

**FACE CAPTURE-BASED EMPLOYEE ATTENDANCE SYSTEM: A CASE STUDY
OF HOLY INNOCENTS CHILDREN'S HOSPITAL MBARARA**

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**UGANDA CHRISTIAN
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DECLARATION


I **INNOCENT BYARUGABA** declare that this dissertation is my original work and has never been presented by anybody to the Uganda Christian University, Bishop Barham University College or any other institutions of higher learning for the award of Bachelors Degree in science and information technology.

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Approval

This research has been submitted to the Uganda Christian University, Bishop Barham University College for examination under the Supervision of

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Name: SIKORUGINGO REASON

Dedication

I dedicate this Dissertation to my beloved parents the late Mr. Tarebwa Louis and Miss. Bahendekyerabusha Angelica, my brothers Mr. Tugume Louis and Mr. Baryaija Charlse without forgetting all my friends for the care, love, mentorship, tireless effort and parental responsibility they rendered to me when doing research and the two semesters I have completed.

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Most special thanks go to my parents the late Mr. Tarebwa Louis and Miss. Bahendekyerabusha Angelica, my brothers; Mr. Tugume Louis, and Mr. Namara Didas.

Am grateful to the management of Uganda Christian University Bishop Barham University College which gave me the required knowledge, skills and experience in both studies and compiling my research proposal.

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Lastly, I would like to thank all those who helped me to accomplish this research proposal in time.

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Table of Contents

Declaration.....	i
Approval.....	ii
Dedication.....	iii
Acknowledgement.....	iv
Table of Contents.....	v
ACRONYMS/ LIST OF ABBREVIATIONS.....	vii
ABSTRACT.....	viii
CHAPTER ONE.....	1
GENERAL INTRODUCTION.....	1
1.0 Introduction.....	1
1.2 Background.....	1
1.2.1 Historical background.....	1
1.2.2 Theoretical background.....	2
1.2.3 Conceptual background.....	2
1.2.4 Contextual background.....	3
1.2.5 Theoretical framework.....	3
1.3 Problem statement.....	3
1.4 Objectives.....	3
1.4.1 General objective.....	3
1.4.2 Specific objectives.....	3
1.5 Research questions.....	4
1.6 Scope.....	4
1.7 Significance.....	4
CHAPTER TWO.....	5
LITERATURE REVIEW.....	5
2.0 Introduction.....	5
2.1 Face detection.....	5
2.2 Open Computer Vision (OpenCV).....	5
2.3 Existing systems.....	5
2.4 Research gap.....	7
2.5 Proposed system.....	7
2.6 The developed system.....	7
CHAPTER TREE.....	8
METHODOLOGY.....	8

3.0	Introduction	8
3.1	Research approach.....	8
3.2	Achieving the specific objectives.....	9
3.3	Designing the system	10
3.4	Implementing the system.	10
3.5	Test and validate the system.....	10
CHAPTER FOUR.....		11
Presentation of results		11
4.0	Introduction.....	11
4.1	System description	11
4.2	System requirements	11
4.2.1	Hardware specification	11
4.2.2	Software specification.....	11
4.3	Requirement specification	11
4.3.1	Functional requirements.....	11
4.3.2	Non-functional requirements	12
CHAPTER FIVE		17
Conclusion and recommendation.....		17
5.0	Introduction.....	17
5.1	Challenges faced during system development.....	17
5.2	Recommendations.....	17
5.3	Future researchers	17
References.....		19

ACRONYMS/ LIST OF ABBREVIATIONS

AI – artificial intelligence

HICH – Holy Innocents Children’s Hospital

OpenCV – Open Computer Vision

CCHU-Cure Children’s Hospital of Uganda

PIL- Python Imaging Library

ABSTRACT

The Research will be conducted on 5th March 2024 at Holy Innocents Childrens'Hospital located on Plot 6, Nyamitanga ward, Nyamitanga Division, Mbarara city South, Mbarara City, Uganda.

It is 3kms (2mls) from Mbarara Regional Referral Hospital on the high way Kaberebere-Isingiro Road on the left-hand side.

It is a pediatric general hospital in the western region of Uganda founded in 2009, and it is the second pediatric hospital in Uganda after Cure Children's Hospital of Uganda (CCHU) in Mbale Eastern Uganda which was founded in 2000.

This document of the research proposal is for developing a Face capture-based employee attendance system for Holy Innocents Children's Hospital. It consists of the current background of the Hospital and problems having due to present a system and how I will overcome those matters through my proposed system.

After gathering the required information, I found HICH has no computerized system, they use manual system where people could go directly and register their attendance in the register book or counter books, and then the information is stored in the counter books. Staffs sign for their friends as if they have attended to work. This have made patients not being attended to and some turn back home with their sickness and others to the neighborhood hospitals due to absenteeism. For the case of HICH is a business oriented, this puts the hospital and its Directors at a stake of losing business.

The research project is aimed at designing a fully functional Face capture-based employee attendance system in order to manage absenteeism.

The overall mission of system development is to make Hospital Director easily and quickly track staff attendances.

CHAPTER ONE

GENERAL INTRODUCTION

1.0 Introduction

Face capture attendance system is a system being proposed, that will capture faces of employees and their environment when they report to work.

