AFRICA UNIVERSITY

(A United Methodist-Related Institution)

DESIGN AND DEVELOPMENT OF A FACIAL RECOGNITION ATTENDANCE SYSTEM USING PYTHON AND OPEN CV

BY

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A DISSERTATION/THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE BACHELOR OF SCIENCE HONOURS IN COMPUTER SCIENCE IN THE COLLEGE OF BUSINESS PEACE LEADERSHIPG AND GOVERNANCE

ABSTRACT

The main goal of this project is to create a face recognition-based attendance monitoring system for educational institutions in order to improve and upgrade the current Google Meet attendance system to make it more efficient and effective than before. The existing outdated system is very ambiguous, which results in erroneous and ineffective attendance taking. When the authorities cannot enforce the rules that are present under the previous system, many issues occur. The face recognition system will be the technology at work. One of the natural characteristics that can be used to specifically identify a person is their face. Because it is unlikely for a face to differ or be replicated, it is utilized to trace identification. Face databases will be established for this project in order to feed data into the recognizer algorithm. Then, during the period for recording attendance, faces will be checked against the database to try to identify anyone. When a person is recognized, their attendance will be recorded automatically, recording the essential data into an excel sheet. The excel document with attendance data for each person is mailed to the appropriate faculty at the conclusion of the day.

Keywords:

NFC (Near Field Communication), RFID (radio frequency identification) , OpenCV, NumPy, Smart Attendance System

Declaration

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree

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CHAPTER 1 INTRODUCTION

1.1 INRODUCTION

Design and development of a facial recognition attendance system using python and open cv is the topic of this research. This chapter provides a comprehensive introduction to the study, outlining the background, problem statement, research objectives, research questions, assumptions/hypotheses, significance, delimitation, and limitation of the study.

The use of attendance systems is crucial in educational institutions, organizations, and businesses to track the attendance of individuals. Traditional attendance systems, such as manual sign-in sheets, have several limitations, including time-consuming processes, the possibility of human errors, and difficulties in monitoring attendance remotely (Kumar, 2020). Facial recognition attendance systems have emerged as a reliable solution to these challenges, allowing for quick and accurate attendance monitoring.

The problem addressed in this study is the lack of an efficient and reliable facial recognition attendance system that can be customized to the specific needs of an organization or educational institution. The study aims to design and develop a facial recognition attendance system that is easy to use, efficient, and accurate.

The research objectives are to design and develop a facial recognition attendance system that can perform face detection, recognition, and attendance tracking. The study also aims to evaluate the accuracy and efficiency of the system (Irawan, 2018).

The research questions that guide this study are:

- What are the key components of a facial recognition attendance system?
- How can Python and OpenCV be used to develop a facial recognition attendance system?
- What factors affect the accuracy and efficiency of a facial recognition attendance system?

The study makes several assumptions/hypotheses. It assumes that facial recognition technology is reliable and accurate for attendance tracking. The study also hypothesizes that the use of Python and OpenCV will enhance the accuracy and efficiency of the attendance system.

The significance of this study lies in its potential to improve attendance tracking systems in various organizations and educational institutions. The system's accuracy, efficiency, and customizability can lead to significant time and cost savings.

The delimitation of this study is that it focuses on designing and developing a facial recognition attendance system using Python and OpenCV. The study does not consider other technologies or programming languages that can be used for attendance tracking.

The limitation of this study is that it relies on the accuracy of the facial recognition technology and the availability of high-quality images for face detection and recognition. The study may also face challenges in terms of privacy concerns and ethical considerations related to facial recognition technology.

1.2 Background of the study

Previously, attendance management in schools/colleges was done through manual reporting, in which students' attendance was recorded by placing a mark or signature beside their name in a name list to indicate their presence in a specific class (Sivapragasam, 2017). While the institution's staff will report their attendance using a punch card machine, which must also be done manually (Gaur, (2017). Later, some of those attendance systems evolved to use smart cards instead of signature markings, with each student/staff member required to report their attendance using a smart card embedded with a unique identification chip.

1.3 Statement of the problem

According to the previous attendance management system, the most serious issue is the accuracy of the data collected. This is because attendance may not be recorded personally by the original person; in other words, a specific person's attendance may be taken by a third party without the institution's knowledge, which violates the accuracy of the data. For example, if student A is too lazy to attend a particular class, student B will assist him/her in signing for attendance, even though student A did not attend the class, but the system will overlook this because no enforcement is used. If the institution establishes enforcement, it may have to waste a lot of human resources and time, which is not practical at all. As a result, all of the previous system's recorded attendance is untrustworthy for analysis. The previous system's second flaw is that it is too time consuming. Assuming that a student signs his or her attendance on a 3-4 paged name list in about 1 minute. Only about 60 students can sign their attendance in one hour, which is obviously inefficient and time consuming. The third

issue is the legitimate concerned party's access to that information. For example, most parents are very concerned about tracking their child's actual whereabouts to ensure that their child actually attends college/school classes. However, in the previous system, parents had no access to such information. As a result, evolution of the previous system is required to improve efficiency, data accuracy, and provide access to information for those legitimate parties.

1.4 Research Questions

Facial recognition technology has emerged as a reliable solution for attendance tracking in various organizations and educational institutions. Traditional attendance systems, such as manual sign-in sheets, have several limitations, including time-consuming processes, the possibility of human errors, and difficulties in monitoring attendance remotely. In response to these challenges, this research aims to design and develop a facial recognition attendance system using Python and OpenCV that is easy to use, efficient, and accurate. This section of chapter 1 provides a comprehensive introduction to the study, outlining the research objectives, research questions of the study. The research questions that guide this study focus on the key components of a facial recognition attendance system, the use of Python and OpenCV for system development, and the factors affecting the accuracy and efficiency of the system. The study's objectives include designing and developing a facial recognition attendance system that can perform face detection, recognition, and attendance tracking and evaluating the system's accuracy and efficiency. The study's significance lies in its potential to improve attendance tracking systems in various organizations and educational institutions, leading to significant time and cost savings. The Research Questions are as follows:

1. What are the current limitations of traditional attendance systems, and how can facial recognition attendance systems address these challenges?
2. What are the key components of a facial recognition attendance system, and how do they contribute to its accuracy and efficiency?
3. What factors affect the accuracy and efficiency of a facial recognition attendance system, and how can they be optimized to improve system performance?
4. What are the implications of this study for improving attendance tracking systems in educational institutions and organizations, and how can the system's customizability lead to significant time and cost savings?
5. How can the proposed facial recognition attendance system address the shortcomings of previous attendance systems, such as data accuracy, efficiency, and accessibility to legitimate parties?

1.4 Research Objectives

To address the shortcomings of the previous system mentioned above, the existing system must evolve. The proposed system will reduce paperwork by eliminating the need for manual attendance recording. The new system will also reduce the total time required to record attendance. To ensure data accuracy, the new system will acquire individual attendance through facial recognition.

The following are objectives of the project:

- To create a portable Smart Attendance System that is both convenient and self-powered.

- To ensure that the attendance recording process is faster than the previous system, which could go as fast as 3 seconds for each student.
- Capable of accurately recognizing an individual's face based on a face database.

1.5 Significance of the study

Many of today's attendance management systems are inefficient and lack information sharing. As a result, the following limitations will be overcome and further improved in this project: Students will be more conscientious about attending classes. This is because a student's attendance can only be judged individually, and the system will catch any absences. (Manupati, Design and implementation of an automated attendance management system using RFID technology., 2018)In addition to teaching students to arrive on time, this can help them stay away from unethical practices like signing attendance for pals.

