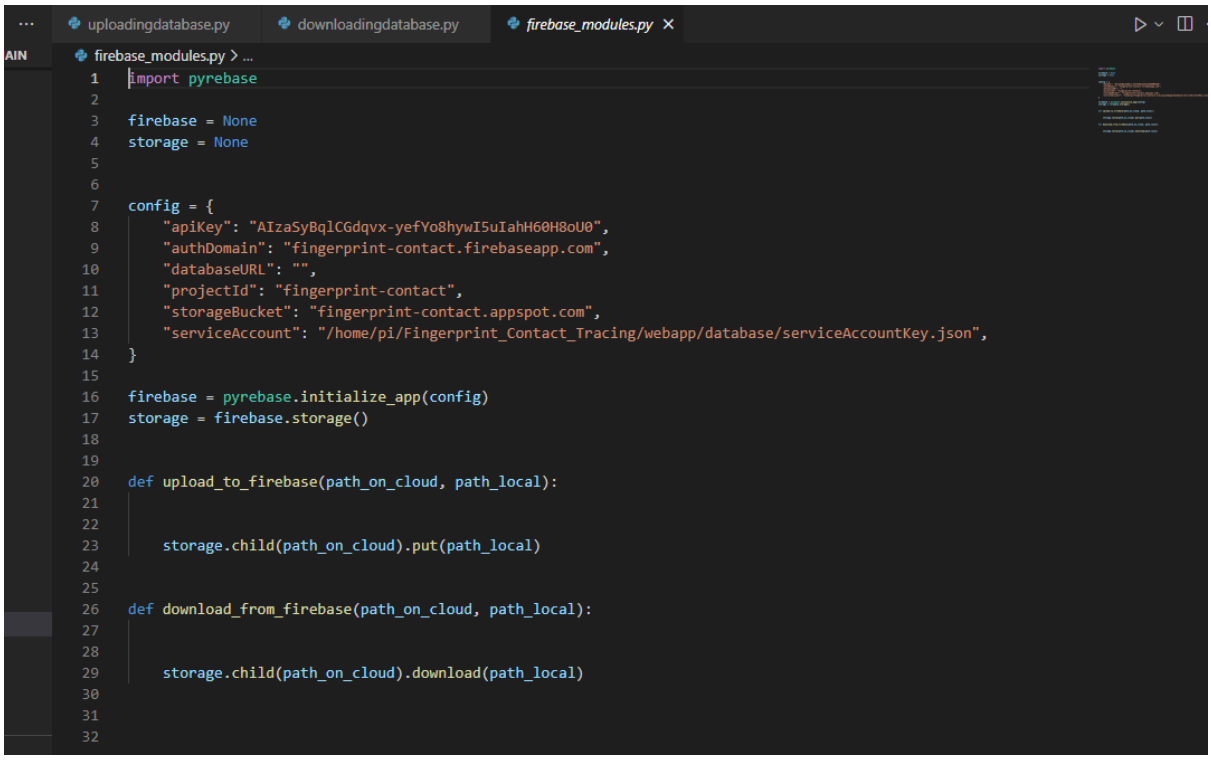



```python
    fingerprint_list = ready_fingerprint_list()
    print(fingerprint_list)
    if len(ddevs) > 0:
        # Choose the first one
        # dev: fprint.Device
        dev = ddevs[0].open_device()

        # Start fingerprint verification. In that moment you should
        # place your finger on the device.
        # matched: bool

        matched, i, num = dev.identify_finger_img(fingerprint_list)

        if num != None:
            dev.close()

            fprint.exit()

            personal_data = get_fingerprint_data(num+1)
            print("-"*20, "WELCOME! ", personal_data[0], "-"*20)
            print(personal_data)
            return personal_data[0], num+1

        else:

            dev.close()

            fprint.exit()

            return False, False
```

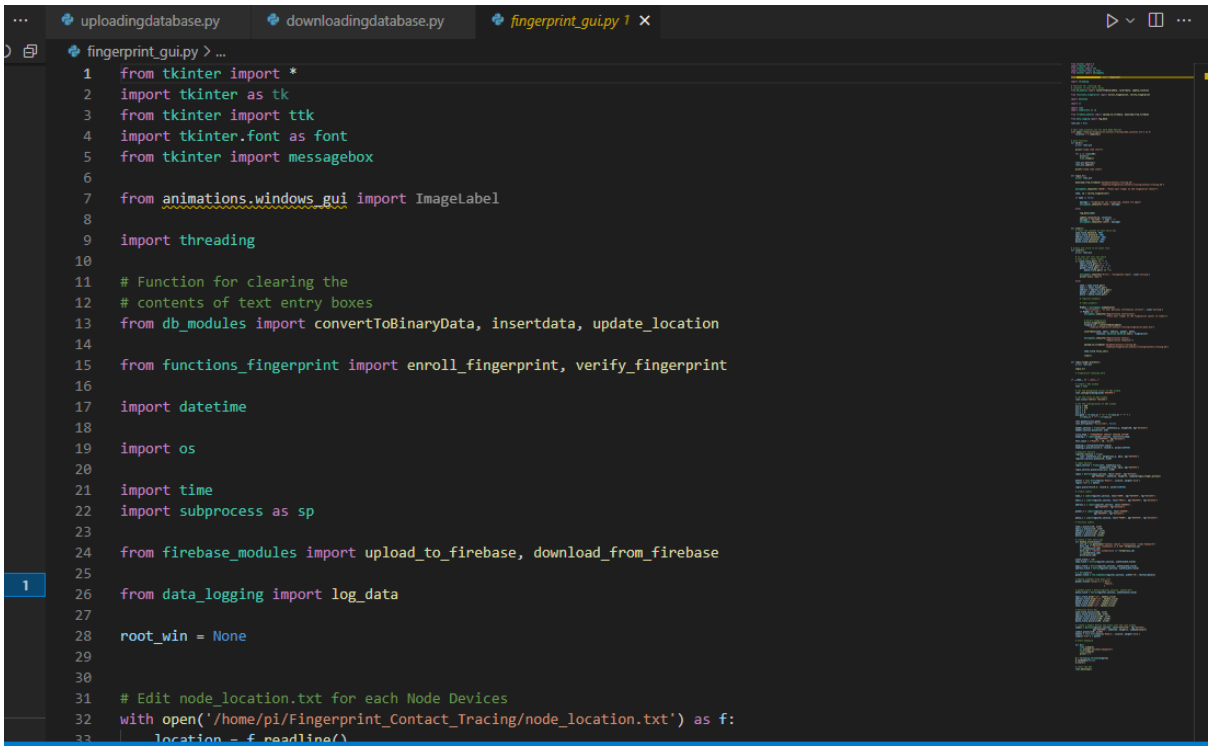
Conditional statements where created for the matching at the verification process.

THE DATABASE

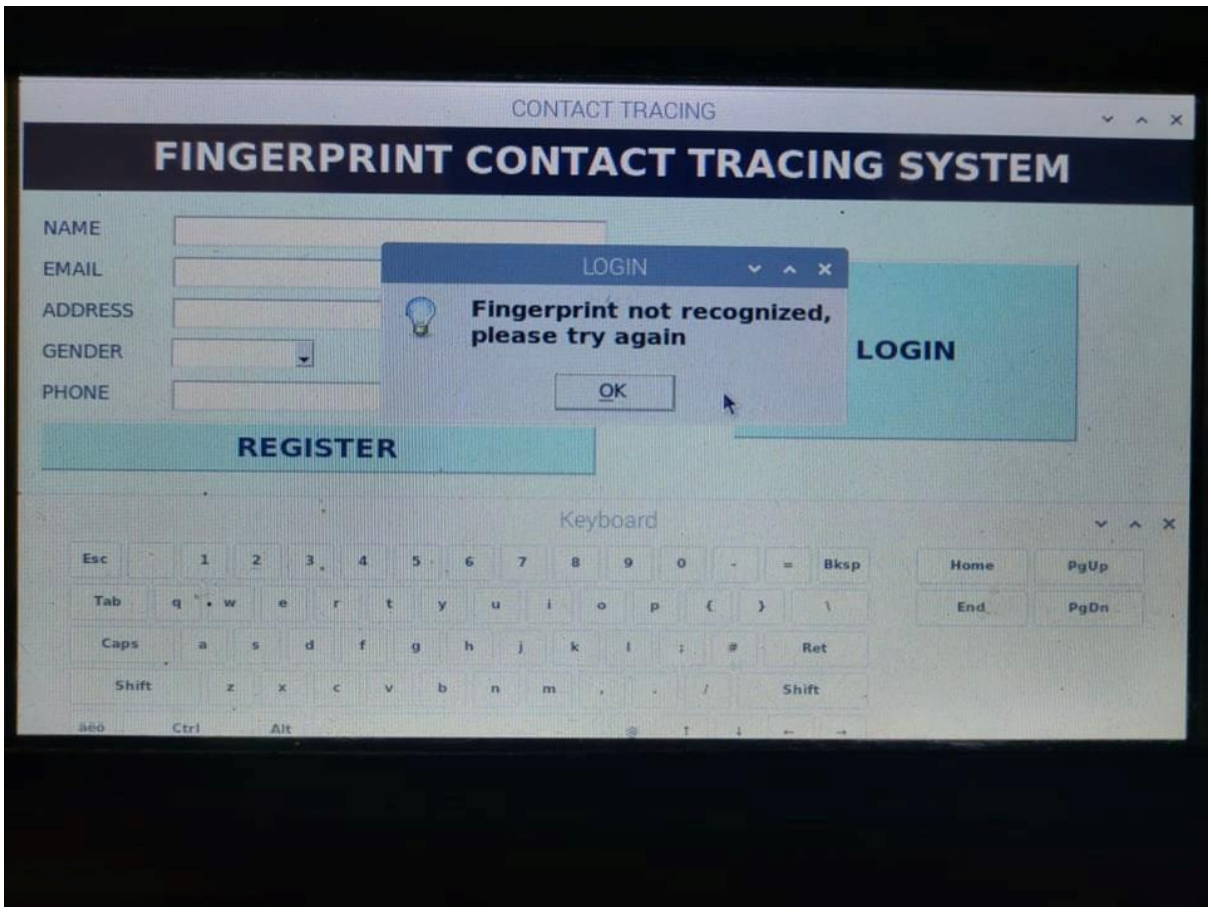
The “firebase_modules.py” is used for creating the configuration for the database of the system. We import pyrebase for as to create the path on our cloud storage.



Our GUI (Graphical User Interface) was designed by “tkinter” command of python where we import the parameters of our interface. This design opens up long lines of code because all of the commands are applied to this and needs to be synchronous with the reloading of the database.



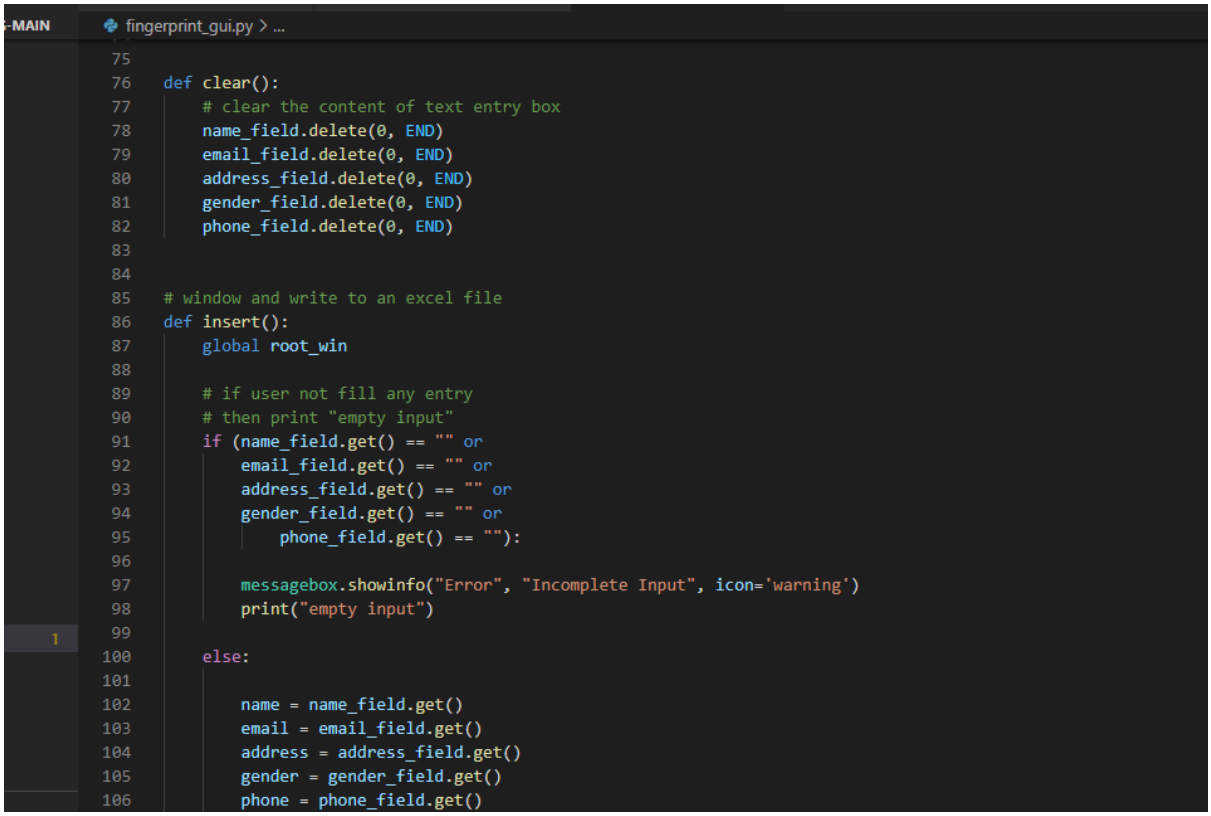
```
    root_win.destroy()
    root_win.update()

    print("sleep time stop")


def login_f():
    global root_win

    download_from_firebase('database/Contact_Tracing.db',
                           '/home/pi/Fingerprint_Contact_Tracing/Contact_Tracing.db')

    messagebox.showinfo("LOGIN", "Place your finger on the fingerprint sensor")

    name, id = verify_fingerprint()

    if name is False:

        message = "Fingerprint not recognized, please try again"
        messagebox.showinfo("LOGIN", message)

    else:

        log_data(name)

        update_location(id, location)
        message = "WELCOME " + name + "!"
        messagebox.showinfo("LOGIN", message)


def clear():
    # clear the content of text entry box
```