This section seeks to introduce the main the researcher's main terminologies, and the general understanding of face capture-based employee attendance system.

To begin with is face capture. A face is an area of the human body where eyes, the nose, mouth and the forehead are found. It is part of the head, in the front. Capturing, in this proposal will mean taking a photo of someone. Combining the two terms, face capture will be taking a photo of an employee's face and performing necessary operations as will be explain in the later sections.

Face detection is an artificial intelligence technique used to extract features of the face for further image processing (Nick, 2023). This is the same way people look at others and recognize their faces. Extracting face features is a skill that humans learn in their life of growth and it becomes automatic. Likewise, face detection, using machine artificial intelligence techniques, we are able to extract faces from a video and or a photo for further processing.

Attendance system, in this proposal will mean a system that will be used to capture workers when they report to work. The case study being Holy Innocents Children's Hospital, the system will not be limited to the hospital alone but can be used in other organizations. The system is expected to capture the face of the employee and save it in a suitable location on the computer. Saving the image means, capturing a photo and giving it a name before it is stored on the computer where the system is installed.

1.2 Background

1.2.1 Historical background

Back in the days, organizations were tracking employee attendance for no big importance (in.adp.com, 2024). Organizations did not look at employee attendance capturing as something crucial. It was taken as a good to have thing. Today, many organizations look at attendance systems as a must to have. This is due to the measure of work done by an employee in a given period of time. Common payment periods include hourly, weekly or monthly, and attendance

systems help record the time the employee starts and ends work so that an appropriate payment can be made to them.

Today, many organizations, tracking employee attendance is one of the most important activities in the organization and or business (Cassio, 2023). There are so many advantages of doing so including but not limited to high productivity, reduced workload for other employees in the business and good collaboration among staff which keeps the spirit of team work high. (Cassio, 2023) explains how absenteeism affects the organization as below;

- It leads to decreased productivity.
- Other employees will have increased workloads.
- Potential delays in project completion.
- Higher costs due to hiring other temporary workers.

The stated effects above maybe dangerous to any organization and or business. For the case of HICH, it is a business oriented. The fact that there is competition among other hospitals providing similar services, this puts the hospital and its directors at stake of losing business.

There may be various solutions to reduce absenteeism at work, including but not limited to providing breaks to employees, increasing their salary but, these may not guarantee that the employee will not miss work. It would be better to track employee's attendance at work on a daily basis, to confirm their attendance. There can be different methods used including but not limited to registering in the book, which is a common method among many companies, using thumb prints among others.

1.2.2 Theoretical background

Before the deep learning revolution redefined computer vision, Haar features and Haar cascades were the tools you must not ignore for object detection. Even today, they are very useful object detectors because they are lightweight (Tam, 2024).

Haar cascade is an algorithm that is trained before being use to detect objects (Tam, 2024). It is an advantage that opencv has pretrained haar cascades that can be used to detect objects without prior training. They are saved in opencv as *.xml* files. Among the objects that they can detect include faces, eyes, upper body and mouth, among other body parts. Haar cascades can be loaded by the onpencv library using *cascadeClassifier* function. From the object created from the classifier, *detectMultiScale* is used to detect the objects.

1.2.3 Conceptual background

Face capture and attendance are the variables that the research focuses on. Attendance is dependent on face capture. For any staff that reports to work, the face is captured. If there is no

face photo of the employee in the directory where face images are saved, it will then be evident that the employee did not report on that day.

1.2.4 Contextual background

At HICH, the system used to capture attendance is manual, that is, physical registration. Someone can register another employee who is not there and there will be no evidence that the employee did not come.

The researcher proposes a face capture-based attendance system that will require an employee to login in the system, and upon login success, the camera loads, detects a face and take the photo of the employee that will have logged in and a photo saved with their name as the filename. This will eliminate potential help given by fellow employees who login for others especially when manual systems are used.

Face detection is an AI based technology used to find and identify human faces in digital images and or videos (Nick, What is face detection?, 2024).

1.2.5 Theoretical framework

The dependent variable is the attendance and independent variable is the face capture. According to how the system will be working, it will be taking the photo that includes the face of the employee who will have reported, and save it in a specific directory. If the face does not exist in the directory, it means the employee will not have attended work that day. Thus, attendance depends on face capture.

1.3 Problem statement

Work output is lower than before at HICH, because there is less efficiency among staff caused by absenteeism. The method used to track their attendance is manipulated by someone registering and signing for someone who has not reported at work and it cannot be confirmed by the attendance book in case reference has to be made from it.

1.4 Objectives

1.4.1 General objective

To develop a face capture-based employee attendance system.

1.4.2 Specific objectives

1. To design a face capture-based attendance system.
2. To implement the system.

3. To test and validate the system.

1.5 Research questions

1. How can a face capture-based attendance system be designed?
2. How will the face capture-based system be implemented?
3. How will the system be tested and validated?

1.6 Scope

Geographical scope covers Holy Innocents Hospital (HIH) staff.

Time scope: This research is expected to be complete by end of April, 2024.

Content scope: Only faces are focused on and there is no further processing of the image. The system is expected to detect a face of an employee, the image taken automatically, given the name of the employee, and saved in a database (folder) where the supervisor can check details of employees that have attended work for a certain working day.