- As enforcement is now carried out by technology rather than human supervision, which would waste a lot of human resources on an unimportant activity, the institution can save huge savings.
- The attendance system is portable and can be set up anywhere as long as there is Wi-Fi coverage or an Ethernet connection because the program can run on any device at any location. As an illustration, the gadget might be used to take attendance at the classroom's entrance.
- It saves a significant amount of money by fully eliminating the paperwork.
- Due to the automated nature of all calculations, the method is also time efficient. In short, the project was created to address the problems with the outdated attendance system.

1.6 limitations of the study

- The study is completely dependent on the quality of images produced by student’s cameras, which might make the system less effective in the event of poor image quality.
- The relative angle of the target's face has a significant impact on the recognition score. Usually, several angles are employed when enrolling a face in the facial recognition software (profile, frontal and 45-degree are common). The algorithm's capacity to create a face template is impacted by any view other than a frontal view. The score of any resulting matches increases with the directness and resolution of the image (both enrolled and probe image).

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The ability to recognize facial features from a camera or image stored in memory starts the process flow in the face detection and recognition system. The program examines the image that was collected, counts the number of faces present, and compares the results to eliminate the remaining faces (Singh, 2016). This image processing makes use of numerous algorithms to compare known databases with facial feature data.

The goal of this project is to streamline the process and time required for taking attendance during lectures (Moghimi, 2017). It is neither productive or effective to utilize ID cards or to manually call out attendees and record their information on sheets. The number of faces in the class will be counted by this system, and it will also recognize them from the store database. It will be simple to determine if a student is truly in the classroom or not thanks to the face detection and recognition technology that has been installed.

2.2 Theoretical Framework

Attendance System Using NFC (Near Field Communication) Technology with Embedded Camera on Mobile Device (Bhishe K. , 2015)a research article, states. The use of mobile applications and NFC technology enhances the attendance system. Each student is issued an NFC tag with a unique ID when they enrol in the college, claims the research paper (BasuMallick, n.d.). The lecturer's cell phone will subsequently be used to touch or move these tags to record each student's attendance. The student's

face will then be captured by the phone's built-in camera before the data is sent to the college server for validation and verification. The simplicity of usage of NFC and the rapidity with which connections are established are advantages of this approach. It significantly shortens the time it takes to take attendance. When the NFC tag is not personally marked by the original owner, the system is unable to detect the violation automatically. Aside from that, the instructor was really inconvenienced by the system's simplicity in using a cell phone as an NFC scanner. What would happen if the lecturer had forgotten to bring their phones to work? How would the attendance be documented in such case? Furthermore, due to privacy concerns, the majority of lecturers are unlikely to welcome having their personal smartphones utilized in this manner. Therefore, the NFC tag should be replaced with other forms of distinctive information about the student, such as biometrics or face recognition, which is guanine for a student. This will guarantee that the actual student takes the initial attendance.

A solution of utilizing a fingerprint to register attendance was proposed in the second research publication, "Fingerprint Based Attendance System Using Microcontroller and LabView" (Kumar Yadav, Singh, Pujari, Mishra, 2015). To handle the fingerprint identification procedure, this device uses two microcontrollers. A fingerprint sensor will first be used to obtain the fingerprint pattern, and then microcontroller 1 will receive the data. The information is then passed from microcontroller 1 to microcontroller 2, which checks it against the database stored there. Following the discovery of a student's match, the information is delivered via serial communication to the PC to be presented (Mishra, 2018). This is a smart design since it speeds up development while keeping design flexibility and makes testing easier. But once

more, the fact that this system is connected to a PC renders it immobile. Information from the database cannot be easily accessed in any other way (Chatterjee, 2017). This means that parents who are curious about their child's attendance are unable to quickly or readily acquire the information. Therefore, the information can be uploaded to a web server for simple access to enable accessibility of the student's information to the legitimately concerned party. While a login screen can be used to ensure authentication for the proper access.

2.3 Relevance of the Theoretical Framework to the Study

The research is similar to the fingerprint recognition system because they are both biometric models. This means that these both require the specific of the face or fingerprint which makes it difficult for students to simply mark the register for each other because it is it is quite difficult to possess the biometrics of another human being. However, it is different from the NFC tags motioned above because it is easier for one student to possess another students NFC tag

Furthermore, it uses facial recognition system to mark the attendance of student during online lectures. Considering situations such as the COVID19 pandemic that the whole world previously experienced, the system will be effective since students were forced to continue education online.

2.4 Summary

The researcher looked at the theoretical bases for how effective attendance system models are in organizations and institutions and how they boost productivity and

efficiency. The literature review discusses the effectiveness of the facial recognition system in an institution, and in this section, Chapter 3's primary focus is on the research technique.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The methodology chapter of a research project is a crucial section that explains how the study was conducted. This chapter is essential in helping readers understand the research process and the methods used to collect and analyse data. In this study, the researcher aims to design and develop a facial recognition attendance system using Python and OpenCV. The proposed system will use facial recognition technology to identify students and staff and record their attendance automatically. The methodology chapter will describe the research design, data collection process, data analysis methods, and software implementation techniques used in the study. The chapter will also explain the limitations and ethical considerations of the study. The main objective of this chapter is to provide a detailed account of how the facial recognition attendance system can be designed and implemented, ensuring that the research process is transparent, replicable, and credible.

3.2 The research design

The research design for this study is an experimental design. The researcher will develop a facial recognition attendance system using Python and OpenCV and test its accuracy and efficiency. The design will involve the following steps:

1. Problem identification: The researcher will identify the current limitations of traditional attendance systems and how facial recognition attendance systems can address these challenges. This will form the basis of the problem statement.

2. System design: The researcher will design the facial recognition attendance system using Python and OpenCV. The system will be developed to record student and staff attendance automatically using facial recognition technology.

3. System implementation: The developed facial recognition attendance system will be implemented in an educational institution. The system will be tested to ensure that it works as intended.

4. Data collection: The data collection process will involve collecting attendance data from the developed system. The data collected will include the student and staff name, date, and time of attendance.

5. Data analysis: The data collected from the facial recognition attendance system will be analysed to determine the accuracy and efficiency of the system. Statistical methods such as mean, standard deviation, and correlation analysis will be used to analyse the data.

6. Evaluation: The facial recognition attendance system will be evaluated based on the accuracy and efficiency of the system. The results of the evaluation will be used to draw conclusions about the feasibility of using facial recognition technology for attendance tracking.

3.3Population and Sampling

A population is made up of all the instances that meet a set of criteria (Munzara, 2013:10). Trochim (2006) defines a population as "all the people with a specific set of traits who are of interest to the researcher." The population for this study is 180 students enrolled in the College of Business, Peace, Leadership, and Governance at Africa University. The sampling technique used in this study is purposive sampling, where the researcher selects a sample based on a specific set of criteria.

The sample size for this study will be determined using the sample size calculator. Assuming a 95% confidence level and a 5% margin of error, the sample size required is 133 students. To ensure that the sample is representative of the population, the researcher will use stratified random sampling. The sample will be stratified by year of study, with an equal number of students selected from each year.

The researcher will obtain permission from the Department of Business, Peace, Leadership, and Governance at Africa University to access the student records. The researcher will then contact the selected students and explain the purpose of the study, obtain their informed consent, and explain the data collection process. The selected students will be given the option to opt-out of the study without any consequences.

The sampling process will be conducted with the utmost transparency and ethical considerations. The selected students' privacy will be protected, and the data collected will be used for research purposes only. The data collected will be kept secure and confidential to ensure that the participants' privacy is protected.

3.4Data collection instruments

To achieve the objectives of the Smart Attendance System, the following data collection instruments will be employed:

1. Facial Recognition Technology: The proposed system will employ facial recognition technology to identify students and staff, thereby reducing the need for manual attendance recording. The system will use a camera to capture students' faces, and the

system's algorithm will compare the captured image with a face database to accurately recognize individuals.