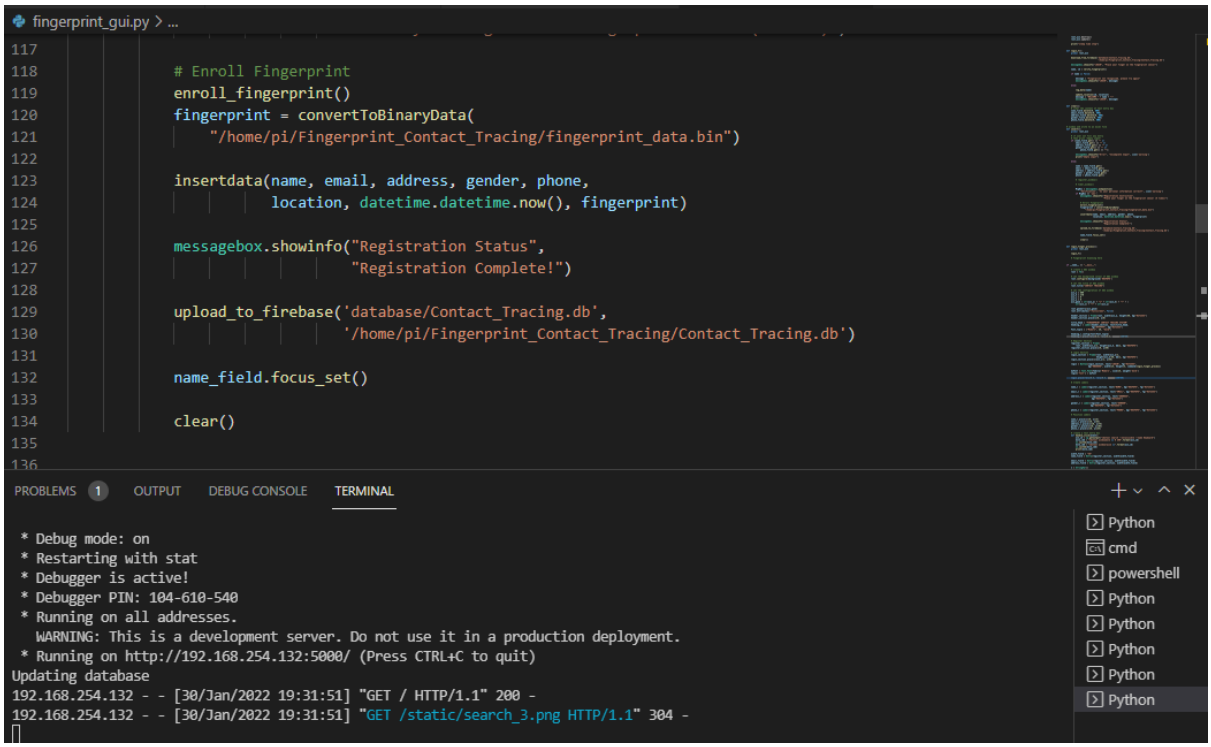
Login details, input bars and display message command are present on this function.

Conditional statements are provided in this example as if there was a mismatch at the verification

process, message = “fingerprint not recognized, please try again” and this is place in a box frame. Else if it is recognized it will display “Welcome” and it will automatically update location and input it as a log data on the existing information in the database.



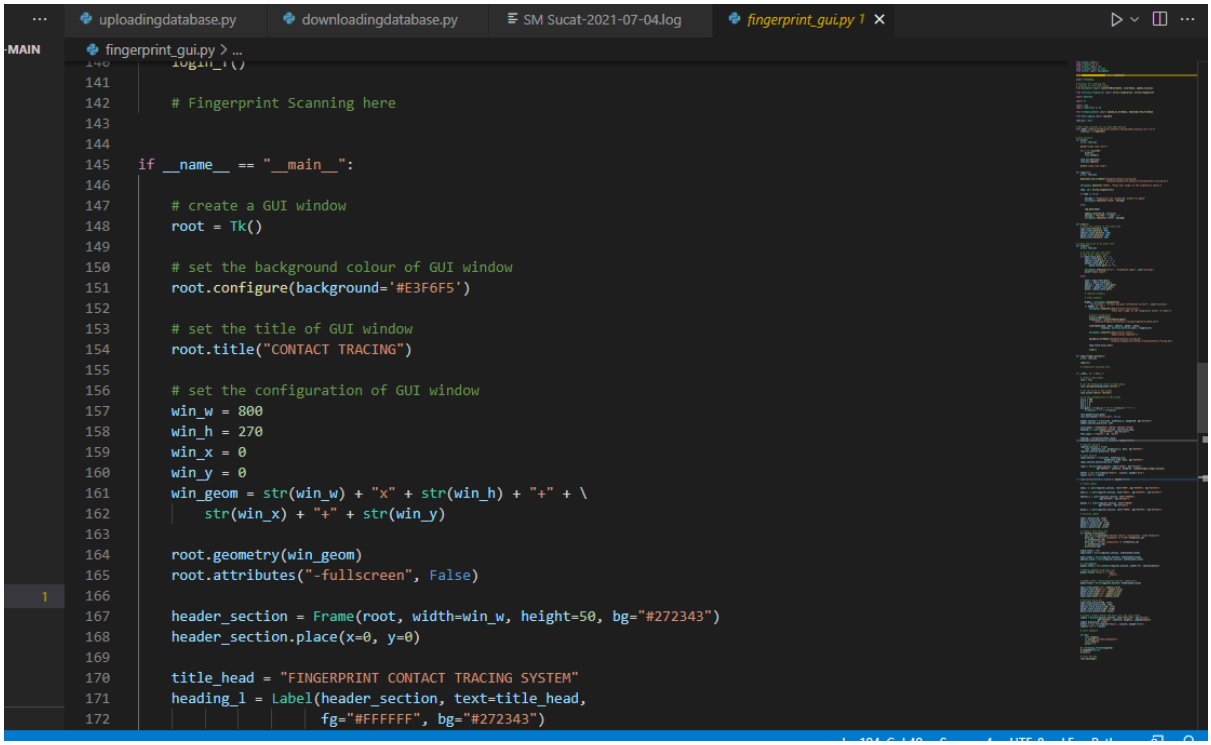
Fields that are needed to input the data of user’s name, age, email, address, gender and phone number. The touchpad has a touchscreen interface for more portable user feel.



```
fingerprint_gui.py > ...
117
118             # Enroll Fingerprint
119             enroll_fingerprint()
120             fingerprint = convertToBinaryData(
121                 "/home/pi/Fingerprint_Contact_Tracing/fingerprint_data.bin")
122
123             insertdata(name, email, address, gender, phone,
124                        location, datetime.datetime.now(), fingerprint)
125
126             messagebox.showinfo("Registration Status",
127                                 "Registration Complete!")
128
129             upload_to_firebase('database/Contact_Tracing.db',
130                                '/home/pi/Fingerprint_Contact_Tracing/Contact_Tracing.db')
131
132             name_field.focus_set()
133
134             clear()
135
136
PROBLEMS 1   OUTPUT   DEBUG CONSOLE   TERMINAL

 * Debug mode: on
 * Restarting with stat
 * Debugger is active!
 * Debugger PIN: 104-610-540
 * Running on all addresses.
   WARNING: This is a development server. Do not use it in a production deployment.
 * Running on http://192.168.254.132:5000/ (Press CTRL+C to quit)
Updating database
192.168.254.132 - - [30/Jan/2022 19:31:51] "GET / HTTP/1.1" 200 -
192.168.254.132 - - [30/Jan/2022 19:31:51] "GET /static/search_3.png HTTP/1.1" 304 -
```

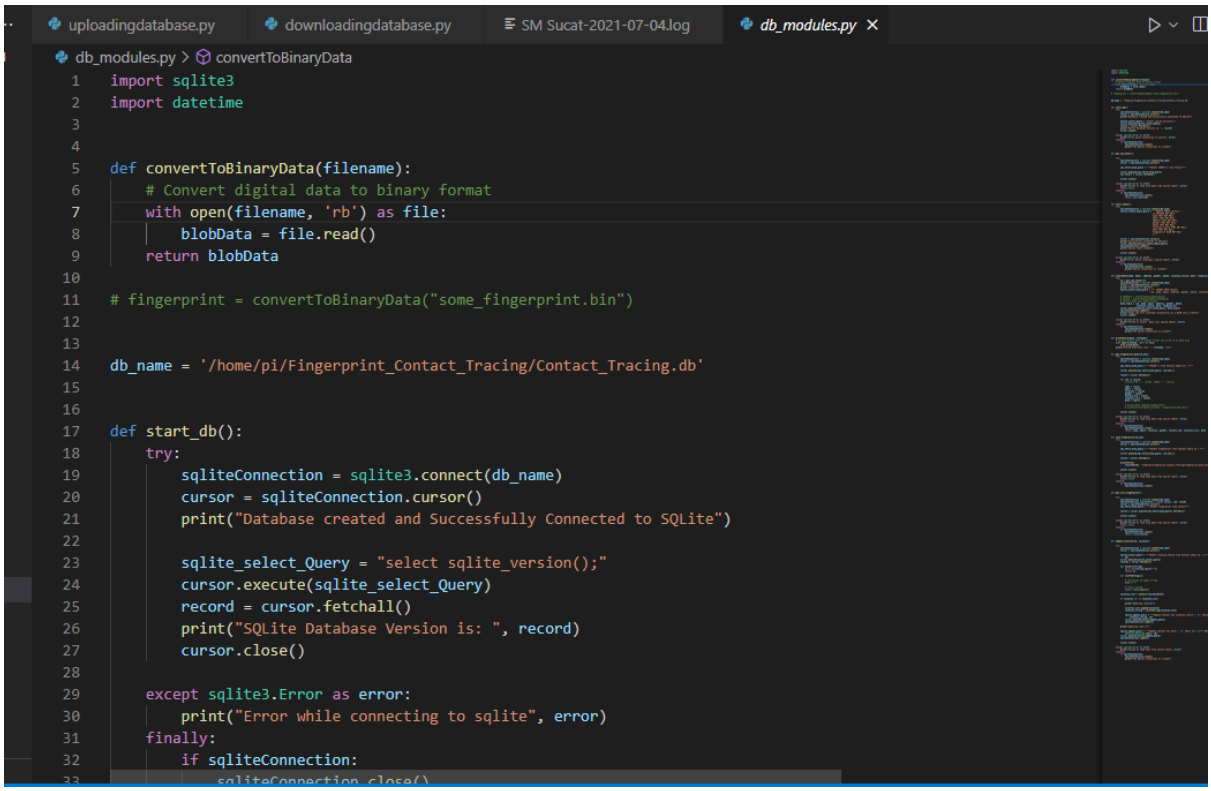
Python
cmd
powershell
Python
Python
Python
Python
Python

Enrollment Process – registration of the fingerprints that synchronizing the data set or and the binary data of the fingerprint.

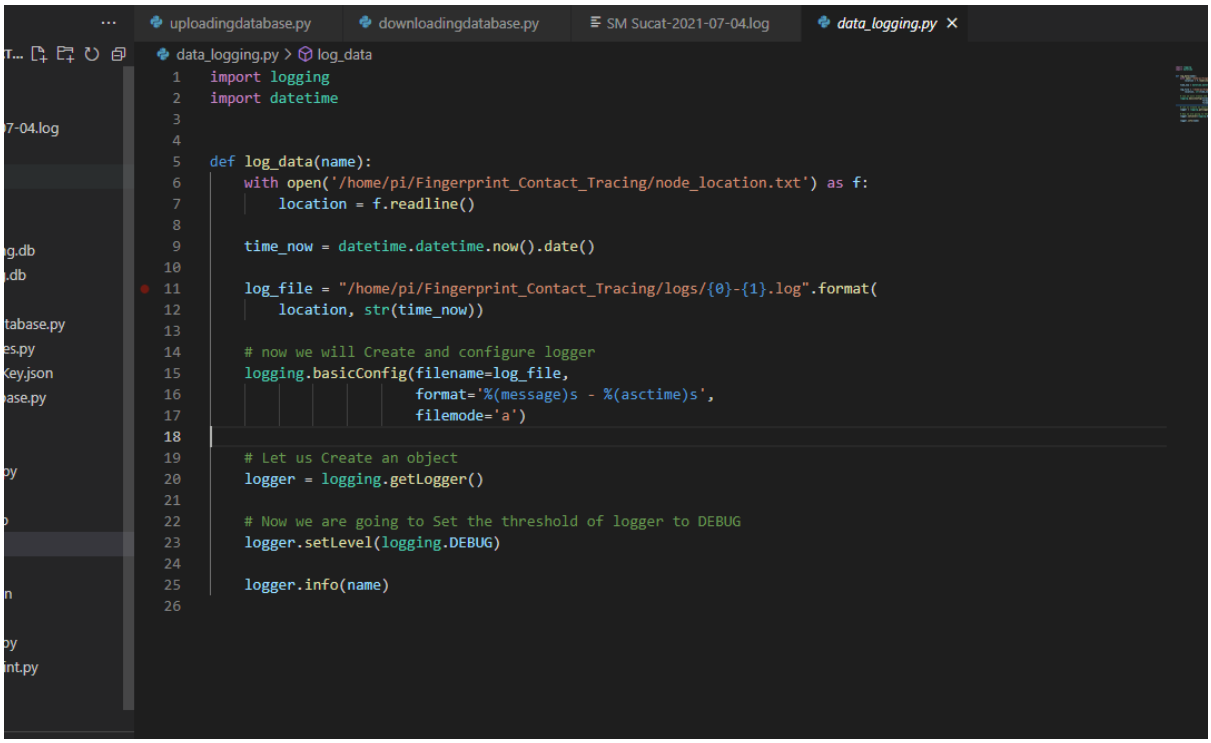


```
uploadingdatabase.py   downloadingdatabase.py   SM Sucat-2021-07-04.log   fingerprint_gui.py 1
MAIN
fingerprint_gui.py > ...
141
142     # Fingerprint Scanning here
143
144
145 if __name__ == "__main__":
146
147     # create a GUI window
148     root = Tk()
149
150     # set the background colour of GUI window
151     root.configure(background='#E3F6F5')
152
153     # set the title of GUI window
154     root.title("CONTACT TRACING")
155
156     # set the configuration of GUI window
157     win_w = 800
158     win_h = 270
159     win_x = 0
160     win_y = 0
161     win_geom = str(win_w) + "x" + str(win_h) + "+" + \
162         str(win_x) + "+" + str(win_y)
163
164     root.geometry(win_geom)
165     root.attributes("-fullscreen", False)
166
167     header_section = Frame(root, width=win_w, height=50, bg="#272343")
168     header_section.place(x=0, y=0)
169
170     title_head = "FINGERPRINT CONTACT TRACING SYSTEM"
171     heading_l = Label(header_section, text=title_head,
172                       fg="#FFFFFF", bg="#272343")
```