1.7 Significance

Academically, the researcher upon completion of this proposed system will be awarded a bachelor's degree in Information Technology. Alongside academic achievement, the researcher also plans to advance the system for economic gain in reputable organizations and businesses.

To the hospital, the administrator will get rid of system manipulation by avoiding staff signing for others for having reported falsely

The system will be evidence based since a face of the employee will be captured and saved in a database for future reference, and they (employees) will be committed to their jobs which will increase their production.

This research will be put in the university library for future researchers to build from it to achieve more advanced systems. This will enrich the university library with more and updated information, which contributes to its reputation.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter talks about literature related to the researcher's research topic highlighting important information. It also seeks to look at similar methods used in employee attendance recording systems in place.

Sections discussed in this chapter include face detection, OpenCV, existing systems and the research gap. It also briefly discusses the proposed system.

2.1 Face detection

Reference (Rajesh, HimaBindu, & RahithiVarma) defines face detection as “the process of identifying and locating all the present faces in a single image or video regardless of their position, scale, orientation, age and expression”. The face in this proposal is the front area of the head where there is a nose, mouth, eye and iris. It may include the fore head also.

To detect a face, haarcascades (github, 2022) will be used. Haarcascades extract features and draw shapes on the area where the feature is detected. This will help the researcher to set dimensions of the photo to be taken that includes the face.

2.2 Open Computer Vision (OpenCV)

OpenCV, launched early 2000 (O'Reilly Media,, 2024) (wikipedia, 2012), is an open-source computer vision and machine learning software library (opencv, 2024). It contains thousands of functions and functions that can be leveraged to work with the images. For example, it can be imported as cv2 in python 3, and then, a camera on the computer can be loaded using one of its functions called *Video Capture*.

The choice for OpenCV library is because its ability of some of its functions to imitate the human behavior (Gaudenz , 2024). It also includes many other functions that help in image processing and it works with real time applications.

2.3 Existing systems.

There are quite a number of attendance systems in place as reference (Sloneek.com, n.d.) explain. Attendance tracking systems can be implemented through various methods, including paper-based systems, time clocks, spreadsheets, or dedicated time and attendance software.

The following are some of the existing systems (Sloneek.com, n.d.) (RACHEL, 2022);

Paper-based Systems

Paper-based systems involve manually recording employee work hours on timesheets or attendance registers. This method requires employees to write down their clock-in and clock-out times, which are then entered into a payroll system for wage calculation. While paper-based systems are simple and low-cost, they are prone to errors, difficult to manage, and time-consuming for payroll processing. In addition, a staff can help sign for another staff that is absent and there will be no evidence that someone else signed for them.

Time Clocks

Time clocks are physical devices that employees use to punch in and out of work. These devices can be traditional punch clocks or modern biometric time clocks that use fingerprint or facial recognition for identification. Time clocks provide a convenient and accurate way to track employee attendance, reducing the risk of time theft and fraud. However, they require upfront investment and ongoing maintenance.

There is no evidence that the system records images when the employee punches in their card, and someone else may use the card. The fact that face recognition depends on probabilistic prediction, someone may have similar facial features and they are authenticated. In addition, this kind of system maybe expensive for the hospital yet the biometric time clock can be eliminated since the hospital wants to track absenteeism from work.

Spreadsheets

Spreadsheets offer a digital alternative to paper-based systems, allowing businesses to create customized timekeeping templates. Employees enter their clock-in and clock-out times into the spreadsheet, which can be configured with formulas for automatic wage calculations. While spreadsheets provide more flexibility and accuracy than paper-based systems, they still require manual data entry and can be prone to errors.

Time and Attendance Software

Time and attendance software is a comprehensive solution for tracking employee time and managing attendance data. These software systems offer a range of features, including time clock integration, absence management, employee self-service portals, reporting and analytics tools, and seamless integration with payroll systems. Time and attendance software eliminates

manual data entry, streamlines payroll processing, and provides real-time visibility into employee attendance records.

To conclude the existing systems, it is the biometric time clocks that use biometrics to record attendance that may not be manipulated by the employees. But on the side of the business owners, they require extra input to buy time clocks for each employee which is not feasible because anytime the employee may leave or lose the card and there will be need for replacement of that card. This reduces their profits and the hospital management may fail because of heavy expenditures.

The researcher recommended that the existing systems can include saving the images of faces of employees who will report to work, since the feature is not included.

2.4 Research gap

Considering the existing systems, one is most relevant, and that is, biometric time clock. Depending the biometric used, either finger print or facial recognition, there is no image recording that is done. Also, a face can be recognized from a still photo which the system can't detect and the system records attendance of the person.

It remains evident that recording and saving the photo becomes cost effective since a camera and software are need as opposed to time clock system that requires physical device to read the physical cards of the employees.

2.5 Proposed system

The proposed system will take and record the photo of the employee who has reported to work so that there is digital evidence that the exact person reported.

2.6 The developed system.

The developed system takes and records the photo of the employee who has reported to work so there is digital evidence that the exact person reported.