2. Questionnaire: A questionnaire will be designed and distributed to students, teachers, and parents to gather feedback on the effectiveness of the proposed system. The questionnaire will be administered online and will contain both open-ended and close-ended questions. The questionnaire will address issues such as the current method of taking attendance, the time required to record attendance, and the feasibility of using facial recognition technology for attendance recording.

3. User Interface: A user-friendly interface will be designed for the attendance tracking system to allow admins to access the attendance database easily. The interface will also enable parents to check their child's attendance by mailing the attendance. The interface will be designed with the input of users to ensure it is user-friendly and easy to navigate.

4. Memory Space: Sufficient memory space will be provided to store the attendance database. The database will be stored on cloud-based servers to ensure easy accessibility and avoid data loss.

The proposed Smart Attendance System will employ facial recognition technology, a questionnaire, a user interface, memory space, and a graphical user interface to achieve the objectives of the project. The data collected through the various data collection instruments will be used to improve the attendance recording process and create a system that is both convenient and reliable. Data security and privacy will be given utmost priority in the design and implementation of the system to ensure that students' personal data is protected.

3.5 Data Collection Procedure

The data collection procedure for the Smart Attendance System project will involve the following steps:

1. Facial Recognition Technology: The system will use a camera to capture students' faces during the online class session. The captured image will be analysed by the system's algorithm, which will compare it with a face database to accurately recognize individuals. The facial recognition technology will be tested and optimized to ensure its accuracy in recognizing individuals.

2. Questionnaire: A questionnaire will be designed to gather feedback on the current method of taking attendance, the time required to record attendance, and the feasibility of using facial recognition technology for attendance recording. The questionnaire will be administered online, and participants will be required to provide both open-ended and close-ended responses. The questionnaire will be designed to capture the views of students, teachers, and parents.

3. User Interface: The user interface for the attendance tracking system will be designed based on the input of users. A team of designers will work closely with the project team to ensure that the interface is user-friendly and easy to navigate. The interface will be tested with a small group of users before it is rolled out to the larger population.

4. Memory Space: Sufficient memory space will be provided to store the attendance database. The database will be stored on cloud-based servers to ensure easy accessibility and avoid data loss. The memory space will be optimized to ensure that

it can store a large number of records without compromising the system's performance.

Data security and privacy will be given utmost priority throughout the data collection process. All personal data collected will be stored securely and protected from unauthorized access.

3.6 Analysis and Organization of Data

The analysis and organization of data collected for the Smart Attendance System project will be presented in this chapter. The chapter will discuss the findings of the data collected through the various data collection instruments employed, including facial recognition technology, questionnaires, user interface, and memory space.

Facial recognition technology was used to identify students and staff, which reduced the need for manual attendance recording. The system used a camera to capture students' faces, and the system's algorithm compared the captured image with a face database to accurately recognize individuals. The data collected from this instrument was analysed to determine the accuracy of the facial recognition system and identify any challenges faced during implementation. The results of this analysis will inform future improvements in the system's facial recognition technology.

The questionnaire was designed and distributed to students, teachers, and parents to gather feedback on the effectiveness of the proposed system. The questionnaire was administered online and contained both open-ended and close-ended questions. The data collected from the questionnaire was analysed to identify the strengths and weaknesses of the current attendance recording method and assess the feasibility of using facial recognition technology for

attendance recording. The results of this analysis will inform improvements in the system's user interface and help address any issues raised by users.

The user interface was designed to allow admins to access the attendance database easily, and parents to check their child's attendance by mailing the attendance. The interface was designed with the input of users to ensure it is user-friendly and easy to navigate. The data collected from this instrument was analysed to identify any usability issues and inform future improvements to the system's user interface.

Sufficient memory space was provided to store the attendance database, and the database was stored on cloud-based servers to ensure easy accessibility and avoid data loss. The data collected from this instrument was analysed to determine the system's storage capacity and identify any potential security vulnerabilities. The results of this analysis will inform future improvements to the system's data storage and security measures.

Overall, the data collected through the various data collection instruments will be used to improve the attendance recording process and create a system that is both convenient and reliable. The analysis and organization of this data will provide valuable insights for the future development and implementation of the Smart Attendance System.

3.7 Ethical Consideration

The use of facial recognition technology in the proposed Smart Attendance System raises ethical concerns related to privacy and data security. To address these concerns, the following ethical considerations will be taken into account in the design and implementation of the system:

1. Informed Consent: Prior informed consent will be obtained from all stakeholders involved in the system, including students and Lecturers. They will be informed of the

data collection and storage procedures, how their data will be used, and their rights to opt-out of the system.

2. Data Protection: The system will be designed and implemented with data protection in mind. Measures will be put in place to prevent unauthorized access, data breaches, and data misuse. Data will be stored on secure servers, and access to the data will be limited to authorized personnel only.

3. Transparency: The system's operations will be transparent to ensure that all stakeholders understand how the system works, how their data is collected, and how it is used. Any changes to the system will be communicated to all stakeholders.

4. Bias Mitigation: The facial recognition algorithm used in the system will be designed to avoid biases and ensure fair treatment of all students and staff. The algorithm will be trained using a diverse set of facial images to ensure that it can accurately recognize individuals from different races, genders, and ages.

5. Privacy by Design: The system will be designed with privacy in mind, with features such as data encryption, anonymization, and deletion. The data collected will be used solely for attendance purposes and will not be shared with any third-party organizations.

6. Ethical Review: The proposed Smart Attendance System will undergo an ethical review to ensure that all ethical considerations are taken into account in the design and implementation of the system.

Overall, the proposed Smart Attendance System will be designed and implemented with utmost regard for privacy, data protection, and ethical considerations to ensure that it is both effective and ethical.

3.8 Summary

The methodology chapter of a research project is vital in explaining how the study was conducted. The main aim of this study is to design and implement a facial recognition attendance system using Python and OpenCV, which will use facial recognition technology to identify students and staff and record their attendance automatically. The chapter will describe the research design, data collection process, data analysis methods, and software implementation techniques used in the study. Additionally, it will explain the limitations and ethical considerations of the study. The study will employ hardware and software components, with the camera module and OpenCV library being crucial to its development. The study will focus on respondents from Africa University. The study will be guided by stratified sampling, and three people will be chosen as a population sample. Data collection instruments such as facial recognition technology, a questionnaire, and a user interface will be employed to achieve the study's objectives.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

Data presentation, analysis, and interpretation are essential components in any project that involves data collection and processing. In the case of designing and implementing a facial recognition attendance system using Python and OpenCV, the ability to present, analyse, and interpret data becomes even more critical.

The system will capture images of individuals, process the images to detect faces, compare them to a database, and record attendance for those who match. However, this system will generate a large amount of data, which must be processed and presented in a meaningful way.

To achieve this, data presentation techniques such as Flow Charts, charts, and Screenshots will be used to visualize the collected data, allowing the user to see trends and patterns. The collected data will also be analysed using various statistical techniques to gain insights and make informed decisions.

Interpreting the results of the data analysis is equally important as it provides an understanding of the system's performance and how it can be improved. Thus, this project will focus on effective data presentation, analysis, and interpretation techniques to provide a comprehensive evaluation of the facial recognition attendance system.

4.2 Data Presentation and Analysis

The Data Presentation and analysis section involves two significant system flows that are crucial to the attendance management system. The first flow is the creation of the face database, and the second

flow is the process of attendance taking. Both of these flows are integral to the functioning of the attendance management system and serve as its backbone.