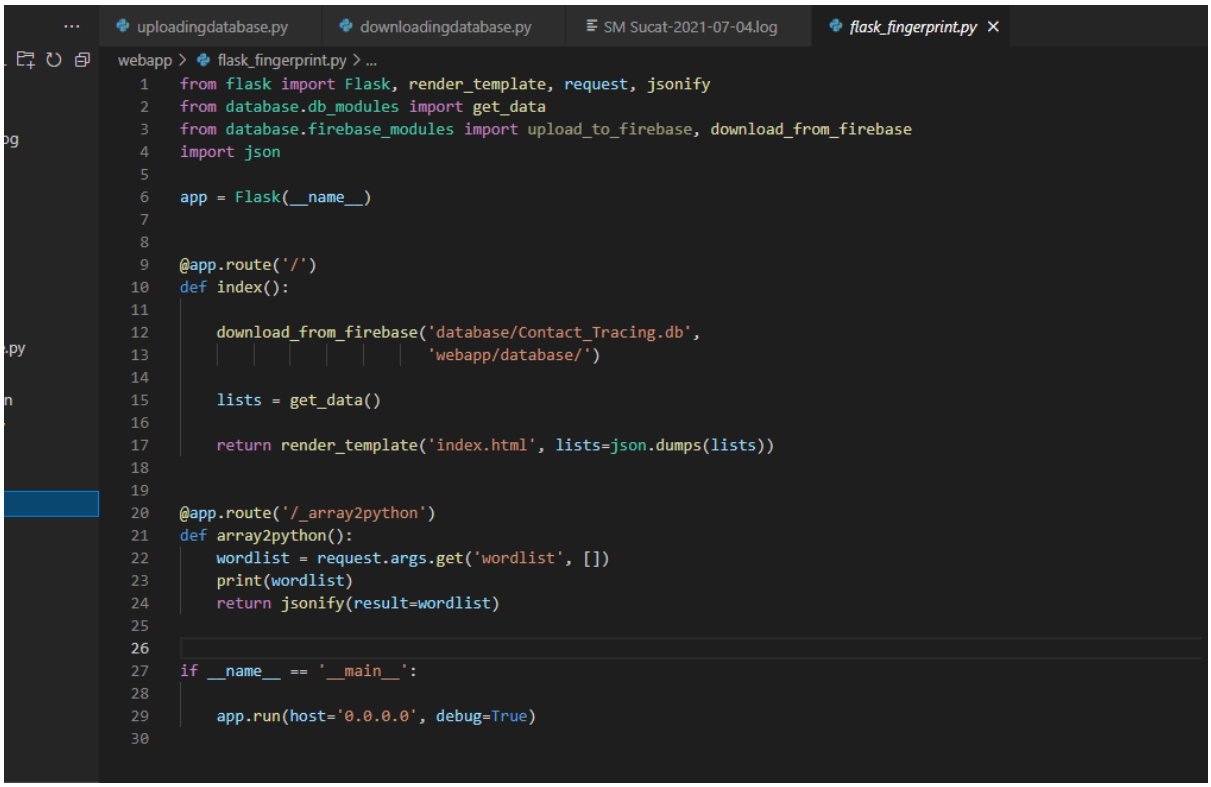
This is the object for the GUI where all its attributes are set and setting its configuration.



This is the “db_modules.py” where the source code of our connection between the fingerprint data and the database. We import “sqlite3” package together with the “datetime”. The fingerprint data is introduced as “blob” which means that this data is encrypted for security purposes.

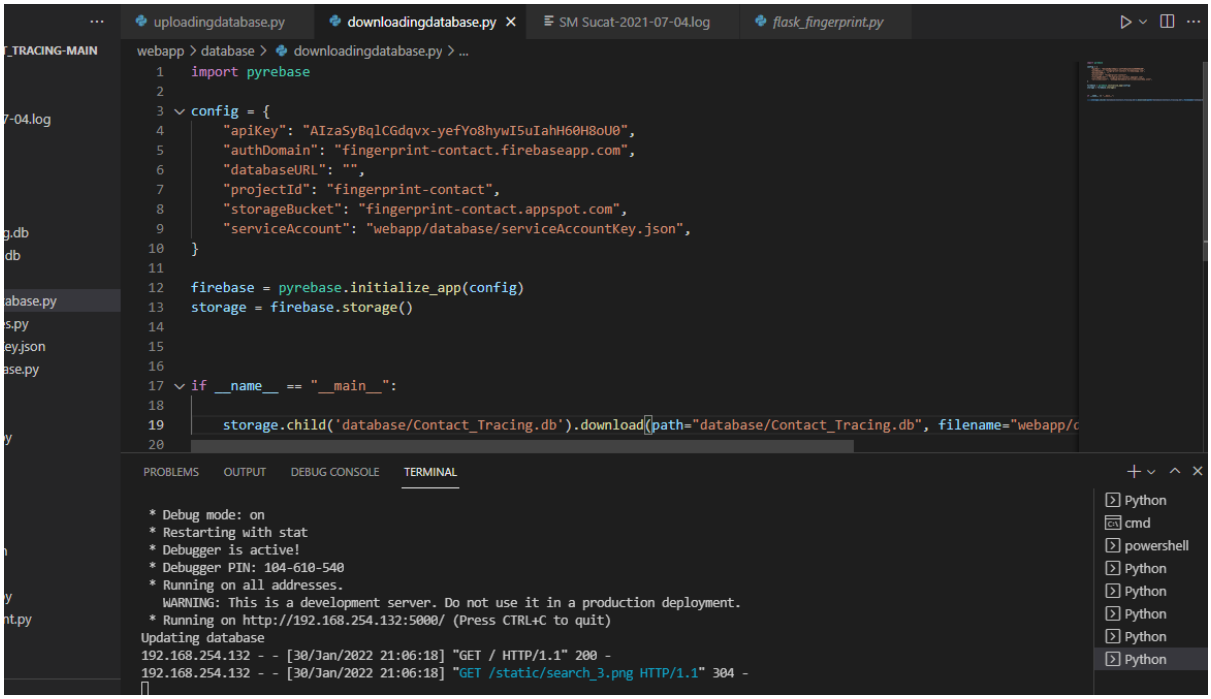


The “data_logging.py” is responsible for setting up the location of the device.



```python
from flask import Flask, render_template, request, jsonify
from database.db_modules import get_data
from database.firebase_modules import upload_to_firebase, download_from_firebase
import json

app = Flask(__name__)


@app.route('/')
def index():

    download_from_firebase('database/Contact_Tracing.db',
                           'webapp/database/')

    lists = get_data()

    return render_template('index.html', lists=json.dumps(lists))


@app.route('/_array2python')
def array2python():
    wordlist = request.args.get('wordlist', [])
    print(wordlist)
    return jsonify(result=wordlist)


if __name__ == '__main__':

    app.run(host='0.0.0.0', debug=True)
```

This is the main running platform of our system to get real time updates to our database. The read and write of data and troubleshooting is perform this way where we run this together with the “downloadingdatabase.py” and “uploadingdatabase.py”.



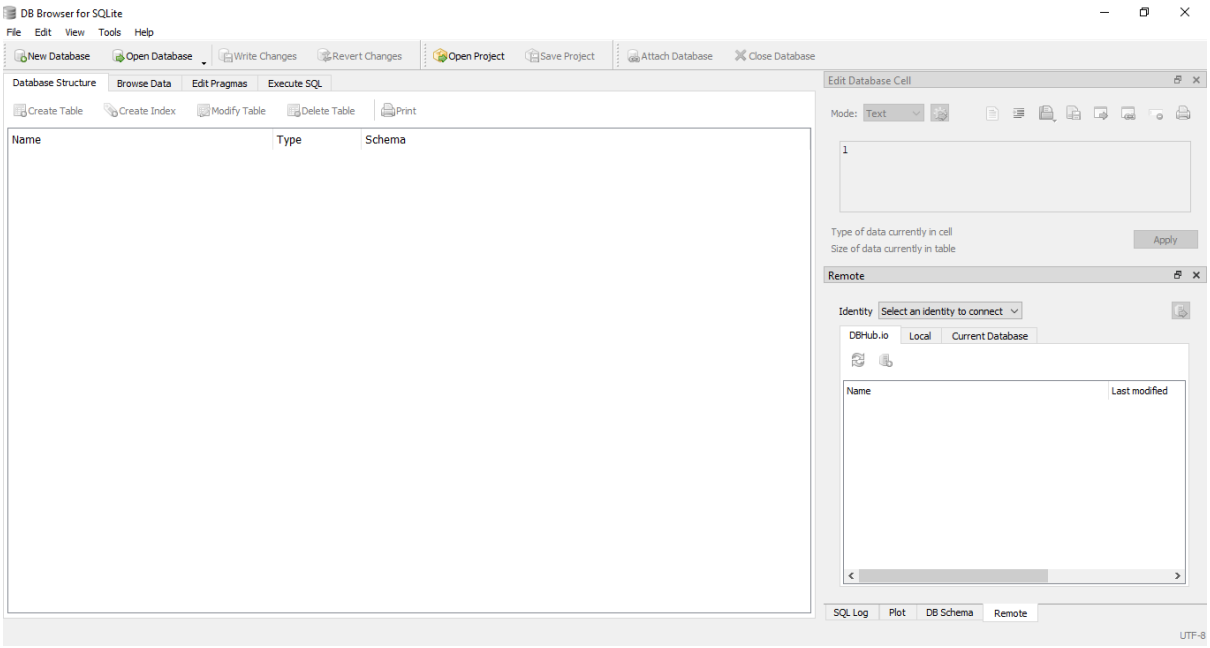
```python
import pyrebase

config = {
    "apiKey": "AIzaSyBqlCGdqvx-yefYo8hywI5uIahH60H8oU0",
    "authDomain": "fingerprint-contact.firebaseapp.com",
    "databaseURL": "",
    "projectId": "fingerprint-contact",
    "storageBucket": "fingerprint-contact.appspot.com",
    "serviceAccount": "webapp/database/serviceAccountKey.json",
}

firebase = pyrebase.initialize_app(config)
storage = firebase.storage()



if __name__ == "__main__":

    storage.child('database/Contact_Tracing.db').download(path="database/Contact_Tracing.db", filename="webapp/c
```

```
 * Debug mode: on
 * Restarting with stat
 * Debugger is active!
 * Debugger PIN: 104-610-540
 * Running on all addresses.
   WARNING: This is a development server. Do not use it in a production deployment.
 * Running on http://192.168.254.132:5000/ (Press CTRL+C to quit)
Updating database
192.168.254.132 - - [30/Jan/2022 21:06:18] "GET / HTTP/1.1" 200 -
192.168.254.132 - - [30/Jan/2022 21:06:18] "GET /static/search_3.png HTTP/1.1" 304 -
```

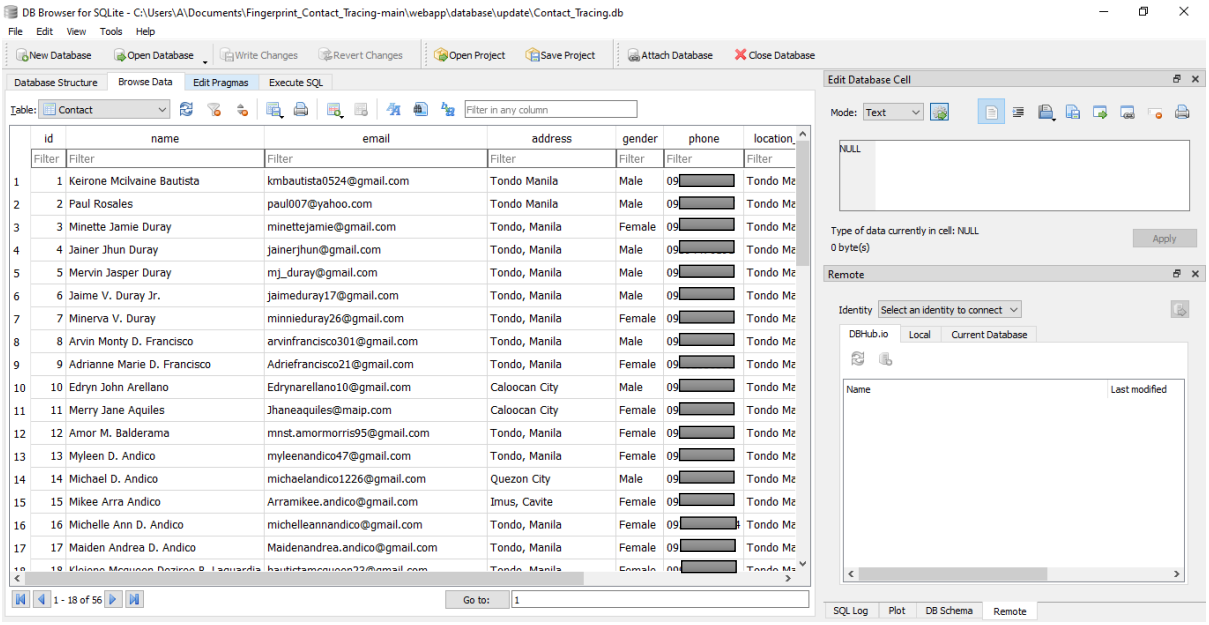
The terminal keeps the debugger active where it keeps track on the error on the code whenever we keep on running it. This ensures that the application would not crash even if we were trying to get a lot of data reflect on our database.

Now let us move on to the stage of our database where everything was put in allocation. The user data are input like list are input like list.

The SQLite environment is where we store our data. The file is access in this directory with the fingerprint use as blob where you can see it as an encrypted file.



This is where we make changes in our data that is store, we can delete the existing data if it is necessary.



These are the updated information on our device. This can only be accessed by database admin, meaning even if anyone can have the program the files remain secured.

3.3 Project Testing and Evaluation

The prototype requires the following software to be installed: Python 3.5, Raspberry Pi library, Flask extensions and SQL lite. The first part was testing the scanning capability of the fingerprint scanner as we integrate it on python and the next one was testing the speed of real time updates of our database.

We found an establishment that suits the need of having a contact tracing system and has typical number of individuals daily. The prototype was tested on a Japanese Restaurant which caters 50-100 customers daily. This is an ideal and typical establishment for our device. We tested 100 persons to scan their fingerprint and they need to scan their thumb 5 times in a row. This will ensure that the device will completely read the fingerprint. Then, the users will need to put their details in a

keyboard along with the touchpad GUI. The fingerprint is encrypted together with the information and can only be access by database admin.