CHAPTER TREE

METHODOLOGY

3.0 Introduction

This chapter presents different methods that were used to achieve the main goal of the research. Each objective had a method to achieve it. This chapter also explains the approach that was used in the research.

In this chapter, the researcher seeks to discuss research approach and how specific objectives were achieved. Under the section of achieving specific objectives, the researcher answered research questions which triggered more details to the researcher about research topic and guided them to achieve specific objectives.

3.1 Research approach.

The researcher used iterative development model, since it allows adding in additional user requirements after each review is made (GeeksforGeeks, 2023). It also allows development of the system in small and manageable portions which allowed the researcher to take advantage of what was learnt in the previous parts or versions of the system (Surya, 2015).

The choice of the model was geared by its advantages of being flexible, it allows stakeholder engagement and allows release of functional components at an early stage.

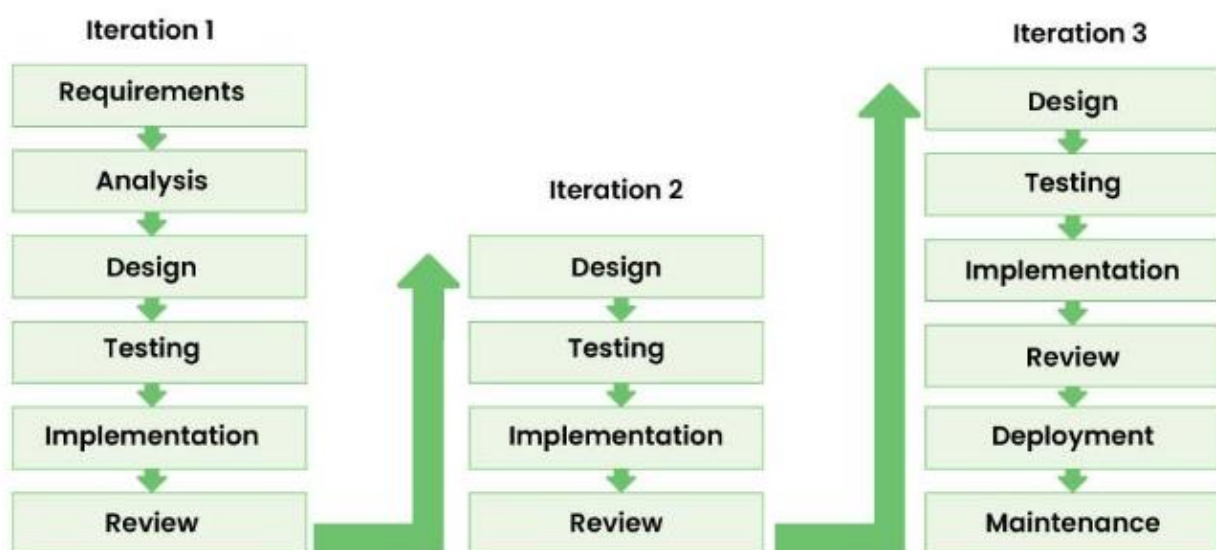


Figure 1: The iterative model

Image source: (GeeksforGeeks, 2023)

According to the figure above, the process of the model allows gathering requirements, analyse, design, test and implement. Importantly, the product is reviewed and changes made, which will be in the iteration 2. After system implementation in iteration 2, it is also reviewed before going to integration 3. The review stage may be continuous and until the system is accepted by the clients. The review stage confirms stakeholder involvement in the process of system development which is to the advantage of the researcher since, the final output will be the required one by the clients.

3.2 Achieving the specific objectives.

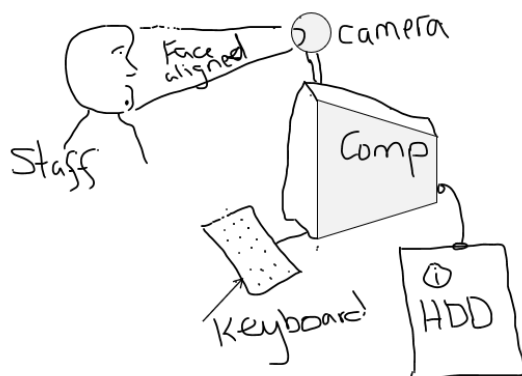
This section explains how specific objectives were achieved on independent or dependent on each other.

3.2.1 Requirements gathering

The researcher observed the process of registration when employees arrived at work and found out that, some staff were registering for others that were absent. The solution to this was getting evidence to show that the person who signed in actually attended, and that was by capturing the face of the person.

Since the system required capturing the face of the person, it was found out that a camera was needed to take the photo. Further, not any photo is taken to be the face of someone, it was required to detect the face of the person before the photo was taken. Therefore, a photo taken depends on whether the face is detected. All these requirements needed to be implemented using a computer.

Below is the sketch of how the system is presented in the mind of someone.



According to the image above, any staff that arrives to report to work, first, they have to go login in, so that their face image can be captured. Staff must align their face to the camera so that it is detected, a photo taken automatically and saved to the folder which is on the hard disk, HDD. The computer, comp, acts as the display for the staff to interact with the system. It is the device where commands are displayed for the staff to take the next step as instructed by the system.

The keyboard is used to login in to the system before a face is captured from the user. Only staff in the database are allowed to login.