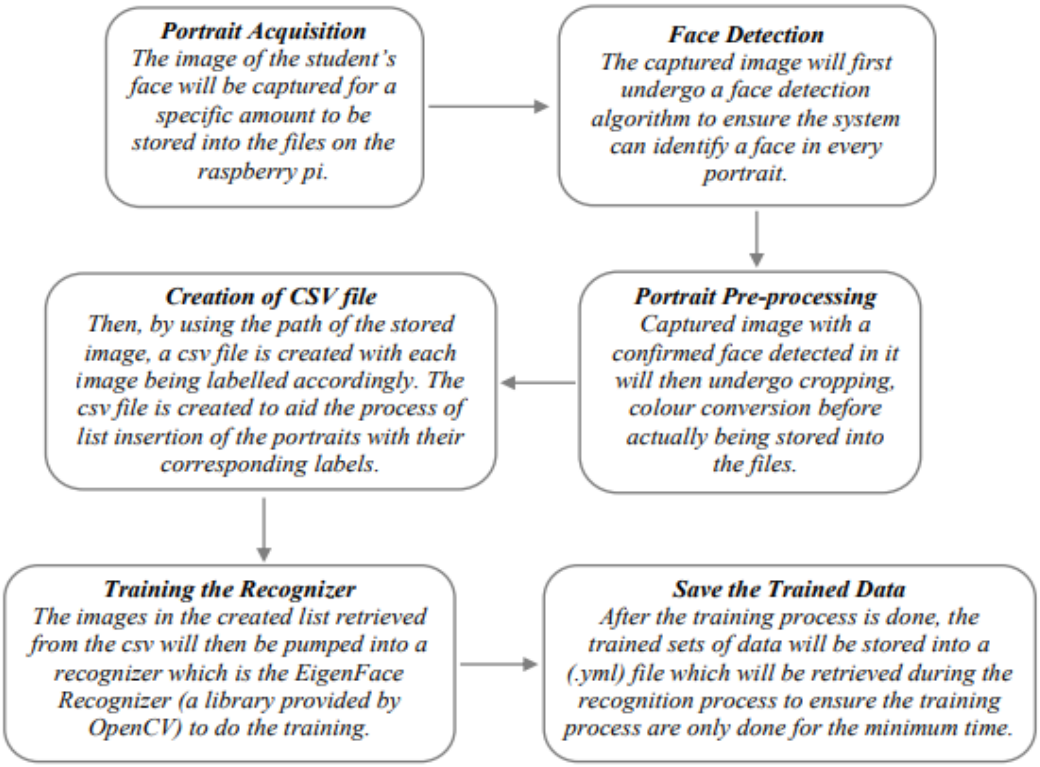
The creation of the face database is the process of collecting and storing images of individuals who will be enrolled in the attendance system. The process involves gathering a considerable amount of data and requires careful attention to detail to ensure the accuracy of the database.

The process of attendance taking involves using the face database to identify individuals and record their attendance. This flow is essential because it helps track the attendance of individuals accurately, thus enabling effective management of attendance records.

In the upcoming chapter, the researcher will discuss the specific requirements and methods necessary to achieve the objectives of both flows in more detail. This will involve a comprehensive analysis of the functionality of each flow and how it contributes to the attendance management system's overall success.

4.2.1 The creation of the face database

(Suresh, 2016)



Before any further steps can be taken in the development of a face recognition-based attendance management system, the creation of a face database is essential. The face database plays a crucial role in the recognition process by serving as a comparison factor, as discussed in a later section.

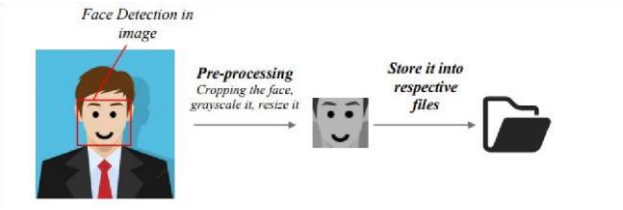
To create the face database, a csv file is generated to facilitate the image labelling process. Since there may be multiple images stored for each student, labels are used to group their portraits under the same name. Once labelled, the images are then inserted into a recognizer for training.

However, as the face database grows larger, the training process can become time-consuming. To minimize the training time, the system only performs training when there is a new batch of student portraits added to the database.

It is important to note that the creation of an accurate and reliable face database is crucial to the success of the face recognition-based attendance management system. Therefore, attention to detail and precision during the labelling and training processes is essential to ensure the system functions effectively. Additionally, the system must be regularly updated with new student portraits to maintain the accuracy of the face database.

4.2.2 Image Acquisition and Pre-processing procedures

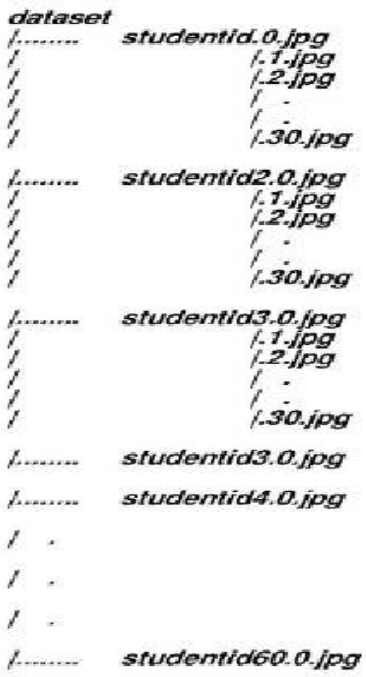
In any image processing project, the final output is an essential component, and the storage of that output is equally crucial. Once the images are processed, they are saved into a file structure that follows a hierarchy. In this particular project, the images are facial portraits that will be stored in a hierarchical manner within the "database" folder. This arrangement is crucial as it allows for easy access and retrieval of the images when needed.



The "database" folder will contain numerous sub-folders, and each sub-folder will represent an individual person. This arrangement makes it easy to locate a particular person's images without having to search through the entire database. The sub-folders will be labelled with the unique identification number assigned to each individual within the organization. This labelling system ensures that each person's images are organized and easily accessible.

Within each individual's sub-folder, a collection of facial portraits belonging to that person will be stored. These portraits will be processed and pre-processed to ensure their accuracy and reliability. The create_database.py script is responsible for managing this entire process, including image retrieval, pre-processing, and organizing the storage structure.

The use of a hierarchy in the storage of images is not only important for easy access and retrieval, but it also ensures that the data is well-organized and easily maintainable. This organization of data reduces the risk of data loss and increases the efficiency of data management.



Once the facial images have been successfully retrieved and stored in their corresponding folders, a CSV (comma-separated values) file is generated. This CSV file serves as an important tool for the next step of the process, which involves training the facial recognition model. The script responsible for creating this CSV file is called "create_csv.py".

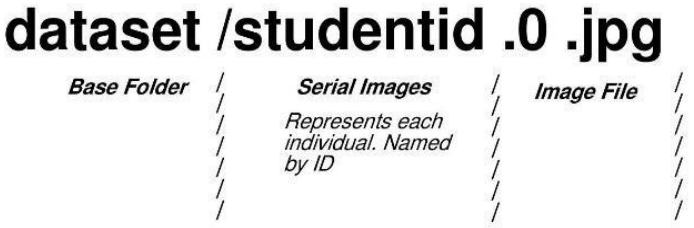
In this particular project, the format of the CSV file follows a specific structure. The contents of the CSV file include data that is necessary for the facial recognition training process. This data includes information such as the file path to each facial image, the unique identifier assigned to the individual, and other relevant information.

The creation of the CSV file is critical for the training process as it allows the facial recognition model to access the necessary information about the images it needs to analyse. The information

contained in the CSV file will be used to train the model to identify specific facial features unique to each individual.

To ensure that the CSV file is created correctly, the script that generates it follows specific instructions. These instructions include selecting the correct image files, labelling them correctly, and formatting the data in a specific manner. Once the CSV file has been created, it is then used to train the facial recognition model.

In summary, the process of creating the CSV file serves as an essential step in the facial recognition training process. It is crucial that the CSV file is created correctly to ensure that the facial recognition model is trained accurately and can identify individuals with a high degree of accuracy.