Our testing includes how fast the scanner can read all the fingerprint data and the information be uploaded in the database after the registration and matching

Fig 3.3.1 The Japanese Restaurant "Kentara Izakaya" where we test our device.

Fig. 3.3.2 One of the owners of Kentara Izakaya registering his fingerprints

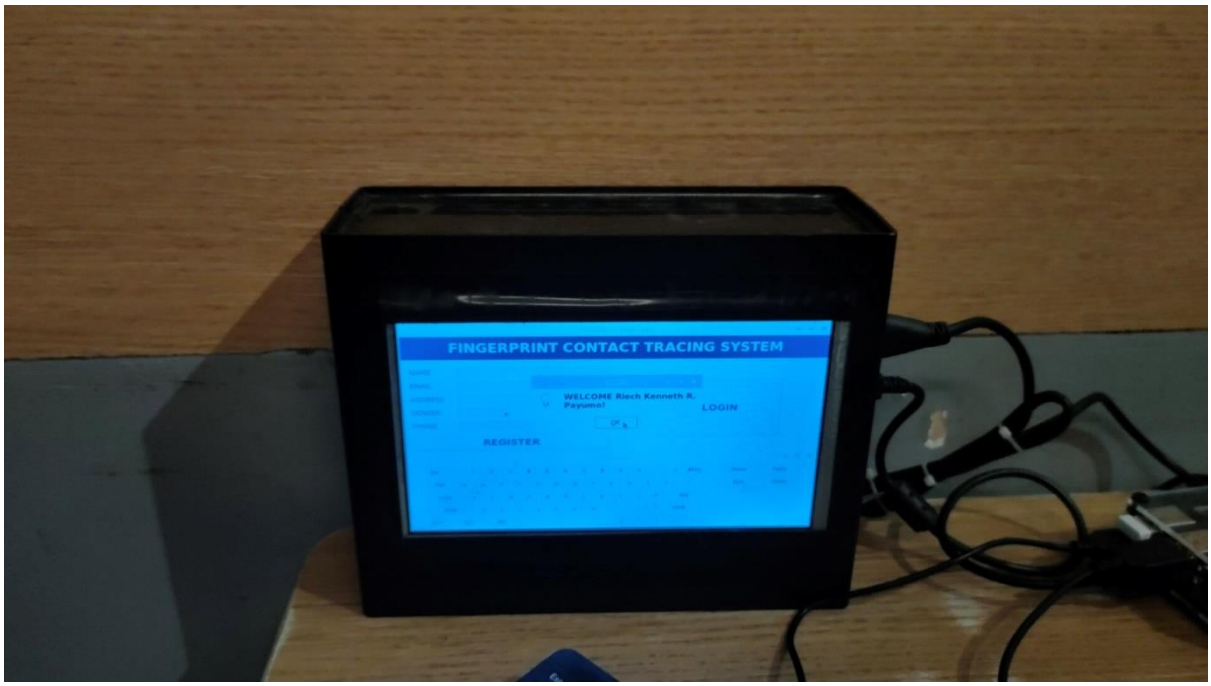


Fig 3.3.3 The contact tracing system log device

Fig. 3.3.4 One of the staffs registering fingerprints

Fig. 3.3.5 One of the staffs registering fingerprints

Fig. 3.3.6 One of the customers registering fingerprints

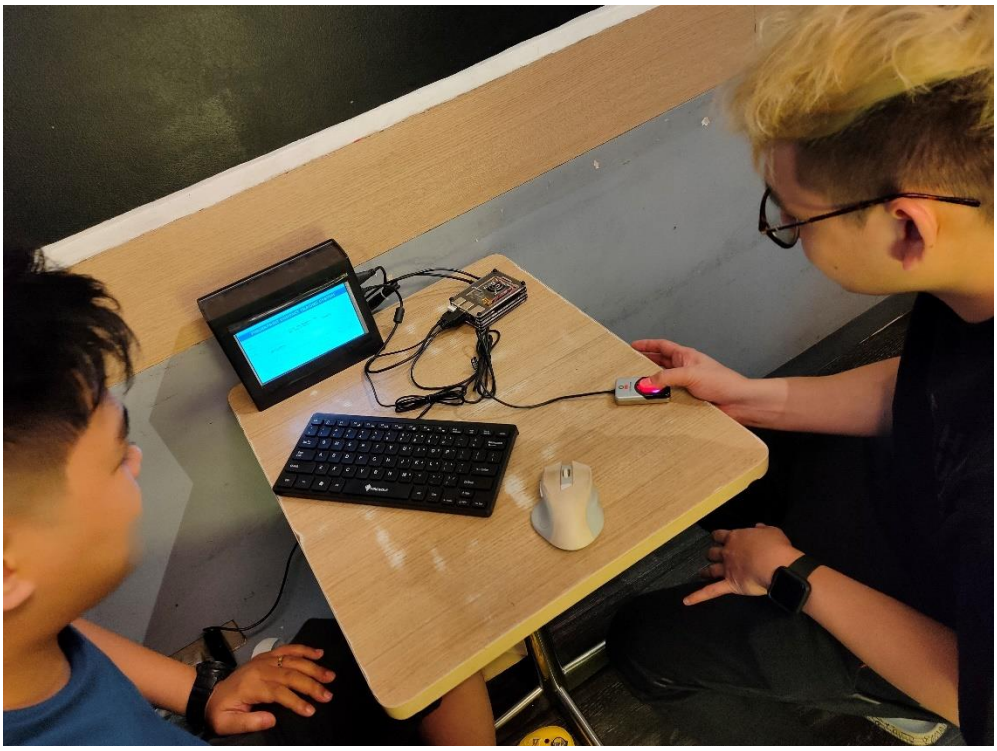


Fig. 3.3.7 One of the customers registering fingerprints

A. Testing Procedure

Enrollment part

1. Check the connection of the fingerprint sensor via usb2.0 connector with the Raspberry Pi computer.
2. Turn on the device and connect it to a WIFI network.
3. Check the sensing capability of the fingerprint sensor, the sensing capability must have a quality image for feature extraction. The blue and red led light that can be seen in the scanner is an indicator that it is ready for scanning.
4. There is a login button that user must click and there will be a prompt to place their thumb for scanning.
5. The user needs to tap thumb by 5 times to ensure feature extraction.
6. Now if user's fingerprint is not recognized, it will prompt to input their details.

7. Now after the details the database updates and proponents will now check if the information was stored at the right time.

B. VERIFICATION PART

1. Check the connection of the fingerprint sensor via usb2.0 connector with the Raspberry Pi computer.
2. Turn on the device and connect it to a WIFI network.
3. Check the sensing capability of the fingerprint sensor, the sensing capability must have a quality image for feature extraction. The blue and red led light that can be seen in the scanner is an indicator that it is ready for scanning.
4. There is a login button that user must click and there will be a prompt to place their thumb for scanning.
5. Now if the user's fingerprint is recognized the first time, then the matching was successful.
6. The GUI will display the welcome statement with the name of the identified user.

3.4 PROJECT EVALUATION AND CRITERIA

The phase of evaluation occurs at the end of the study period. It is the method of evaluating a subject's content, importance, and efficiency using parameters that are driven by a set of standards. These criteria are used to assess the level of accomplishment in relation to the subject's goal and objectives.

These are the criteria that is set to evaluate the performance of the fingerprint system:

Percentage of confirmed scan – here we can determine the exact feature extraction rate of our fingerprint sensor.

Scanning Speed – here we can determine how fast and convenient our scanning.

Matching – here the matching should reach approximate 100% to ensure effectivity of our device.

Database real time update – here we always update the database on every interaction these ensure real time recording of information.

CHAPTER 4: RESULTS AND DISCUSSION

INTRODUCTION:

After of a series of testing and evaluation done in the Kentara restaurant, we tabulate everything and make necessary conclusion on how effective our devices when it comes to log-in time of customers and staffs and how fast our device can capture the fingerprints. There is somewhat a delay that is occurring in the system due to wireless connectivity, but we made sure that all the information provided is correct.

A. FINGERPRINT SCANNER

Scanned 2 thumbs of 4 users and repeat it for 5 times then we got a total of 40 samples.

The GUI will display “Welcome, (name)” or “Fingerprint not recognized, please try again” indicates a confirmed scan.

CRITERIA	1 TAP	2-3 TAPS	4 TAPS OR MORE
NUMBER OF CONFIRMED SCAN	37	3	0
PERCENTAGE OF CONFIRMED SCAN (%)	92.5%	7.5%	0%

Table 4.1. Number of confirmed scans along with the percentage of confirmed scan

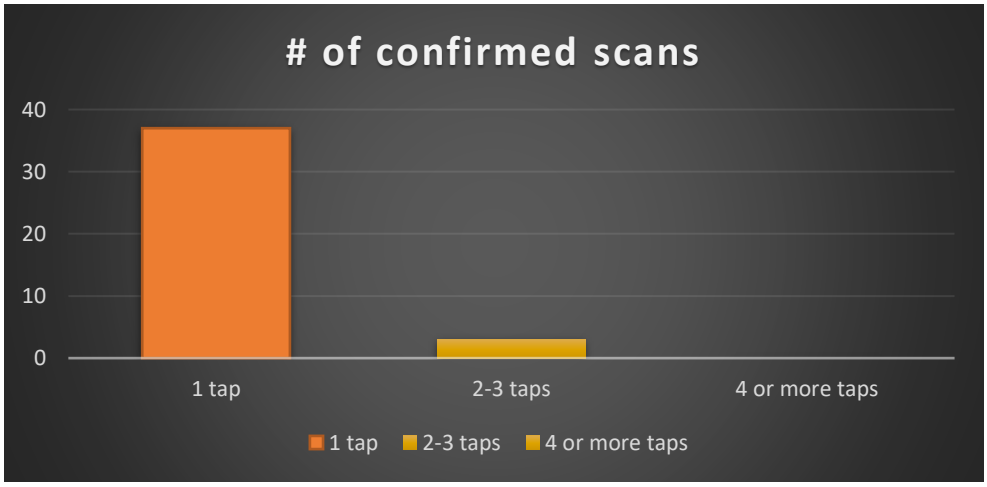


Figure 4.1. Number of Confirmed Scans

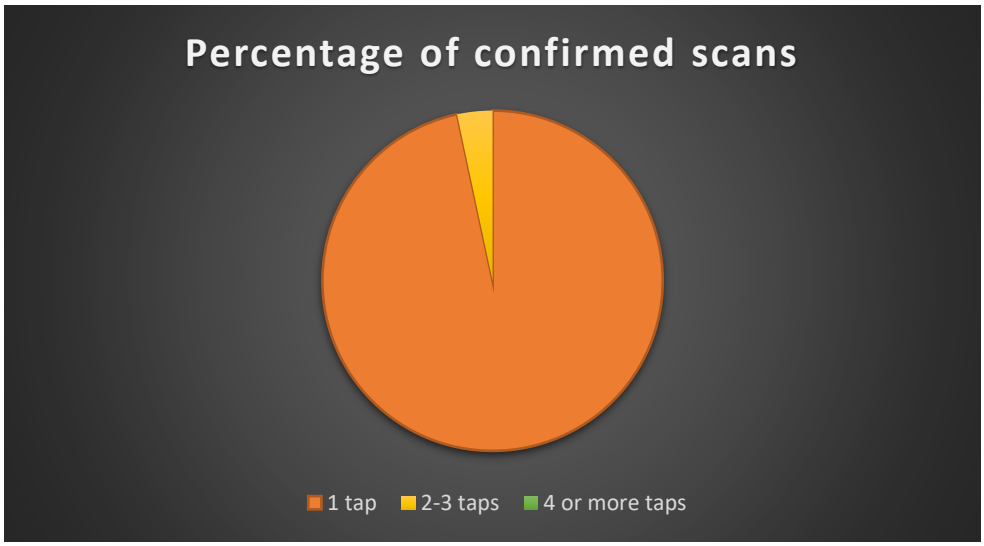


Figure 4.2. Percentage of Confirmed Scans

Here we can see how we test the capability of our scanner to accurately gather the fingerprints. We recorded if all taps will be read the first time the user taps. The samples made 37 out of 40 score for the 1st tap which automatically pops up either of the two messages in GUI.

The remaining 3 scanned fingerprints did take 2 or 3 taps to be read by scanner because there are reasons that can contribute to it:

1. If the user didn't lay the thumb properly where the fingerprint has having trouble reading the fingerprint image.

2. The second reason is that the smudgy surface, sweat or other liquids which may contribute on an error for extracting the fingerprint image.

B. MATCHING (ENROLLMENT AND VERIFICATION TIME)

We tested 80 persons to scan their fingerprint and go through verification to make matching. We recorded the time it takes to completely verify the individual and welcome that individual in the establishment. We just recorded the time of enrollment and verification as we didn't take note of recording the whole process as it varies from person to person on how fast they can input their details.