3.3 Designing the system

System design is the process of defining elements of the system, such as modules and how they interact with each other. This answered the question of how the system was designed.

Using the documentation produced after the analysis stage, the researcher designed the system. It was in this stage that each and every requirement found applicability before real implementation of the system. Since the iterative model was be used and supports small portions of the system, the researcher broke down the system in modules, so that it was easy to work on the final output of the system.

Having a clear system design eased the work of the researcher when it came to implementation of the system, since, the requirements were engineered and knew how each of them was to interact with other.

3.4 Implementing the system.

How the system was to be implemented? After the system design was complete, the researcher implemented the system using python programming language. Python programming language has a nice graphical user interface library called *tkinter* which the researcher imported and used. The graphical user interface makes it very easy for the staff at HICH navigating the system.

3.5 Test and validate the system.

How was the system tested and validated? System testing was as important in the development as it confirmed that the system was working well. For that matter, the researcher presented the system to the stakeholders who either agreed that the system met all requirements or it did not. The researcher improved the system by including the requirements which the stakeholders requested and presented it to the stakeholders again for another review. This was done until the stakeholders agreed that all system requirements were included and that the system did what was expected.

CHAPTER FOUR

Presentation of results/implementation

4.0 Introduction

In this chapter, the researcher describes how results are presented and interpreted and understand how the system works.

4.1 System description

Face-capture based attendance system is a system that takes photos of the surrounding only and only when a face is detected. In addition, like described in earlier chapters, for a face to be captured, the user/employee first logs in and upon login success, a photo is captured if their face is detected. If the login is incorrect, the system pops up the message on the screen to inform you to try again with correct credentials.

If the user is not in the database, the system will not allow the user login. Only employees of HICH are allowed to login.

4.2 System requirements

4.2.1 Hardware specification

Among the hardware required for this system is a computer with a webcam.

For best performance, a computer should have the following specifications;

1. First, the computer must have an inbuilt webcam to take the photos.
2. At least 8 GB of random-access memory. This is because computer vision library needs a computer with high computing power to speed up the process.
3. 500 GB of hard-disk. This may not be an issue if it is less, but it should be enough to store face images captured by the system.

4.2.2 Software specification

Among software required for this system includes;

1. Programming language such as Python 3.11.3
2. A face detection library such as opencv 4.9
3. A face recognition library such as Face_recognition
4. A database management system such as MySQL 0.0.3
5. PIL 9.4.0: PIL, which stands for Python Imaging Library, is a powerful library in Python used for opening, manipulating, and saving many different image file formats.

4.3 Requirement specification

4.3.1 Functional requirements

These requirements are key and so much necessary. The system should have and must be working perfectly. Among the functional requirements include

Face detection to detect the face of the person. This was achieved. The system is able to extract face features of the employee.

Saving the photo of the employee who will have signed in for work.

An admin is able to search for photos taken on a specific date to confirm the employees that attended work.

4.3.2 Non-functional requirements

These are requirements without which, the system is still able to meet the main objective. Such requirements. For example, how system interface looks like. Among the nonfunctional requirements include;

System interface. This helps the user interact with the system components with ease.

Below is the system interface for the user to login

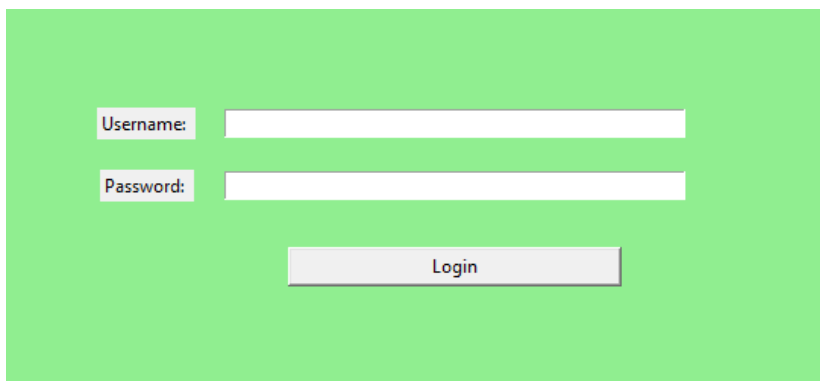
A screenshot of a login interface on a green background. It features two white input fields: the top one is labeled 'Username:' and the bottom one is labeled 'Password:'. Below these fields is a grey button with the text 'Login' centered on it.

Figure 3: login interface

If the user provides wrong credentials, the system displays a message as seen in the following screen shot.

A screenshot of the login interface showing an error message. The message is in red text and reads: 'You supplied a wrong username or password! Please check and try again'. Below the message are the same 'Username:' and 'Password:' input fields as in Figure 3. The 'Username' field contains the text 'admin' and the 'Password' field contains '*****'. The 'Login' button is still present below the fields.

Figure4: wrong username or password

If the login is successful, the system takes a photo of the user first, and if the user role is “admin”, and admin interface is displayed where they are able to add, delete or view employees that will have attended work.

Admin interface is shown below.