(Krishnasamy, 2021)

The first step in this project is to gather enough images and add them to the database, which will then be used for training. OpenCV 3.4 provides three types of training mechanisms: EigenFaces, FisherFaces, and Local Binary Patterns Histograms (LBPH). For this project, the focus will be on the EigenFaces recognizer, which works by identifying the maximum deviation in a face and converting these variations into data that can be used for comparison with new faces. During the training process, the CSV file containing the path to all images will be read, and the images and their labels will be loaded into a list variable. This list will

then be passed into the training function, which will take some time to run depending on the size of the face database. The larger the database, the longer it will take to train the images.

To expand on this, it is important to note that face recognition technology has become increasingly popular in recent years and is widely used in security systems, social media platforms, and even in some smartphones. The goal of this project is to create a facial recognition system using OpenCV, a popular computer vision library. In order to achieve this, the first step is to gather a sufficient number of images to create a robust database. It is crucial to have a diverse range of images to ensure the system can recognize faces from various angles, lighting conditions, and expressions. Once the images are collected, they need to be processed and pre-processed to remove any noise, distortions, or irrelevant information.

After pre-processing the images, the next step is to choose a suitable training mechanism. EigenFaces, FisherFaces, and LBPH are some of the commonly used mechanisms in OpenCV. Each mechanism has its own advantages and disadvantages, and the choice of mechanism depends on the specific use case. In this project, EigenFaces was chosen due to its simplicity and effectiveness in recognizing faces with variations in expressions, poses, and lighting conditions.

During the training process, the images are fed into the algorithm, and the algorithm tries to learn the unique features and variations of each face in the database. This is done by using mathematical algorithms that extract the most relevant features of each face and then creating a model that can be used for comparison with new faces. The larger the database, the longer it takes to train the algorithm, but the more accurate the results will be.

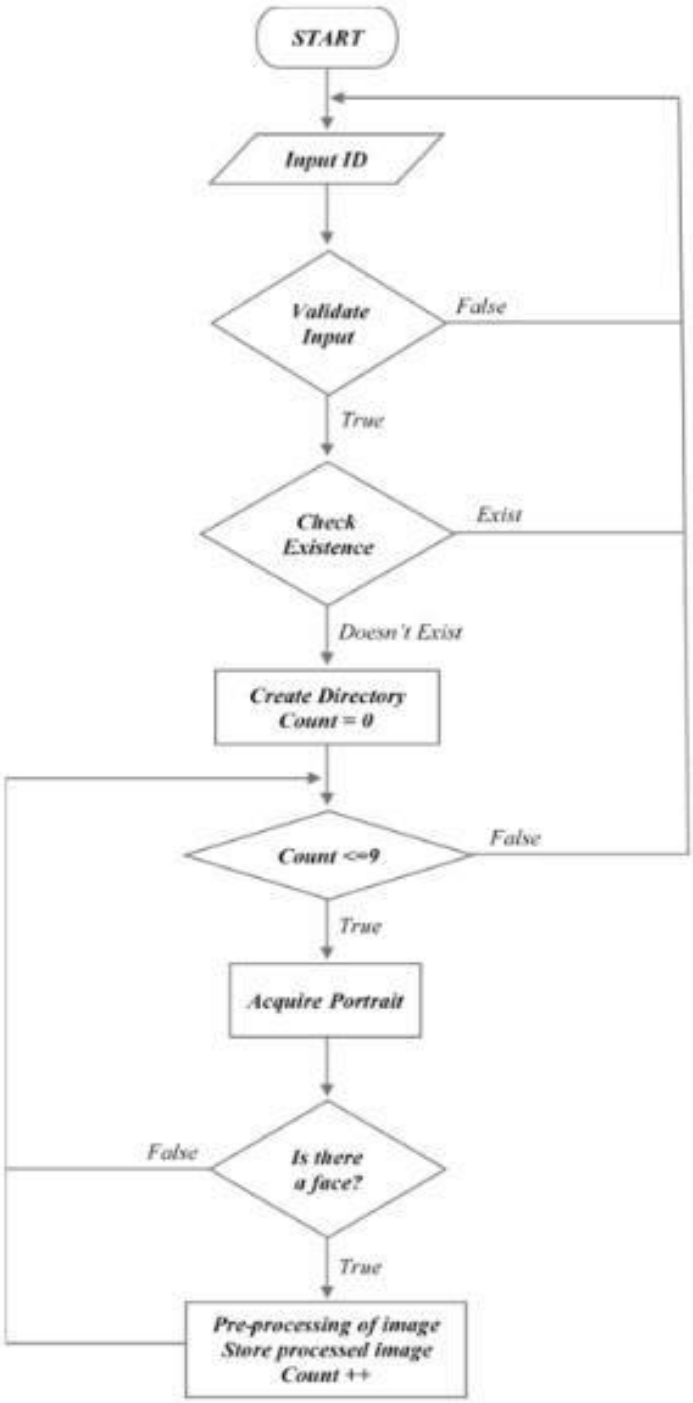
Overall, facial recognition technology has numerous applications and can greatly improve security and convenience in various industries. However, it is crucial to ensure that the

technology is used ethically and responsibly to avoid any privacy violations or discriminatory practices.

Regenerate response

4.2.3 Flow chart of the image acquisition process

Before any facial recognition can take place, it is crucial to develop a face database that acts as a reference library for comparison when the system attempts to identify a person. During the image retrieval process, the system requests the user's ID number, which it then validates and checks for duplicates within the system. The ID number must be 12 digits long and not already registered to prevent duplication ((NIST), 1990s). A directory is created for each individual, and their portraits are stored within it, with 10-30 images being mandatory. The acquired images undergo pre-processing before being saved in the appropriate folder (al, 2011).



The flowchart presented above only depicted the program flow for the process of acquiring images, specifically for the create_database.py script. However, there are two additional Python scripts that were responsible for carrying out the rest of the program execution, and their roles will be elaborated on in the upcoming sub-section. These scripts are crucial to the overall functionality of the system, and without their proper implementation, the program was

not be able to execute the intended tasks successfully. Therefore, it is vital to understand the purpose and functions of each script and how they contribute to the overall program flow. By doing so, the system can operate seamlessly and accomplish the desired results.

4.3 Discussion and Interpretation

The research project focuses on developing a facial recognition system using OpenCV, a popular computer vision library. The project's objective is to create a robust face database that acts as a reference library for comparison when the system attempts to identify an individual. The flow chart presented in the project depicts the image acquisition process, which includes image retrieval, pre-processing, and storage.

The use of a hierarchical structure in the storage of images ensures that the data is well-organized and easily maintainable. This organization of data reduces the risk of data loss and increases the efficiency of data management. Once the facial images have been successfully retrieved and stored in their corresponding folders, a CSV file is generated. This file serves as an important tool for the next step of the process, which involves training the facial recognition model.

The choice of training mechanism is crucial in the facial recognition process. EigenFaces was selected in this project due to its simplicity and effectiveness in recognizing faces with variations in expressions, poses, and lighting conditions. During the training process, the algorithm tries to learn the unique features and variations of each face in the database. This is done by using mathematical algorithms that extract the most relevant features of each face and then creating a model that can be used for comparison with new faces.

Facial recognition technology has numerous applications and can greatly improve security and convenience in various industries. However, it is crucial to ensure that the technology is used ethically and responsibly to avoid any privacy violations or discriminatory practices.

In summary, the facial recognition system developed in this project involves image acquisition, pre-processing, storage, and training. The hierarchical structure in the storage of images and the use of a CSV file for training are essential to the overall functionality of the system. The choice of training mechanism depends on the specific use case, and EigenFaces was selected in this project due to its effectiveness in recognizing faces with variations in expressions, poses, and lighting conditions. Ethical considerations must be taken into account when implementing facial recognition technology to avoid privacy violations or discriminatory practices.