Tested users	User Address	VERIFICATION TIME (sec.)
user 1	Tondo, Manila	65
user 2	Tondo, Manila	68
user 3	Tondo, Manila	71
user 4	Tondo, Manila	63
user 5	Tondo, Manila	64
user 6	Tondo, Manila	84
user 7	Tondo, Manila	83
user 8	Tondo, Manila	84
user 9	Tondo, Manila	64
user 10	Tondo, Manila	66
user 11	Tondo, Manila	68
user 12	Tondo, Manila	65
user 13	Tondo, Manila	73
user 14	Tondo, Manila	78
user 15	Tondo, Manila	70
user 16	Tondo, Manila	83
user 17	Tondo, Manila	79
user 18	Tondo, Manila	79
user 19	Tondo, Manila	68
user 20	Tondo, Manila	80
user 21	Tondo, Manila	84
user 22	Quezon city	70
user 23	Quezon city	76
user 24	Quezon city	76
user 25	Quezon city	74
user 26	Quezon city	81
user 27	Sampaloc, Manila	71
user 28	Sampaloc, Manila	69
user 29	Sampaloc, Manila	83
user 30	Sampaloc, Manila	75
user 31	Sampaloc, Manila	73
user 32	Quezon city	67
user 33	Caloocan city	70
user 34	Caloocan city	83
user 35	Caloocan city	62
user 36	Nagcarlan, Laguna	63
user 37	Nagcarlan, Laguna	63
user 38	Nagcarlan, Laguna	81
user 39	Molino, Cavite	79
user 40	Molino, Cavite	75
user 41	Molino, Cavite	77
user 42	Imus, Cavite	80
user 43	Manggahan, Pasig city	71
user 44	Tondo, Manila	79
user 45	Tondo, Manila	78

user 46	Tondo, Manila	83
user 47	Natividad, Pangasinan	60
user 48	Novaliches, Quezon city	76
user 49	Montalban, Rizal	74
user 50	San Isidro, Taytay Rizal	82
user 51	Labangon, Cebu city	66
user 52	Labangon, Cebu city	68
user 53	Lanao Del Norte	60
user 54	Antipolo city	74
user 55	Lipa city, Batangas	80
user 56	Catbalogan city, Samar	65
user 57	Tondo, Manila	84
user 58	Tondo, Manila	63
user 59	Tondo, Manila	73
user 60	Tondo, Manila	73
user 61	Santolan, Pasig city	79
user 62	Pandacan, Manila	77
user 63	Sta. MESA, Manila	65
user 64	Angono, Rizal	61
user 65	Quezon city	60
user 66	Quezon city	61
user 67	Tondo, Manila	67
user 68	Tondo, Manila	82
user 69	Tondo, Manila	65
user 70	Tondo, Manila	84
user 71	Tondo, Manila	60
user 72	Tondo, Manila	60
user 73	Quezon city	69
user 74	Quezon city	81
user 75	Quezon city	66
user 76	Tondo, Manila	62
user 77	Tondo, Manila	60
user 78	Tondo, Manila	72
user 79	Tondo, Manila	65
user 80	Tondo, Manila	74

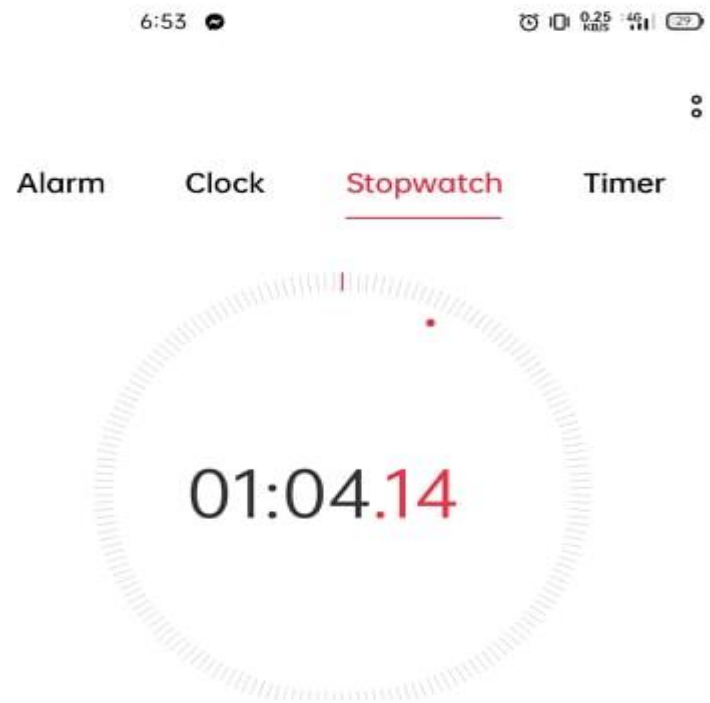
We can see here the exact time in seconds that the whole process takes. We found the average time for each person to interact with our system, it takes approximately:

73.375 seconds

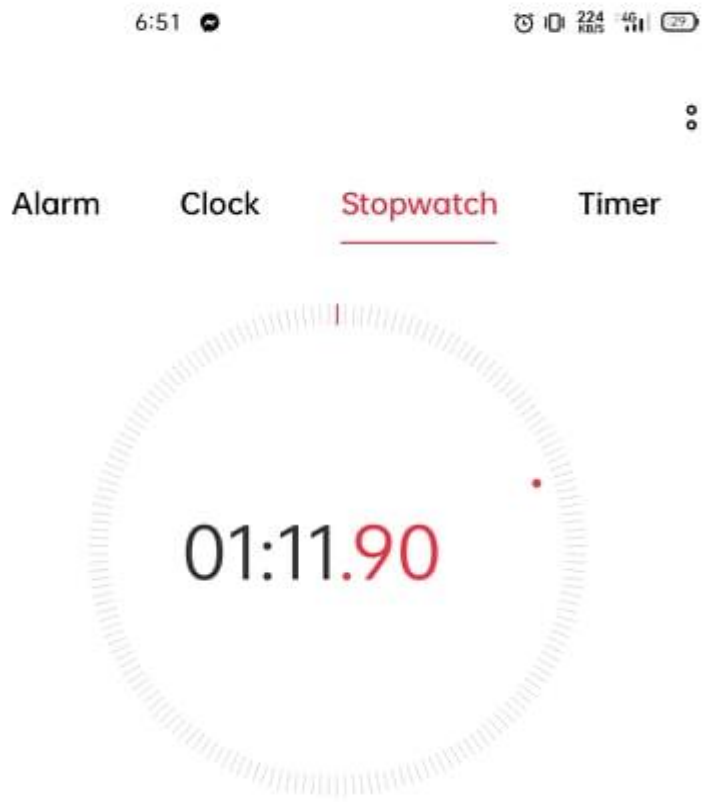
≈

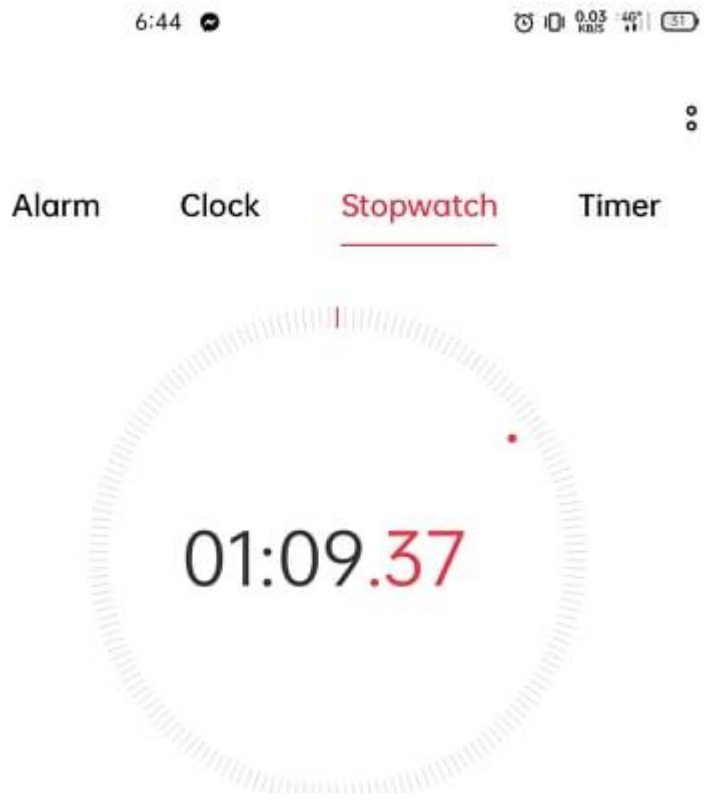
1 minute 13 seconds

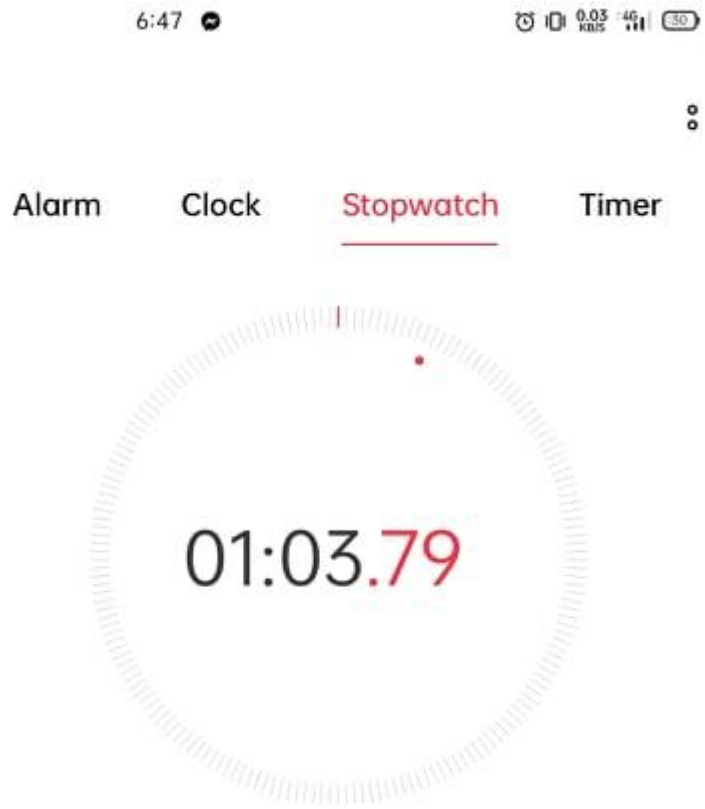
Here is the recording of interaction time in a Clock app




6:46
Alarm
Clock
Stopwatch
Timer
01:05.39

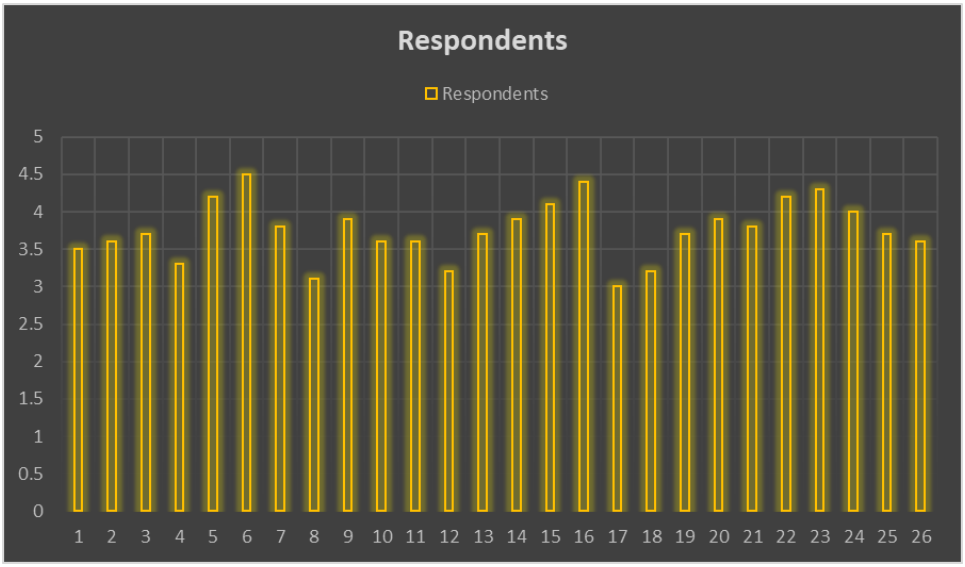

6:51
Alarm
Clock
Stopwatch
Timer
01:11.90


6:44
Alarm
Clock
Stopwatch
Timer
01:09.37

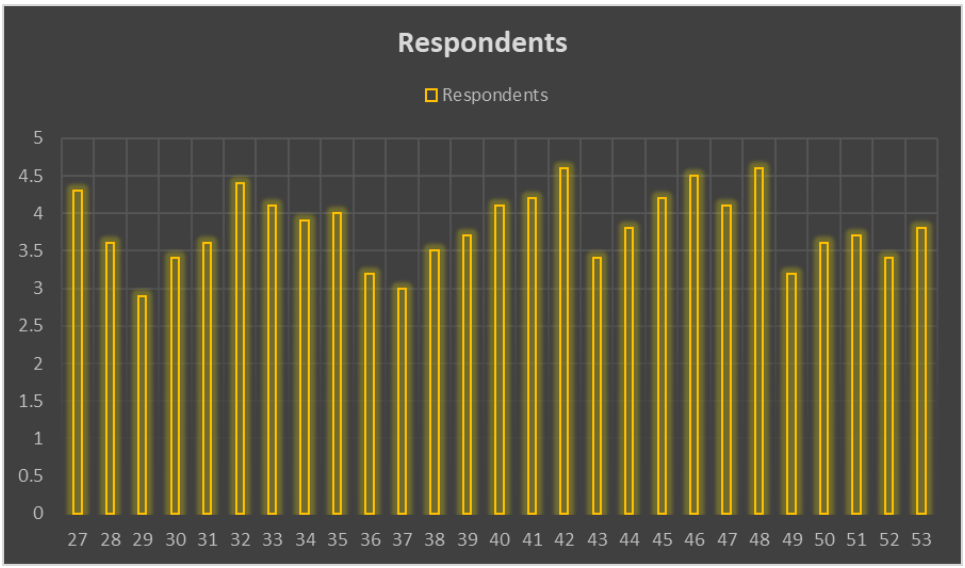

6:47
Alarm
Clock
Stopwatch
Timer
01:03.79


6:49
Alarm
Clock
Stopwatch
Timer
01:29.80

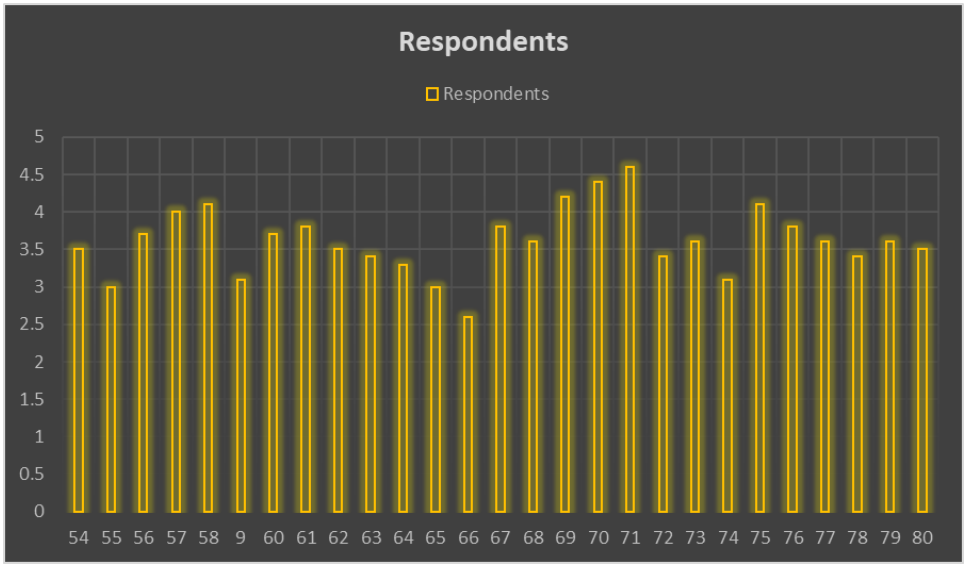
Graphical representation of the time for verification:



(Time response for respondent 1-26)



(Time response for respondent 27-53)



(Time response for respondent 54-80)

Tabular form of the time-response of verification process:

		Responder
2	1	3.5
3	2	3.6
4	3	3.7
5	4	3.3
6	5	4.2
7	6	4.5
8	7	3.8
9	8	3.1
10	9	3.9
11	10	3.6
12	11	3.6
13	12	3.2
14	13	3.7
15	14	3.9
16	15	4.1
17	16	4.4
18	17	3
19	18	3.2
20	19	3.7
21	20	3.9
22	21	3.8
23	22	4.2
24	23	4.3
25	24	4
26	25	3.7
27	26	3.6

		Responder
2	27	4.3
3	28	3.6
4	29	2.9
5	30	3.4
6	31	3.6
7	32	4.4
8	33	4.1
9	34	3.9
10	35	4
11	36	3.2
12	37	3
13	38	3.5
14	39	3.7
15	40	4.1
16	41	4.2
17	42	4.6
18	43	3.4
19	44	3.8
20	45	4.2
21	46	4.5
22	47	4.1
23	48	4.6
24	49	3.2
25	50	3.6
26	51	3.7
27	52	3.4
28	53	3.8

		Responder
2	54	3.5
3	55	3
4	56	3.7
5	57	4
6	58	4.1
7	9	3.1
8	60	3.7
9	61	3.8
10	62	3.5
11	63	3.4
12	64	3.3
13	65	3
14	66	2.6
15	67	3.8
16	68	3.6
17	69	4.2
18	70	4.4
19	71	4.6
20	72	3.4
21	73	3.6
22	74	3.1
23	75	4.1
24	76	3.8
25	77	3.6
26	78	3.4
27	79	3.6
28	80	3.5

The data shown above are the time response for the verification process only of each of the 80 respondents. The data shows that the fastest time for the verification process is about 2.6 seconds while the slowest time to verify oné's fingerprint is 4.6 seconds. The mean or the average time to verify the prints of the 80 participants can be determined by this formula:

Sec(ave)= *respondent 1+ respondent 2 + respondent 3 +. . . + respondent 79 + respondent 80*

Using the data in the table and the formula shown above, the response time for the 80 participants is **3.72125 seconds.**

WEBSITE RESULTS

Now, we will highlight the information that are stored in our website. Here you can see the updated information in our website. You can see the user's information like Name, Address, Email, Contact number, and Device location from where they registered. The link where you can access this website is secured with an IP address of 192.168.254.132:5000

FINGERPRINT CONTACT TRACING SYSTEM

Search for Location..

Resident No#	Name	Email	Address	Gender	Contact No.	Location Record
1	Keirone Mcilvaine R. Bautista	kmbautista0524@gmail.com	Tondo Manila	Male	09	Tondo Manila
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CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary and Findings:

There are three important key points that we will highlight on these findings. The first one is the Importance; we already know how applicable this technology of biometrics important in this age of contact tracing. In the Kentara Restaurant, where we test our device, we really noticed the need for these devices because they still use forms on recording people going to their restaurant. The owners of the restaurant were fascinated on how they can use our technology as a contact tracing, and they even suggest using it for time logging of their employees. We made sure that all their information will be kept confidential and will only be used for research purposes and they totally agree to input their details.

The second point that the proponents also want to highlight is the capability of the device specifically the speed on how it extracts the fingerprint image and analyze it for matching. This will help us save more time in logging in on an establishment. Our device can store a lot of data which is enough for every establishment. The user-friendly interface where anyone can interact with our device without having a hard time. We also realized in our data that it is much faster to store and match fingerprints with latest industrial used fingerprint scanners.

The third one is the scope and limitation of our project which will open room for improvements in our system. Since the system only caters each establishment which is really what our research focused on and the only scope we focused with. There are certain limitations that we encountered along the way. The first limitation is the limited access for every establishment database meaning we need to utilize the use of the main cloud where we can store all the fingerprints of all establishments. The second limitation is the need of sanitation before interacting with our device to avoid contacting diseases. This sanitation is already required on every establishment, and we will have minimal

problems with it. The need of admin security for our website is also a limitation, which is giving access of all information to be edited by only authorized individuals. Despite all of these limitations, the proponents still came up with good implementation of the project's main purpose to serve an establishment.

5.2 Conclusion:

The proponents were able to apply the skills that are need to develop this project by coming up with a solution for implementation of contact tracing on an establishment. The development of the device was not an easy task for the developers, but they were able to record important information from an establishment. The use of fingerprints was proven to be a good choice for the proponents to use as identification for each user in an establishment. No one can manipulate the fingerprint data as this is encrypted in our system and even the database admin cannot have access to it for security purpose.

5.3. Recommendation:

The proponents greatly believe that biometrics such as fingerprint scanning is the key for efficient and accurate contact tracing method without compromising the privacy of the data being gathered. It also proved that it is much more efficient than the traditional manual contact tracing since it greatly saves time and is also helpful for the environment. With the system being designed to cover establishments, it significantly increased the quality of the data gathered and reduced the constraints that are in the previous chapters. With this, the project is recommended for further study to maximize the potential it can impart with regards to providing alternatives for efficient and effective contact tracing method.

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APPENDICES

Appendix 1. Extended Abstract Paper

EXTENDED ABSTRACT TITLE

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ABSTRACT - This research study is about implementation of fingerprint identification as an alternative form of contact tracing method which aims to solve the problems that coincides within the manual contact tracing. With countless papers that could cause environmental issues to avoiding breach in privacy. Our system is designed to ensure that data privacy is heavily implemented. With the integration of Biometrics as the main form of communication between the user and our device, we ensure safe and efficient contact tracing method that manages to list all the basic information needed: (Name, Contact Number, Address, Gender). Lessening the hassle of manually filling up the forms and give them sense of ease with regards to their data being compromised. The device managed to gather data out of 80 persons recording the basic information as mentioned, with the addition of the time it takes for them to go through the whole process (Enrollment and Verification). With the data being provided on Chapter IV, it helped us arrive in the conclusion that implementing our system could greatly help provide efficient means of contact tracing method since manual contact tracing is still being implemented. Observing the limitations that the whole system is designed to cater only one establishment at a time which resulted to limited access for every establishment database meaning utilization of cloud is vital to store all the data across different establishments. Next, The need of sanitation before interaction with the device. And lastly, the need of admin for the website. But despite all these limitations, the proponents were able to provide good implementation of the project. To conclude, the use of fingerprints was proven to be a good choice for the proponents to use as identification for each user in an establishment.

Keywords: Biometrics; Data Privacy; Contact Tracing; Enrollment; Verification; Fingerprint.

1. INTRODUCTION

Contact tracing plays a vital role in fighting the spread of COVID-19. It is an integral part in detecting, recording, quarantining, and tracing the total extent of the spread of the virus. Contact tracing can be broken down into 3 basic steps; contact identification, contact listing, and contact follow up. Contact identification involves asking the person with a confirmed case of the virus his activities to identify the people he had contact or been with, like his family members, work colleagues, friends, or establishments he went to. Contact listing includes all people considered to have contact with the infected person. This people should be notified and be told about the importance of receiving early care and be given information about early prevention of the disease. Contact follow-up includes the monitoring of the people who have been in contact with the infected person to ensure that they are following the quarantine instructions and to track the development of any potential symptoms.

Our research focuses on an establishment within a community where there are a lot of people and safety protocols that are strictly implemented. In these places, it is necessary to record the information of everyone. This information includes the contact details of the person which is the most important data that the contact tracers need. There are a lot of different approaches implemented on this recording of personal information these includes the use of paper forms or logbooks, and the use of QR code system. The study was inspired by the current manual contact tracing implemented in every city establishment. The proponents have noticed challenges on the time-consuming filling up of the forms or logbooks, and the possible false information provided by the people filling up the form due to several reason such as harassment of the customers from the store staffs (Waseem & Chen 2020).

The widely use QR code system seems effective, but the proponents saw a problem in the case of using smartphones as not everyone has the technological capability to use its features, especially the elderly population. Another thing to consider is the availability of internet connection that is needed to generate or scan QR codes. So, the proponents came up with a solution that an individual will only need his own information and biometrics. By this approach, there is no need to bring a quarantine pass or generate a QR code as they enter the establishment.

We applied biometrics as the technology to ease the recording of every information of everyone. Our system employs biometrics in the form of fingerprints. Each individual needs to enroll their fingerprints in our system. There are two main processes for a fingerprint system, it is the Enrollment and Verification. It all starts with the enrollment process when they enter the establishment and then the next time that they enter the establishment is the verification process. When they enroll fingerprints, they need to type their contact details in a tablet. In the verification process, there is no need to type their contact details if they are verified which means that their information is already present in the database. The whole system consists of a Fingerprint Scanner, Graphical User Interface, Tablet, Website and Database. The source coding that we used for the scanner is Python because this is more suitable for our prototype. For the Website and Database, we build it through MySQL and HTML.

2. MATERIALS AND METHODS

The proponents of this research highlight the design of the whole system in this sub chapter. This will include all the block diagrams, the logical flowchart of the fingerprint system, design tradeoff and constraints of the system. The industry standards used we'll be our guide on the project development.

List of Hardware

Digital Persona Fingerprint Sensor

Fingerprint recognition and authentication will be an ease with the Digital Persona Fingerprint Sensor. The image rendering, measurement, feature-finding, and searching are all done by optical fingerprint scanning technology with silicone coating to achieve excellent image quality, a large capture area and superior reliability. Allowing it to read a wide range of fingerprints accurately and rapidly regardless of placement angle.

Figure 3.4 Digital Persona Fingerprint Sensor

Raspberry Pi 4 Model B (8GB Ram)

Raspberry Pi Model B is the most powerful yet in the line of the Raspberry Pi Single-Board Computers. With its major increase in processing power, enhanced video output and peripheral connectivity. It can also accommodate both Wired and Wireless Connection that wasn't present on the previous models of the Single-Board Computers.

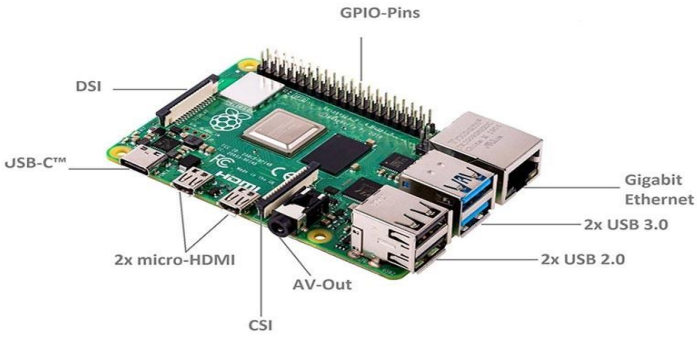


Figure 3.5 Raspberry Pi 4 Model

Capacitive Touch Screen Display

Capacitive Touch Screen is a control display that uses conductive touch or specialized device for input. It is more efficient than resistive or surface wave panels since it requires capacitive touch of a human finger or special capacitive pen or glove to produce input to the device.

Figure 3.6 Capacitive Touch Screen Display

List of Software needed

The logic behind our system is integrated with Python language together with Flask for building the webapp. Using the database and python we can create the functionality of our system. In this part of the paper, we will highlight the codes that was used.

Testing

The phase of evaluation occurs at the end of the study period. It is the method of evaluating a subject's content, importance, and efficiency using parameters that are driven by a set of standards. These criteria are used to assess the level of accomplishment in relation to the subject's goal and objectives.
These are the criteria that is set to evaluate the performance of the fingerprint system:
Percentage of confirmed scan – here we can determine the exact feature extraction rate of our fingerprint sensor.
Scanning Speed – here we can determine how fast and convenient our scanning.
Matching – here the matching should reach approximate 100% to ensure effectivity of our device.
Database real time update – here we always update the database on every interaction these ensure real time recording of information.

3. RESULTS AND DISCUSSION

After of a series of testing and evaluation done in the Kentara restaurant, we tabulate everything and make necessary conclusion on how effective our devices when it comes to log-in time of customers and staffs and how fast our device can capture the fingerprints. There is somewhat a delay that is occurring in the system due to wireless connectivity, but we made sure that all the information provided is correct.

Fingerprint testing

Scanned 2 thumbs of 4 users and repeat it for 5 times then we got a total of 40 samples.

The GUI will display “Welcome, (name)” or “Fingerprint not recognized, please try again” indicates a confirmed scan.

CRITERIA	1 TAP	2-3 TAPS	4 TAPS OR MORE
NUMBER OF CONFIRMED SCAN	37	3	0
PERCENTAGE OF CONFIMED SCAN (%)	92.5%	7.5%	0%

Here we can see how we test the capability of our scanner to accurately gather the fingerprints. We recorded if all taps will be read the first time the user taps. The samples made 37 out of 40 score for the 1st tap which automatically pops up either of the two messages in GUI.
The remaining 3 scanned fingerprints did take 2 or 3 taps to be read by scanner because there are reasons that can contribute to it:
1. If the user didn't lay the thumb properly where the fingerprint has having trouble reading the fingerprint image.
2. The second reason is that the smudgy surface, sweat or other liquids which may contribute on an error for extracting the fingerprint image.

MATCHING

We tested 80 persons to scan their fingerprint and go through verification to make matching. We recorded the time it takes to completely verify the individual and welcome that individual in the establishment. We just recorded the time of enrollment and verification as we didn't take note of recording the whole process as it varies from person to person on how fast they can input their details.