Admin is able to add an employee to the database to clicking the add employee button to get the interface below;

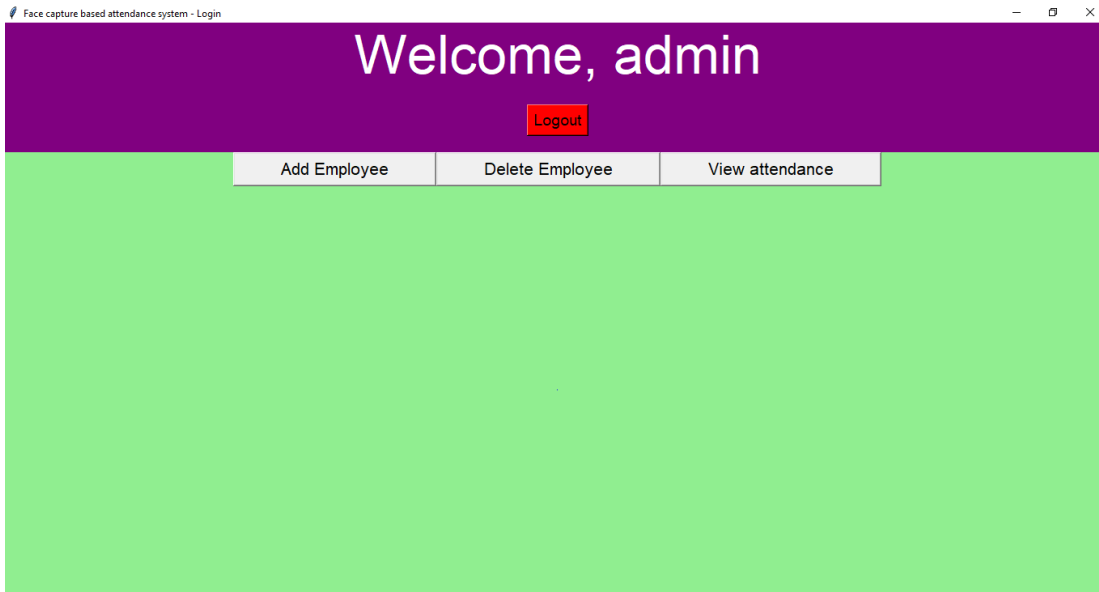


Figure 2: Adding an employee

After the admin registers the employee, the save button is clicked to add the employee to the database.