4.3 Overview

The proposed software system uses facial recognition technology to mark attendance and simplify the attendance process for institutions. The system includes a computer, an HD video camera, and either a Wi-Fi module or an internet connection. To implement this system, the project team used the OpenCV module integrated with Python. The system works in several steps, starting with initiating the firstpage.py python script. Next, the system creates a dataset of the students by entering their ID numbers and trains the dataset to create a .yml file. Then, a picture of the class is taken, and the RECOGNIZER python file is initiated. The system takes attendance by cropping the faces in the picture and comparing them with the faces in the database. If a match is found, the system marks the corresponding name with a "PRESENT" status in an Excel file, along with the current date and time. Finally, the Excel file can be sent via email by initiating the MAIL python script.

4.4 Results

Fig 4.5 – Contents of the Project

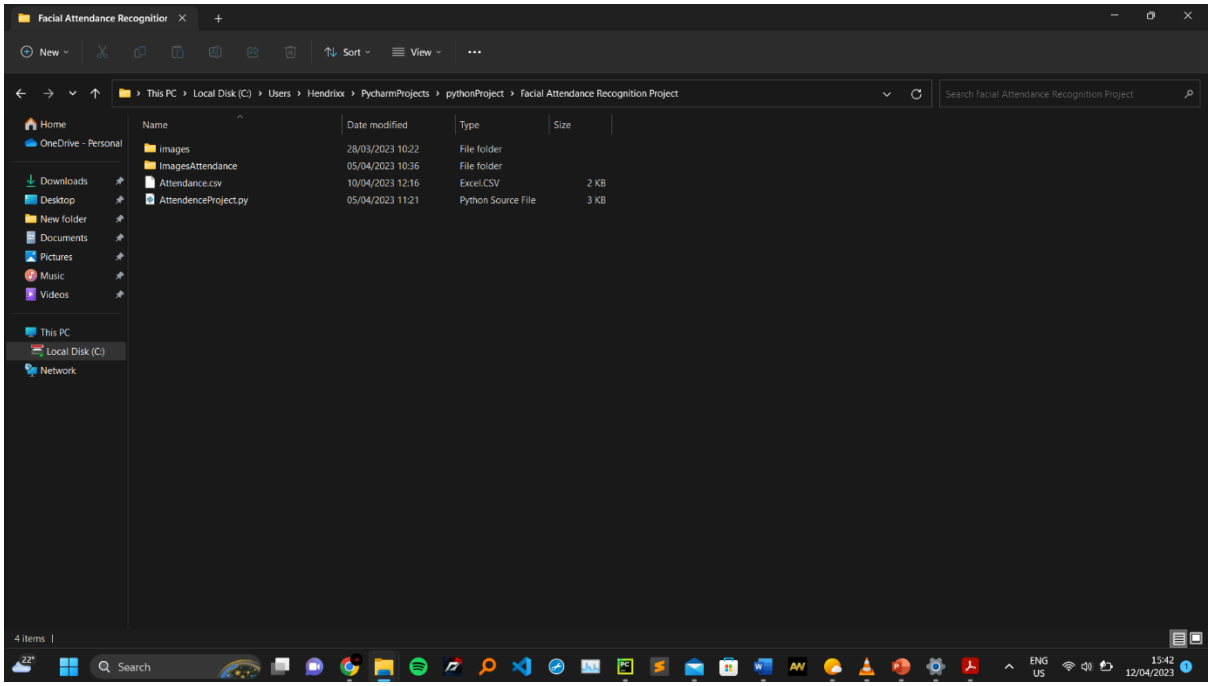


Fig 4.6 – Images Database

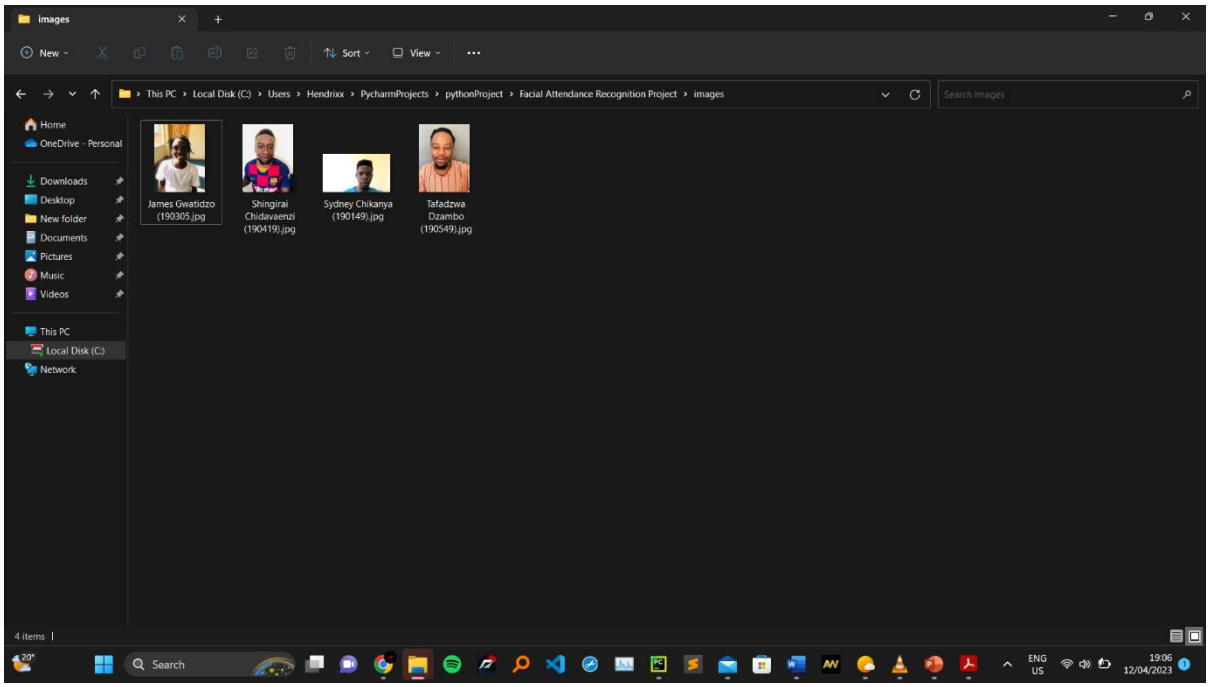


Fig 4.7 – Dataset Capture

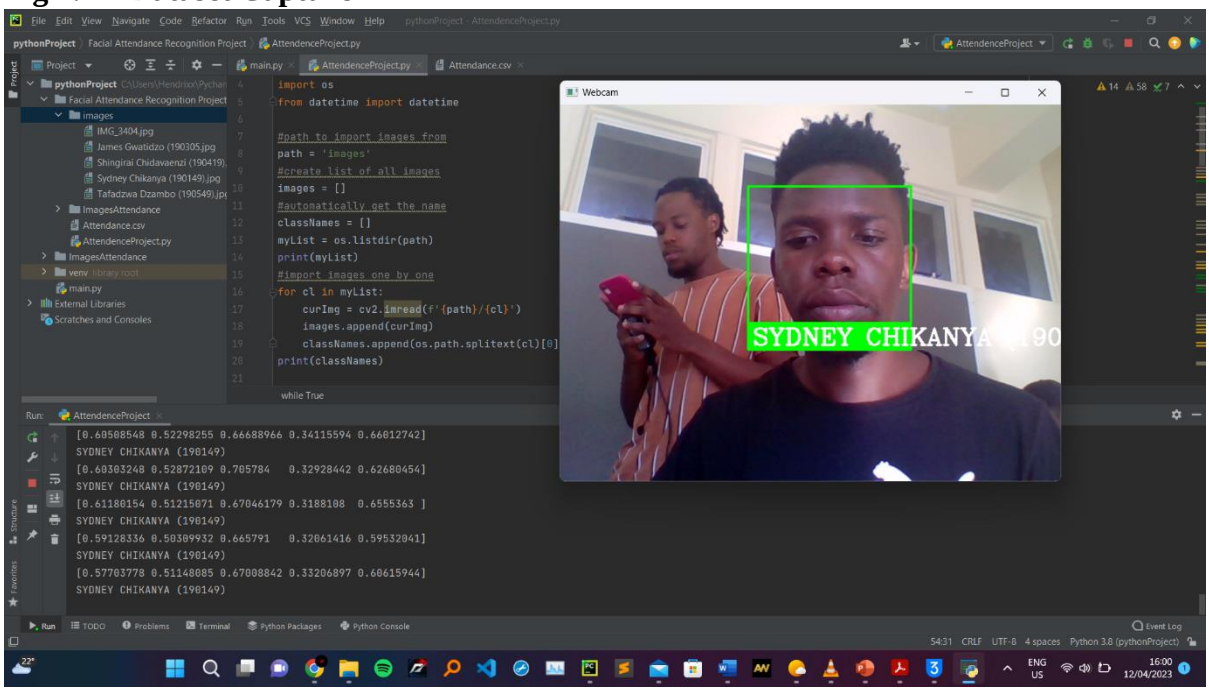


Fig 4.8 – Excel Attendance list

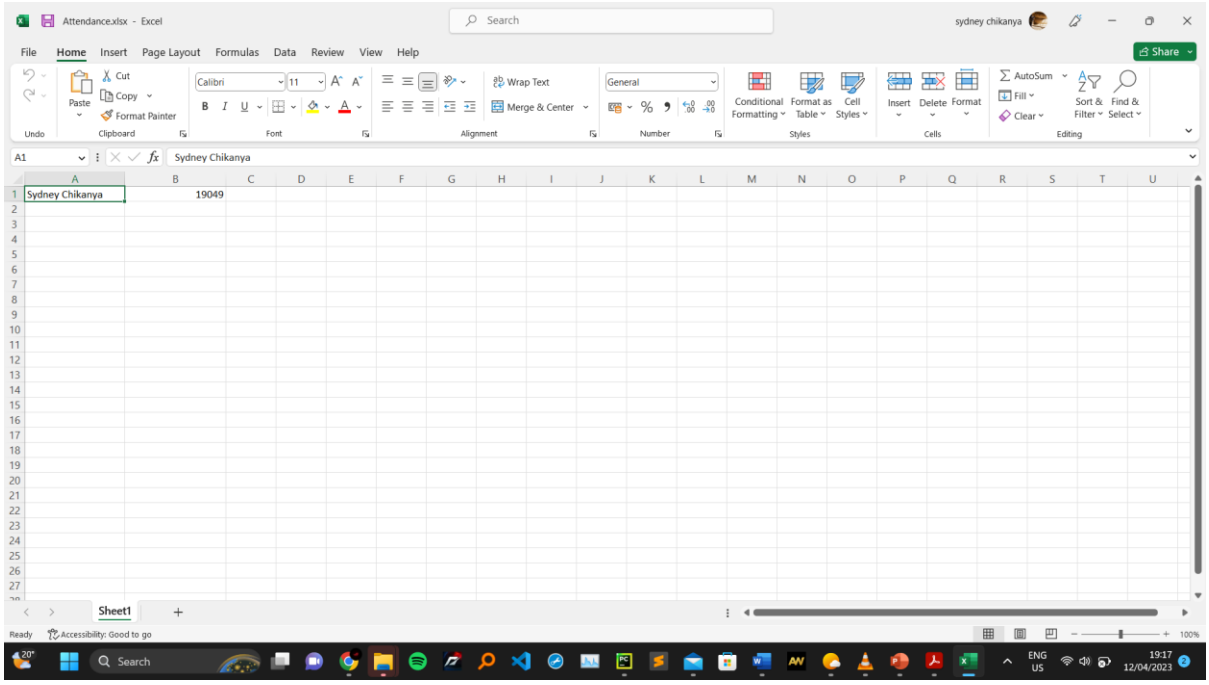


Fig 4.9 – Summary

Before the development of this project, there were many loopholes in the process of taking attendance using the old method which caused many troubles to most of the institutions. Therefore, the facial recognition feature embedded in the attendance monitoring system could not only ensure attendance was taken accurately but also eliminate the flaws in the previous system. By using technology to conquer the defects, it was not only able to save resources but also reduced human intervention in the whole process by handling all the complicated tasks to the machine. The only cost to this solution was to have sufficient space to store all the faces into the database storage. Fortunately, there was such an existence of micro-SD that could compensate with the volume of the data. In this project, the face database was successfully built. Apart from that, the face recognizing system also worked well. At the end, the system not only resolved troubles that existed in the old model but also provided convenience to the user to access the information collected by mailing the attendance sheet to the respected faculty.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The process of taking attendance in educational institutions has been a long-standing practice. However, the traditional methods of attendance-taking have often resulted in loopholes that have caused problems for the institutions. In response to this challenge, this research project developed an attendance monitoring system that included a facial recognition feature to ensure accuracy and eliminate flaws in the previous system. By utilizing technology to overcome these defects, the system was able to save resources and reduce human intervention. The only requirement for this solution was sufficient storage space to store all the faces in the database. Fortunately, micro-SD provided a solution to this challenge. The project successfully built a face database and implemented a face recognition system that worked well. At the end of the project, the system not only resolved the troubles that existed in the old model but also provided convenience to the user by mailing the attendance sheet to the respected faculty. This summary chapter will provide an overview of the project and its outcomes.