Tested users	User Address	VERIFICATION TIME (sec.)
user 1	Tondo, Manila	65
user 2	Tondo, Manila	68
user 3	Tondo, Manila	71
user 4	Tondo, Manila	63
user 5	Tondo, Manila	64
user 6	Tondo, Manila	84
user 7	Tondo, Manila	83
user 8	Tondo, Manila	84
user 9	Tondo, Manila	64
user 10	Tondo, Manila	66
user 11	Tondo, Manila	68
user 12	Tondo, Manila	65
user 13	Tondo, Manila	73
user 14	Tondo, Manila	78
user 15	Tondo, Manila	70
user 16	Tondo, Manila	83
user 17	Tondo, Manila	79
user 18	Tondo, Manila	79
user 19	Tondo, Manila	68

user 20	Tondo, Manila	80
user 21	Tondo, Manila	84
user 22	Quezon city	70
user 23	Quezon city	76
user 24	Quezon city	76
user 25	Quezon city	74
user 26	Quezon city	81
user 27	Sampaloc, Manila	71
user 28	Sampaloc, Manila	69
user 29	Sampaloc, Manila	83
user 30	Sampaloc, Manila	75
user 31	Sampaloc, Manila	73
user 32	Quezon city	67
user 33	Caloocan city	70
user 34	Caloocan city	83
user 35	Caloocan city	62
user 36	Nagcarlan, Laguna	63
user 37	Nagcarlan, Laguna	63
user 38	Nagcarlan, Laguna	81
user 39	Molino, Cavite	79
user 40	Molino, Cavite	75
user 41	Molino, Cavite	77
user 42	Imus, Cavite	80
user 43	Manggahan, Pasig city	71
user 44	Tondo, Manila	79
user 45	Tondo, Manila	78
user 46	Tondo, Manila	83
user 47	Natividad, Pangasinan	60
user 48	Novaliches, Quezon city	76
user 49	Montalban, Rizal	74
user 50	San Isidro, Taytay Rizal	82
user 51	Labangon, Cebu city	66
user 52	Labangon, Cebu city	68
user 53	Lanao Del Norte	60
user 54	Antipolo city	74
user 55	Lipa city, Batangas	80
user 56	Catbalogan city, Samar	65
user 57	Tondo, Manila	84
user 58	Tondo, Manila	63
user 59	Tondo, Manila	73
user 60	Tondo, Manila	73
user 61	Santolan, Pasig city	79
user 62	Pandacan, Manila	77
user 63	Sta. MESA, Manila	65
user 64	Angono, Rizal	61
user 65	Quezon city	60
user 66	Quezon city	61
user 67	Tondo, Manila	67

user 68	Tondo, Manila	82
user 69	Tondo, Manila	65
user 70	Tondo, Manila	84
user 71	Tondo, Manila	60
user 72	Tondo, Manila	60
user 73	Quezon city	69
user 74	Quezon city	81
user 75	Quezon city	66
user 76	Tondo, Manila	62
user 77	Tondo, Manila	60
user 78	Tondo, Manila	72
user 79	Tondo, Manila	65
user 80	Tondo, Manila	74

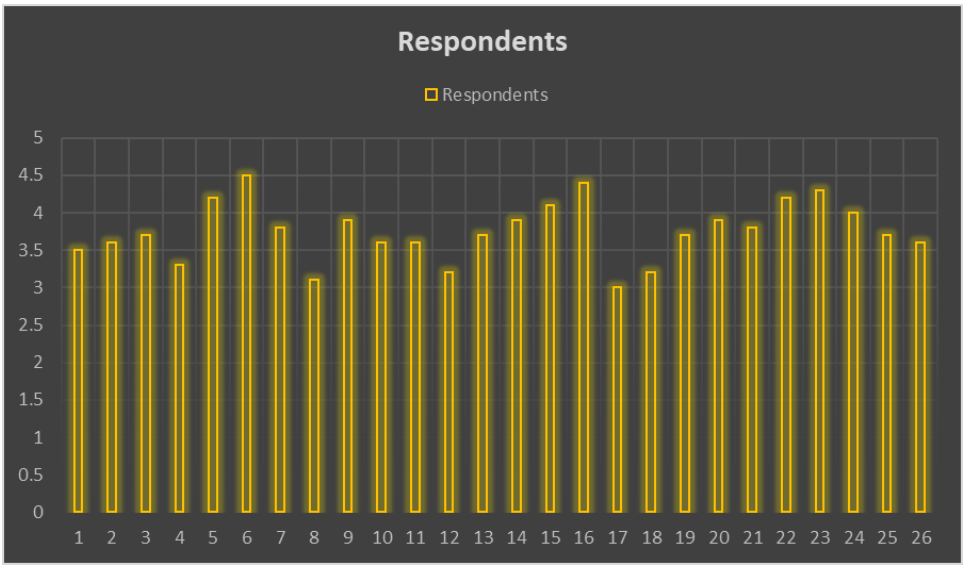
We can see here the exact time in seconds that the whole process takes. We found the average time for each person to interact with our system, it takes approximately:

73.375 seconds

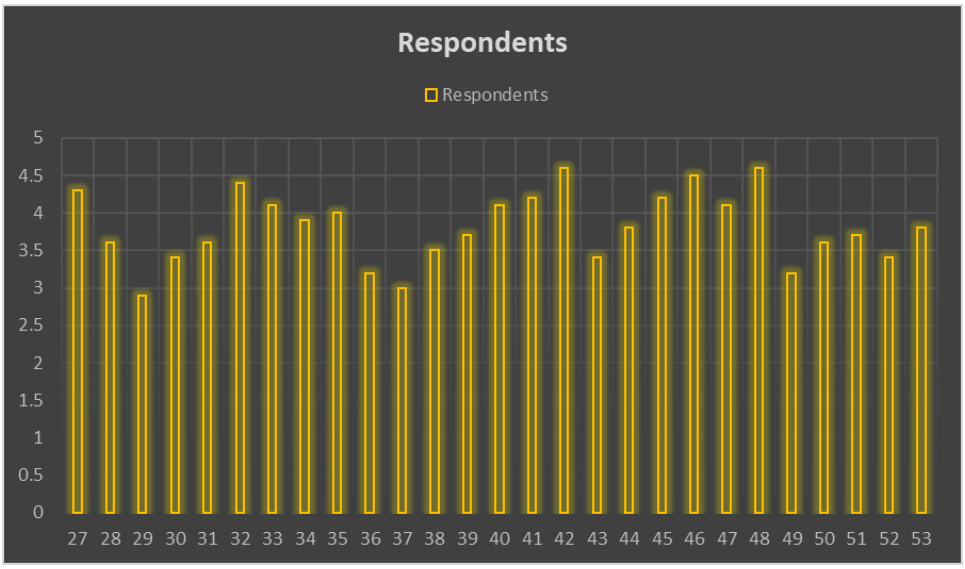
≈

1 minute 13 seconds

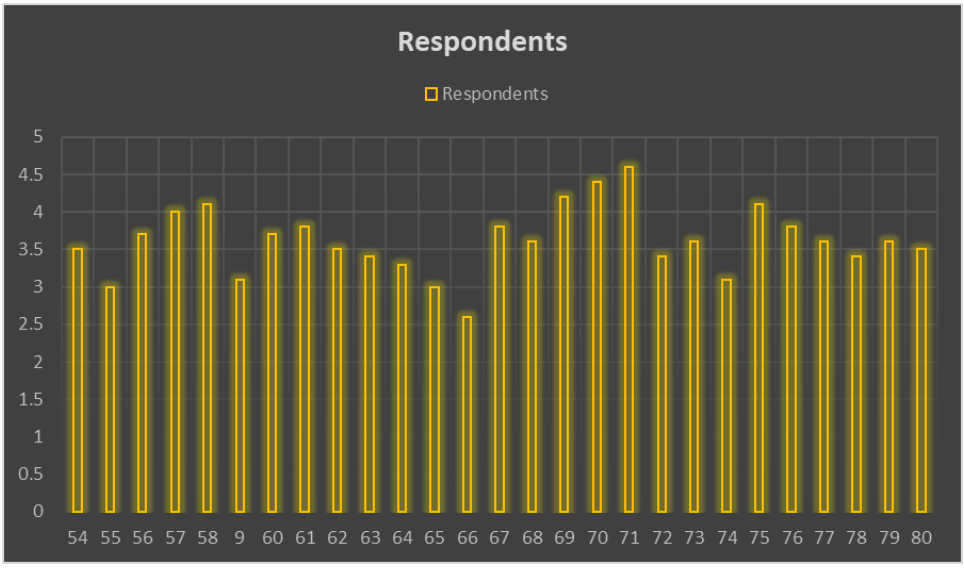
Graphical representation of the time for verification:



(Time response for respondent 1-26)



(Time response for respondent 27-53)



(Time response for respondent 54-80)

Tabular form of the time-response of verification process:

		Responder
2	1	3.5
3	2	3.6
4	3	3.7
5	4	3.3
6	5	4.2
7	6	4.5
8	7	3.8
9	8	3.1
10	9	3.9
11	10	3.6
12	11	3.6
13	12	3.2
14	13	3.7
15	14	3.9
16	15	4.1
17	16	4.4
18	17	3
19	18	3.2
20	19	3.7
21	20	3.9
22	21	3.8
23	22	4.2
24	23	4.3
25	24	4
26	25	3.7
27	26	3.6

		Responder
2	27	4.3
3	28	3.6
4	29	2.9
5	30	3.4
6	31	3.6
7	32	4.4
8	33	4.1
9	34	3.9
10	35	4
11	36	3.2
12	37	3
13	38	3.5
14	39	3.7
15	40	4.1
16	41	4.2
17	42	4.6
18	43	3.4
19	44	3.8
20	45	4.2
21	46	4.5
22	47	4.1
23	48	4.6
24	49	3.2
25	50	3.6
26	51	3.7
27	52	3.4
28	53	3.8

		Responder
2	54	3.5
3	55	3
4	56	3.7
5	57	4
6	58	4.1
7	9	3.1
8	60	3.7
9	61	3.8
10	62	3.5
11	63	3.4
12	64	3.3
13	65	3
14	66	2.6
15	67	3.8
16	68	3.6
17	69	4.2
18	70	4.4
19	71	4.6
20	72	3.4
21	73	3.6
22	74	3.1
23	75	4.1
24	76	3.8
25	77	3.6
26	78	3.4
27	79	3.6
28	80	3.5

WEBSITE RESULTS

Now, we will highlight the information that are stored in our website. Here you can see the updated information in our website. You can see the user's information like Name, Address, Email, Contact number, and Device location from where they registered. The link where you can access this website is secured with an IP address of 192.168.254.132:5000

FINGERPRINT CONTACT TRACING SYSTEM

Search for Location..

Resident No#	Name	Email	Address	Gender	Contact No.	Location Record
1	Keirone Mcilvaine R. Bautista	kmbautista0524@gmail.com	Tondo Manila	Male	09198281889	Tondo Manila
2	Paul Rosales	paul007@yahoo.com	Tondo Manila	Male	09770979227	Tondo Manila
3	Minette Jamie Duray	minettejamie@gmail.com	Tondo, Manila	Female	09198281888	Tondo Manila
4	Jainer Jhun Duray	jainerjhun@gmail.com	Tondo, Manila	Male	09394476191	Tondo Manila
5	Mervin Jasper Duray	mj_duray@gmail.com	Tondo, Manila	Male	09954914109	Tondo Manila
6	Jaime V. Duray Jr.	jaimeduray17@gmail.com	Tondo, Manila	Male	09088861726	Tondo Manila
7	Minerva V. Duray	minnieduray26@gmail.com	Tondo, Manila	Female	09199970186	Tondo Manila
8	Arvin Monty D. Francisco	arvinfrancisco301@gmail.com	Tondo, Manila	Male	09616866411	Tondo Manila
9	Adrianne Marie D. Francisco	Adriefrancisco21@gmail.com	Tondo, Manila	Female	09482558382	Tondo Manila
10	Edryn John Arellano	Edrynarellano10@gmail.com	Caloocan City	Male	09051625886	Tondo Manila
11	Merry Jane Aquiles	Jhaneaquiles@maip.com	Caloocan City	Female	09656097503	Tondo Manila
12	Amor M. Balderama	mnst.amormorris95@gmail.com	Tondo, Manila	Female	09173114193	Tondo Manila
13	Myleen D. Andico	myleenandico47@gmail.com	Tondo, Manila	Female	09052523598	Tondo Manila
14	Michael D. Andico	michaelandico1226@gmail.com	Quezon City	Male	09978077452	Tondo Manila
15	Mikee Arra Andico	Arramikee.andico@gmail.com	Imus, Cavite	Female	09284460360	Tondo Manila
16	Michelle Ann D. Andico	michelleannandico@gmail.com	Tondo, Manila	Female	092023824444	Tondo Manila
17	Maiden Andrea D. Andico	Maidenandrea.andico@gmail.com	Tondo, Manila	Female	09166332275	Tondo Manila
18	Kleiene Mcqueen Deziree B. Laguardia	bautistamcqueen23@gmail.com	Tondo, Manila	Female	09985560720	Tondo Manila
19	Mc Bryan T. Laguardia	mcbryanlaguardia@yahoo.com	Tondo, Manila	Male	09350282122	Tondo Manila

29	Angelo M. Hernandez Jr.	Angelot,hernandez.02@gmail.com	San Isidro, Taytay, Rizal	Male	09516918402	Tondo Manila
30	Shayne Capiral	shaynecapiral546@gmail.com	Montalban, Rizal	Female	09669883905	Tondo Manila
31	Christian Jake A. Narvaez	christiannarvaez@gmail.com	Tondo, Manila	Male	09498110956	Tondo Manila
32	Clyde Mattieu Y. Estrella	clydeestrella7@gmail.com	Tondo, Manila	Male	09214407112	Tondo Manila
33	Renzo H. Dionisio	renzodionisio07@gmail.com	Tondo, Manila	Male	09194591544	Tondo Manila
34	Emmil Jerico Aquarius D. Tamayo	jericotamayo@yahoo.com	Catbalogan City, Samar	Male	09128820631	Tondo Manila
35	Aron Joey D. Mercado	2020-07914@hccs.edu.ph	Tondo, Manila	Male	09052539342	Tondo Manila
36	Lilian Holguin	lilianvalenzuela63@gmail.com	Makati City	Female	09260085724	Tondo Manila
37	Ashrielle Pomarca	azraelpyroxeen@gmail.com	Sampaloc, Manila	Female	09054879679	Tondo Manila
38	Marlou B. Catalan	zayncatalan2000@gmail.com	Lanao Del Norte	Male	09367195394	Tondo Manila
39	Xandrex Van Abad	Xandrex.Abad14@gmail.com	Antipolo City	Male	09354602997	Tondo Manila
40	Gerard Dela Cruz	Geralddelacruz175@gmail.com	Lipa City, Batangas	Male	09158775442	Tondo Manila

89	Nichole Deziree Co	nicholedeziree@gmail.com	Novaliches, Quezon City	Female	09390175721	Tondo Manila
90	Raizza Co	rdeziree3188@gmail.com	Novaliches, Quezon City	Female	09279680331	Tondo Manila
91	Vanessa Danao	vanessadanao15@gmail.com	Sampaloc, Manila	Female	09989567567	Tondo Manila
92	Paul Brian Barzabal	pbarzabal@gmail.com	Marikina City	Male	09178546463	Tondo Manila
93	Romalyn Calma Madrigal	madrigalromalyn@gmail.com	Santa Cruz, Laguna	Female	09774923008	Tondo Manila
94	Melody Duenas	mymeoldyjoy@yahoo.com	Imus, Cavite	Female	09959626794	Tondo Manila
95	Aldrin Joseph Ramos	ramosaldrinjoseph@gmail.com	Imus, Cavite	Male	09294814608	Tondo Manila
96	Karen Canafranca	karen.canafranca@yahoo.com	Quezon, City	Female	09469903039	Tondo Manila
97	Jim Edgar Del Rosario	jimedgarrosario@gmail.com	Tondo, Manila	Male	09169459420	Tondo Manila
98	Leslie Agacer Rado	zanel1906@gmail.com	Quezon, City	Female	09983999858	Tondo Manila
99	George William Barcelona	georgewilliam.barcelona@gmail.com	Las Pina, City	Male	09173181831	Tondo Manila
100	Lorilyn Fajardo	lbfajardo@gmail.com	Antipolo, City	Female	09353002429	Tondo Manila

These are the list of the subjects that tested our device, and this is already the updated number of users in our contact tracing system. These includes all the necessary information and will only be used for contact tracing records.