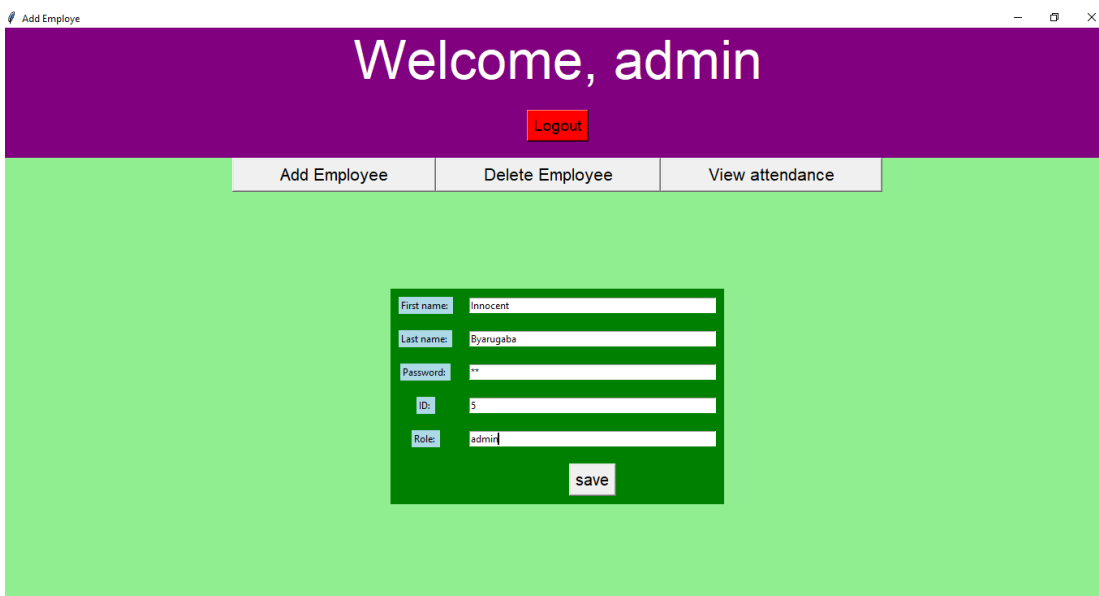


Figure 3: information in field of adding an employee

```

C:\Windows\System32\cmd.exe - python interfaceFinal.py
There was a problem connecting to the database!
Error: 1049 (42000): Unknown database 'facecapture'
Connection to the server established...
Database created successfully!
Table successfully created!
Table empinfo read =====
{'0': {'lastname': 'admin', 'password': 'admin', 'role': 'admin'}}
jsonfile created successfully
Exception in Tkinter callback
Traceback (most recent call last):
  File "C:\Users\INNOCENT\AppData\Local\Programs\Python\Python311\Lib\tkinter\__init__.py", line 1948, in __call__
    return self.func(*args)
    ^^^^^^^^^^^^^^^^^^^^^
  File "D:\Facecapture\interfaceFinal.py", line 385, in <lambda>
    command=lambda : login(usernameEntry.get().strip(), passwordEntry.get())
    ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "D:\Facecapture\interfaceFinal.py", line 322, in login
    loginError.config(text=" ", font=("Arial, 10"), fg="grey")
  File "C:\Users\INNOCENT\AppData\Local\Programs\Python\Python311\Lib\tkinter\__init__.py", line 1702, in configure
    return self._configure('configure', cnf, kw)
    ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "C:\Users\INNOCENT\AppData\Local\Programs\Python\Python311\Lib\tkinter\__init__.py", line 1692, in _configure
    self.tk.call(_flatten((self._w, cmd)) + self._options(cnf))
_tkinter.TclError: invalid command name ".!frame.!label3"
Server connection successful!
1007 (HY000): Can't create database 'facecapture'; database exists
1050 (42501): Table 'empinfo' already exists
Database changed successfully.
Record successfully added to the database.

```

Figure 4: record saved, CLI

The screen shot above indicated that the record was saved successfully.

When the research manually checks the database, they will find the record in the database as seen below

```

Current database: facecapture

+-----+-----+-----+-----+
| FirstName | LastName | Password | Contact | Role |
+-----+-----+-----+-----+
| Innocent | Byarugaba | 123      | 199    | admin |
+-----+-----+-----+-----+
1 row in set (0.05 sec)

MariaDB [facecapture]>

```

Figure 5: Employee added to database

An admin is also able to delete an employee if they are no longer part of the hospital by providing only the ID of the employee as seen in the screen shot below.



Figure 6: Employee deleted from database

Upon clicking delete button, the record will be removed from the database and a message displayed on the command line interface for the admin to confirm action.