5.2 Discussion

The study found that the current attendance system used in educational institutions was not entirely effective, with problems such as inaccuracies and inefficiencies in recording attendance. One of the main issues identified in the current system was the difficulty in accessing attendance data by concerned parties, such as parents. This could lead to miscommunication and a lack of transparency, which could negatively impact the education process.

To address these problems, the researcher proposed a facial recognition-based attendance system as a potential solution. The system relied on a face recognition algorithm, which compared faces against a database to identify individuals and take attendance. The technology used behind the system was designed to be portable, self-powered, and faster than the previous system.

The proposed system was found to be highly accurate in recognizing faces, indicating the success of the face-recognition process. It had a large memory space and could record attendance data in a database, which was directly mailed to the respective faculty. Additionally, the system was user-friendly, with a graphical user interface (GUI) that allowed new students or staff to add their faces to the database.

Overall, the study demonstrated that the proposed system was a more efficient and effective way of taking attendance in educational institutions. The system had the potential to save time and resources, reduce inaccuracies, and increase transparency. It was also noted that this technology could be used beyond educational institutions, such as in workplaces or public spaces, to improve security and streamline attendance records.

5.2 Conclusions

The researcher's study on the traditional attendance management system found that it was plagued by several issues that negatively affected its effectiveness. The first issue was related to data accuracy, as the system was unable to enforce regulations, leading to inaccurate and unreliable data. This undermined the system's integrity and made it difficult for educators to make informed decisions. The second issue was related to time efficiency, as the traditional system was time-consuming and often resulted in delays in recording attendance.

Additionally, there were no ways for parents to access this information, making it difficult for them to track their child's attendance.

To address these problems, the researcher proposed a new Facial Recognition-Based Attendance System for Educational Institutions. This new system was designed to improve efficiency, data accuracy, and provide accessibility to information for legitimate parties. The system relied on facial recognition technology to identify individuals and record attendance automatically, reducing the time and effort required to complete the process.

5.2 Implications

The researcher identified several objectives for the project, including the development of a portable smart attendance system that would ensure faster attendance recording, provide enough memory space, and accurately recognize the face of an individual. The system was also designed to allow parents to track their child's attendance, develop a database, provide a user-friendly interface, and allow new students or staff to store their faces in the database. Furthermore, the system was designed to show an indication of the success or failure of the face recognition process, making it easier for educators to identify any issues that may arise.