4. CONCLUSION

The proponents were able to apply the skills that are needed to develop this project by coming up with a solution for implementation of contact tracing on an establishment. The development of the device was not an easy task for the developers, but they were able to record important information from an establishment. The use of fingerprints was proven to be a good choice for the proponents to use as identification for each user in an establishment. No one can manipulate the fingerprint data as this is encrypted in our system and even the database admin cannot have access to it for security purpose.

Acknowledgement

This research would not be possible without the contribution and guidance of several individuals who extended their valuable assistance in the preparation and completion of this work.

Engr. Herbert V. Villaruel, our adviser, for his knowledge that he shared with us. He has been of great help to us in completing our paper by providing valuable insights and suggestions to further improving the study.

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To our Program Chair, Engr. Jonrey Rañada, for always being open and approachable and for encouragement and support in the improvement of this manuscript.

Lastly, to all the professors of Electronics Engineering Department, who gave their support and knowledge. Without them, we wouldn't be able to reach this point where we were able to complete our thesis.

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Appendix 2. Author Declaration Form

INTEGRATING FINGERPRINT SCANNER IN A LOG DEVICE FOR ESTABLISHMENTS: A DIGITALIZED SYSTEM FOR CONTACT TRACING RECORDS

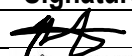
1. We confirm that there are no known conflicts of interest associated with this paper and there has been no significant financial support for this work that could have influenced its outcome.

2. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship, but the ones listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

3. We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property.

4. We understand that the Corresponding Author is the sole contact for publication submission of this paper. He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs.

5. We confirm that we have provided a current, correct email address which is accessible to the Corresponding Author.

Author	e-mail Address	Signature	Date
Ignacio, Robin B.	robinignaciosky70@gmail.com		2/17/2022
Bautista, Keirone Mcilvaine R.	Kmbautista0524@gmail.com		2/17/2022
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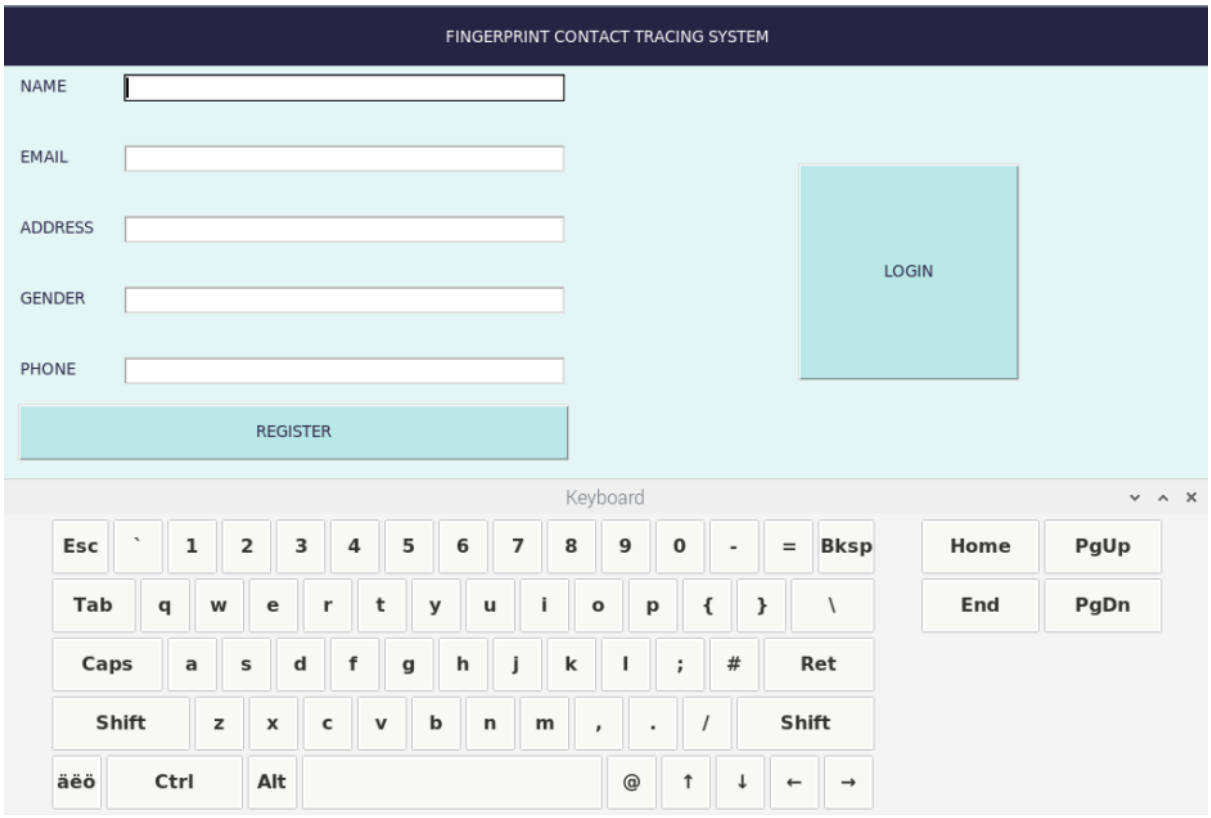
**Corresponding author who is normally the adviser/supervisor or as agreed by the group*

*Appendix **3.** Contact Tracing Form*



*Appendix **4**. Bill of Materials*

Quantity	Material	Price
1	Fingerprint Scanner	₱ 3,539.00
1	7" Raspberry Pi Touchscreen Display	₱ 3,200.00
1	GUI Chassis	₱ 400.00
1	Raspberry Pi Adapter	₱ 300.00
1	8GB Raspberry Pi Model 4 B	₱ 5,689.00
4	Bolt screw	₱ 20.00
TOTAL		₱ 13,145.00

CURRICULUM VITAE

ROBIN IGNACIO

PROFESSIONAL GOALS

-Seeking an entry-level position to begin my career in a high level professional environment.
-Secure a responsible career opportunity to fully utilize my training and skills while making a significant success for the company.

SKILLS AND ABILITIES

- Intermediate Coding skills in Python, c++, and Matlab
- Basic understanding in software development
- Intermediate skills in Electronic Circuit Design
- Basic Troubleshooting skills
- Problem solver
- Working knowledge in Start-Up Businesses.
- Intermediate skills in Microsoft offices.

CONTACT ME AT:

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Phone: 0912-879-5496
Facebook: robinignacio.397
Address: 130 Area 4 Sitio Payong, Matandang Balara, Quezon city

ACADEMIC BACKGROUND

NATIONAL UNIVERSITY - MANILA

Completed 4 years of the course Bachelor of Science in Electronics Engineering - June 2015-2021

- -Member of National University Integrated Electronics Engineering Society (NUIECES) 2017-2021
- -Active member of I.T seminars of NUIECES like "EXCELSIOR 2019. Elevating Electronic Expertise Embodying Engineering Excellence (2017)
- -One of the proponents of Research Development Prototype titled " Integrating Fingerprint Scanner in a log Device for Establishments: A Digitalized system for Contact Tracing Records"
- -Member of Technopreneurship Course developing Start-Up Businesses (2021)
- -Varsity player for National University Men's Chess Team
- -UAAP SEASON 78 Chess Team Tournament Champions (2016)
- -UAAP SEASON 79 Chess Team Tournament Champions (2017)

NAZARETH SCHOOL OF NATIONAL UNIVERSITY

Graduated Highschool - June 2015

- -Varsity player for National University Juniors Chess Team
- -UAAP SEASON 76 Chess Team Tournament Champions (2014)
- -UAAP SEASON 77 Chess Team Tournament Champions (2015)
- -UAAP SEASON 77 Chess Team Gold medalist Individual Category (2015)

INTEREST AND HOBBIES

I enjoy playing Chess, Watching movie, series and Read stuffs about science.
I also love playing guitar.
Coding is also my hobby.

Jason C. Maquiñana

Profile

Enthusiastic and has the eagerness to contribute to team success through hard work, attention to detail and excellent organizational skills. A critical thinker and has willingness to learn, grow and excel.

Contact

PHONE:
0915-935-8126

Address:
1697 E-11 L.R.C. Compound
Sta.Cruz, Manila

EMAIL:
jason.maquinana.22@gmail.com

Hobbies

- Playing billiards
- Watching movies
- Listening to music
- Reading books and manga

EDUCATION

Padre Gomez Elementary School
2005 - 2011

- Received different awards in Mathematics Teacher Association of the Philippines (M.T.A.P.) from Gr.2 to Gr.6 in District to Regional Level in Team and Individual Categories
- Received several awards in different Science Contests from Gr.5 to Gr.6
- 1st Place in Simple House-wiring Contest in District and Division Level in Gr.5
- Graduated 1st Honorable Mention

Manila Science High School
2011 - 2015

- High School Diploma

Pamantasan ng Lungsod ng Maynila
2015 - 2016

- Bachelor of Science in Business Administration Major in Marketing Management

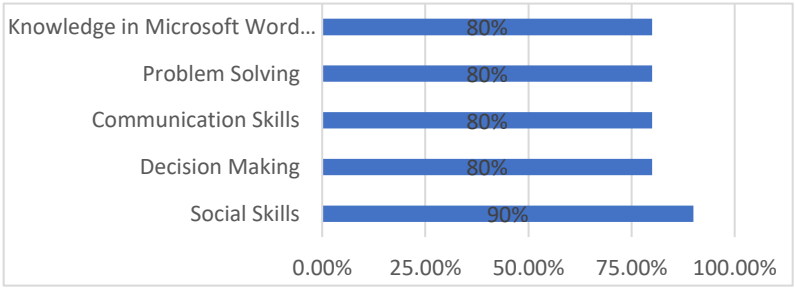
2016-2019

- Bachelor of Science in Electronics and Communication Engineering

WORK EXPERIENCE

None

SKILLS



Ken Tenmatay

To enhance my professional skills in a dynamic and stable workplace and contribute creatively to the benefit of the company.

k.tenmatay@gmail.com | 09171374015 | Imus, Philippines

WORK EXPERIENCE

Freelance QA Tester
Global App Testing
10/2017 - 09/2018
GAT allows teams to test using devices in real environments to deliver high quality products with minimal testing effort.
Achievements/Tasks
- Software Debugging
- Test Case Execution
- App Testing

PERSONAL PROJECTS

Cryptocurrency (12/2021 - Present)
- Invested in NFT's (Axie Infinity)

EDUCATION

Bachelor of Science in Electronics Engineering
National University
09/2018 - 10/2021 *Sampaloc, Manila*

Bachelor of Science in Electronics Engineering
Adamson University
06/2012 - 08/2018 *Ermita, Manila*

Secondary Education
Ann Marris Montessori School
06/2008 - 03/2012 *Imus, Cavite*

SKILLS

Analytic | Adaptive | Flexible | Punctual | Patience

SEMINARS AND TRAININGS

Introduction To WiFi (04/2021)
A webinar that focuses on the background and developments on the field of Wireless Fidelity.

Maintaining a Safe and Secure Philippine Sky: The Importance of Radio Communications (05/2021)
Webinar about Radio Communications and its importance on the field of Aviation.

WLAN LINK BUDGET (05/2021)
Discussion of Radio wave attributes, RF system components, Basic Fundamentals of Transmission, RF signal propagation and FLS.

LANGUAGES

Fllipino
Native or Bilingual Proficiency

English
Professional Working Proficiency

INTERESTS

Network | Software | Hardware | Debugging | Coding

BAUTISTA, KEIRONE MCILVAINE R.

880-D Sto. Rosario St. Tondo, Manila
09198281889
kmbautista0524@gmail.com

OBJECTIVE

To attain a job through which I can enhance myself for a career after college and learn further implied in my skills, experience and educational background to the benefit of my employer and as well as to myself.

EDUCATION

TERTIARY:

2013-2017 Colegio de San Juan de Letran

151 Muralla St, Intramuros, Manila

Bachelor of Science in Electronics and Communications Engineering

2017-2021 National University Manila

551 M.F. Jhocson St, Sampaloc, Manila

Bachelor of Science in Electronics and Communications Engineering

SECONDARY:

2009-2013 Holy Child Catholic School

Plaza Amado V. Hernandez, Ilaya St, Tondo, Manila

ELEMENTARY:

2003-2009 Holy Child Catholic School

Plaza Amado V. Hernandez, Ilaya St, Tondo, Manila

SEMINARS AND TRAININGS ATTENDED

April 30, 2021 Introduction to Wi-Fi (IEEE802.11)

May 01, 2021 WLAN Link Budget

May 08, 2021 WLAN Security Considerations

May 15, 2021 WLAN Site Survey

ON-THE-JOB TRAINING

WEBINAR

Online On-The-Job Training

SKILLS

- Good in speaking English and Filipino
- Good in verbal and written communication
- Skilled in MS Word, PowerPoint, and Excel
- Skilled in AutoCAD
- Good in multitasking and organizing
- Good in Inspection of Electronic devices
- Analytical skills to follow logic of electronic circuits and interface with software
- Excellent in interpersonal, innovative, and logical skills
- Shows good interest and honesty to work

PERSONAL DATA

Age: 24 yrs. old
Birth date: May 24, 1997
Birthplace: Manila
Nationality: Filipino
Religion: Catholic
Civil status: Single

REFERENCES

Mr. Jonrey Rañada, PECE
Program Chair, ECE Department
NU - Manila
09657222692

Keirone McIlvaine R. Bautista