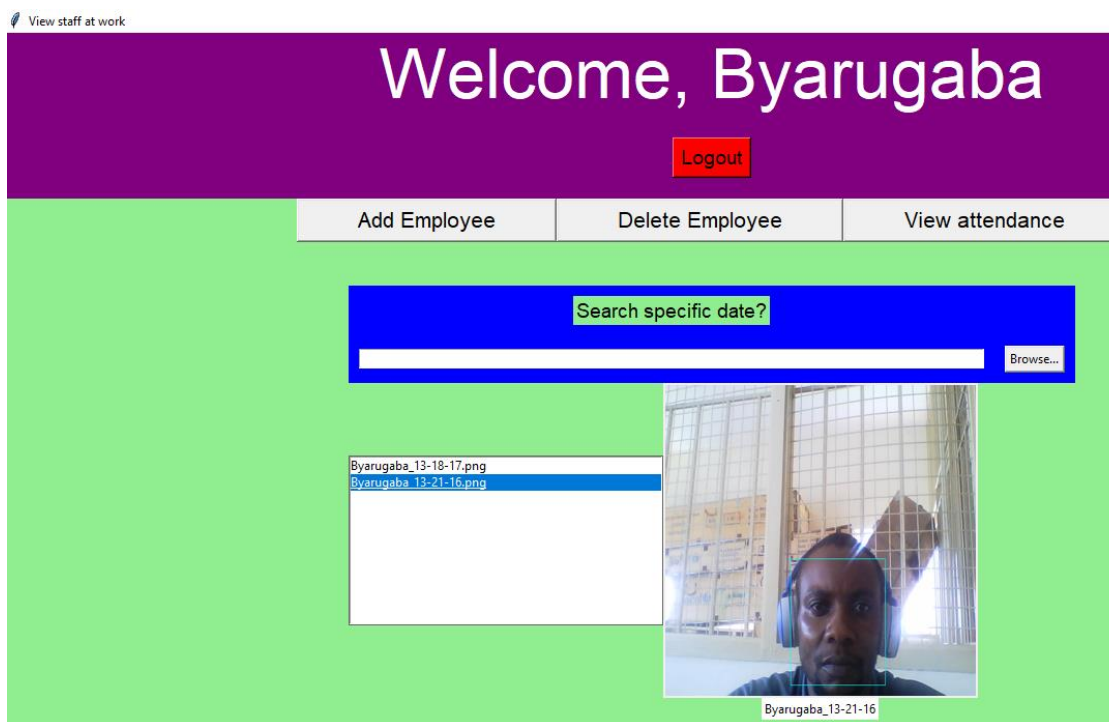


Figure 7: Employee attended

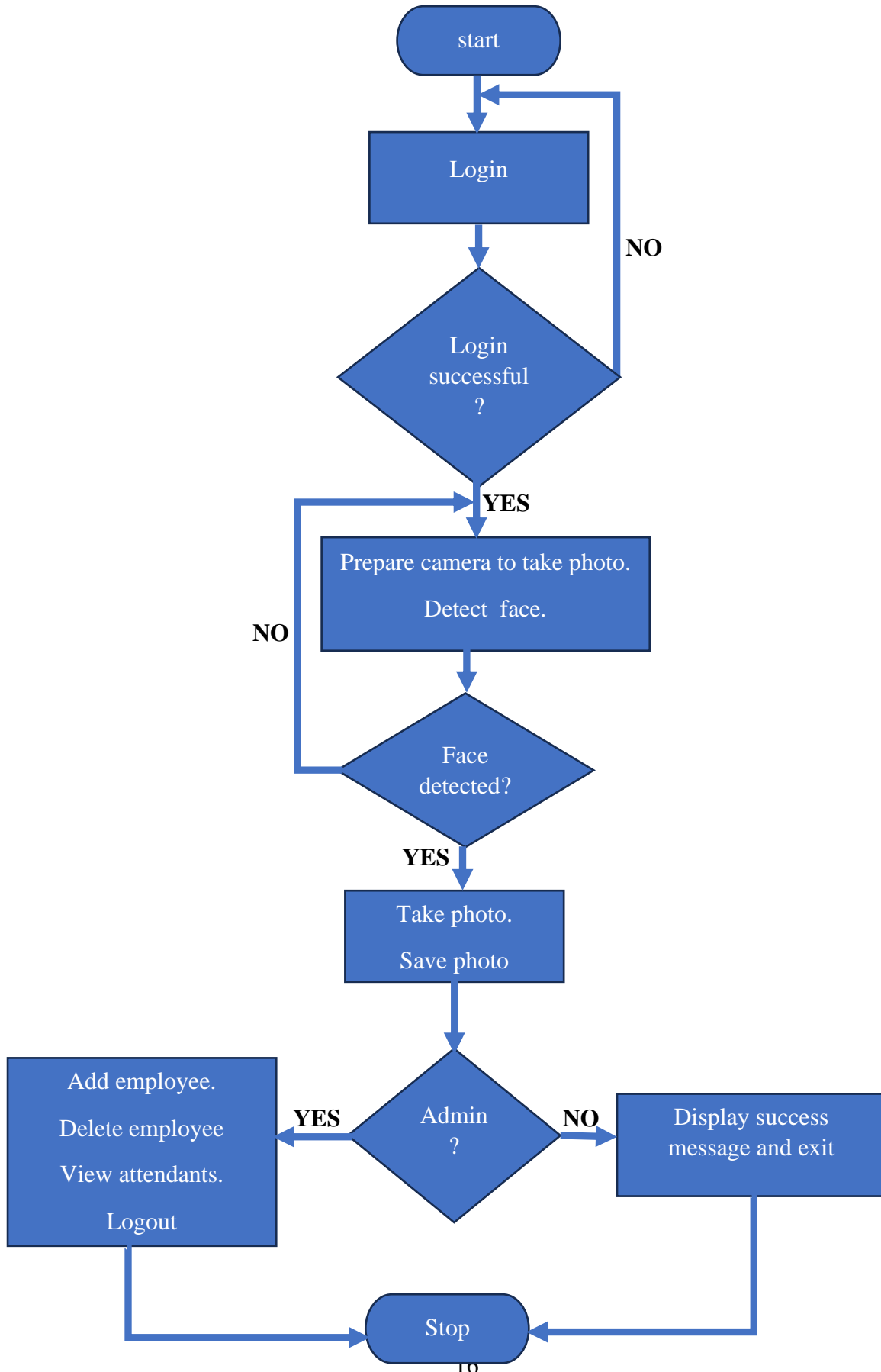
Here Admin is able view Employees' attendance, date, and time.

1. The system is also able to create folders for *faceimages* and *jsonfile* to save photos and the file that stores the names of employees that are in the database in the working directory.

The system also updates some messages to display to the users when their logins are successful.

System flow chart

Below is the system flow chart for the system.



CHAPTER FIVE

Conclusion and recommendation

5.0 Introduction

This chapter talks gives a general recommendation for future researchers and those whose interests are towards achieving more in the computing world. It is important to note that this research project was achieved and they system performs as expected.

5.1 Challenges faced during system development

Like any other project, success comes with challenges. Among the challenges faced by the researcher include but not limited to

Time. The time required to develop the system was not enough and it required heavy extensions for the researcher to accomplish all their tasks. A lot of fatigue and pressure were experienced during system development. This is mainly as a result of multi-tasking between class work and project which requires a lot effort.

Accuracy of haarcascades is not to the standard especially in poor lighting conditions.

The researcher also had a challenge of finance especially at a point when network connection was a must outside the university premises.

Sometimes running the system is unresponsive because of heavy computation brought about by OpenCV library, when loading the camera.

5.2 Recommendations

In response to the challenge of time, it is understandable that time will never be enough but I would recommend for more time to be extended for researchers to complete their projects.

For future researchers, there is need to improve on the accuracy of haarcascades that come with OpenCV, or come up with an alternative since there are some false positives generated by the system. A key reminder is that the system captures a photo if and only if a face is detected. However, there are some scenarios where the system may detect a non-face! This is called a false positive. This error is because of the accuracy of the pretrained haarcascades classifiers (outside the scope of this research project), that need more training for improved accuracy to avoid false positives.

Learners should always be given project management skills for proper planning.

Researchers are advised to purchase high computing power computers to avoid the unresponsiveness of the computer.

5.3 Future researchers

The field of face recognition is a hot cake in this era, and future researchers may look at implementing similar systems with face recognition as key. Technology advances rapidly and there is need to move with such updates.

Any researcher that wishes to modify this piece of work can look at face recognition in line with deep learning and machine learning techniques.

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