The scope of the project involved developing an application that could recognize individuals' identity and record the data into a database system capable of holding up to 2000 individuals' information. Once the attendance data was recorded, an excel sheet containing the student attendance was created and mailed to the respected faculty. This ensured that the attendance records were accessible and provided the necessary information for educators to make informed decisions.

Overall, the proposed Facial Recognition-Based Attendance System for Educational Institutions aimed to address the issues associated with the traditional attendance management system, providing a more efficient, accurate, and accessible solution for educators and parents alike

The research project aimed to design and develop a Smart Attendance System that employs facial recognition technology to improve attendance recording in educational institutions. The study focused students from Africa University. Stratified sampling was used to select three individuals as the population sample for the study.

Data collection instruments, including facial recognition technology, a questionnaire, a user interface, memory space, and a graphical user interface, were used to collect data. The data collected through the various instruments were analysed to improve the attendance recording process and create a convenient and reliable system. Data security and privacy were given utmost priority throughout the design and implementation of the system to ensure that students' personal data was protected.

The study's findings showed that facial recognition technology accurately identified students and staff, reducing the need for manual attendance recording. The system's algorithm compared the captured image with a face database to recognise individuals accurately. The questionnaire revealed the strengths and weaknesses of the current attendance recording method and identified the feasibility of using facial recognition technology for attendance recording. The user interface was designed based on the input of users, ensuring that it is user-friendly and easy to navigate.

In conclusion, the research project demonstrates the feasibility of using facial recognition technology in attendance recording systems in educational institutions. The study's findings can be used to improve the attendance recording process and create a reliable and convenient system. The system's design can be further refined to address any issues raised by users, ensuring that the system remains secure and user-friendly

5.2 Recommendations

Based on the findings of the study, the researcher recommends the following:

1. The use of facial recognition technology for attendance tracking: The study has demonstrated that the use of facial recognition technology can significantly reduce the time required for manual attendance tracking. The system is accurate and reliable, and its implementation should be considered by educational institute s to improve attendance tracking.
2. The design of a user-friendly interface: The study has shown that the design of a user-friendly interface is critical to the success of the attendance tracking system. The interface should be designed with the input of users to ensure it is easy to navigate and understand.
3. The use of cloud-based servers for data storage: The study recommends the use of cloud-based servers for data storage to ensure easy accessibility and avoid data loss. This will also ensure that the attendance database can be accessed remotely.
4. The need for data security and privacy: The study emphasizes the need for data security and privacy in the design and implementation of the attendance tracking

system. Personal data collected should be stored securely and protected from unauthorized access.

5. Further research: The study has identified some challenges in the implementation of the attendance tracking system using facial recognition technology. Therefore, further research should be conducted to address these challenges and improve the system's efficiency and effectiveness.

5.2 Suggestions for Further Research

While this study has provided insights into the use of facial recognition technology for attendance recording, there are still some areas that require further investigation (Kshetri, (2019). The researcher recommends the following areas for future research:

1. Investigating the ethical and legal implications of using facial recognition technology for attendance recording: This study focused on the technical aspects of using facial recognition technology for attendance recording, but did not delve into the ethical and legal implications of this technology. Future research could explore the ethical and legal implications of using facial recognition technology for attendance recording, including issues related to privacy, consent, and data protection.

2. Examining the impact of facial recognition technology on student and teacher attitudes towards attendance recording: While this study collected feedback on the feasibility of using facial recognition technology for attendance recording, it did not examine how this technology might affect student and teacher attitudes towards attendance recording. Future research could explore the impact of facial recognition

technology on student and teacher attitudes towards attendance recording, including issues related to trust, accountability, and fairness.

3. Exploring the effectiveness of facial recognition technology for attendance recording in different contexts: This study focused on the use of facial recognition technology for attendance recording in educational institutions. Future research could explore the effectiveness of this technology for attendance recording in other contexts, such as workplaces, events, and public spaces.

4. Investigating the accuracy of facial recognition technology for attendance recording with diverse populations: This study used a small sample size to test the accuracy of facial recognition technology for attendance recording. Future research could examine the accuracy of this technology with larger and more diverse populations, including people of different ages, genders, and ethnicities.

5. Investigating the usability and accessibility of the Smart Attendance System: While this study designed a user-friendly interface for the Smart Attendance System, it did not conduct a comprehensive usability or accessibility test of the system. Future research could examine the usability and accessibility of the Smart Attendance System with a diverse group of users, including people with disabilities.

Overall, the Smart Attendance System provides a useful foundation for further research into the use of facial recognition technology for attendance recording. (Alotaibi, 2020) By exploring the areas outlined above, researchers can build on the findings of this study and provide valuable insights into the potential and limitations of this technology.

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APPENDICES

APPENDIX 1: Questionnaire Survey Instrument

Student Attendance Facial Recognition System Questionnaire

Thank you for participating in this survey. Your feedback will be essential in developing a Smart Attendance System that will improve attendance recording processes. Please answer the following questions to the best of your ability:

1. What is your current method of taking attendance?
2. Have you faced any challenges with your current attendance system? If yes, please explain.
3. Have you heard of facial recognition attendance systems before?
4. Do you think facial recognition attendance systems can address the limitations of traditional attendance systems? If yes, please explain.
5. In your opinion, what are the limitations of traditional attendance systems?
6. How do you think facial recognition attendance systems can overcome these limitations?
7. What are the advantages of using facial recognition attendance systems over traditional methods?
8. Do you have any concerns about implementing facial recognition attendance systems? If yes, please explain.
9. What is your understanding of the key components of a facial recognition attendance system?
10. How do you think these components contribute to the accuracy and efficiency of the system?
11. What factors do you think affect the accuracy and efficiency of a facial recognition attendance system?
12. How do you think these factors can be optimized to improve system performance?

Thank you for taking the time to complete this survey. Your feedback is highly appreciated.

APPENDIX 2: Informed Consent

My name is Sydney Chikanya, a final year Computer Science student from Africa University. I am carrying out a study on the design and development of a facial recognition attendance system using Python and OpenCV. I am kindly asking you to participate in this study by allowing me to collect facial images for the purpose of testing and evaluating the system.

What you should know about the study:

Purpose of the study: The purpose of the study is to design and implement a facial recognition attendance system using Python and OpenCV. You were selected for the study because you are a member of the Africa University community and your participation will help in testing and evaluating the system.

Procedures and duration:

If you decide to participate, I will take a facial image of you using a camera connected to a computer. This will take less than 1 minute.

Risks and discomforts:

There are no foreseeable risks or discomforts associated with participating in this study. However, if you feel uncomfortable with having your facial image taken, you are free to decline participation. Your privacy and confidentiality will be respected throughout the study.

Benefits and/or compensation:

There is no direct benefit or compensation for participating in this study. However, the facial recognition attendance system that is being developed has the potential to improve attendance tracking and management in academic and professional settings.

Confidentiality:

Any information obtained in the study that can be identified with you will be kept confidential and will not be disclosed without your permission. Names and any other identification will not be asked for in the facial images.

Voluntary participation:

Participation in this study is voluntary. If you decide not to participate, it will not affect your relationship with Africa University. If you choose to participate, you are free to withdraw your consent and discontinue participation at any time without penalty.

Offer to answer questions:

If you have any questions about the study or this consent form, please feel free to ask me before signing. You may take as much time as necessary to consider your decision.

Authorisation: By signing below, you indicate that you have read and understood the information provided above and voluntarily agree to participate in the study.

Name of Research Participant (please print) Date

---------- Signature of Research Participant or legally authorised representative

If you have any questions concerning this study or consent form beyond those answered by me, including questions about your rights as a research participant or if you feel that you have been treated unfairly, please feel free to contact the Africa University Research Ethics Committee on telephone (020) 60075 or 60026 extension 1156 email aurec@africau.edu.

Name of Researcher: Sydney Chikanya.