UNIVERSITY of RWANDA

MUSANZE CAMPUS

COLLEGE OF SCIENCE AND TECHNOLOGY

SCHOOL OF ICT

DEPARTMENT OF COMPUTER SCIENCE

PROJECT REPORT:

CRIMINAL INVESTIGATION USING FACE RECOGNITION BASED ON DEEP LEARNING ALGORITHMS

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Under supervision of:

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Submitted in partial fulfillment of the requirements for the award of

BACHELOR OF SCIENCE DEGREE IN INFORMATION SECURITY.

November 2022

CERTIFICATION

This is to certify that the Project Work entitled, **"CRIMINAL INVESTIGATION USING FACE RECOGNITION BASE ON DEEP LEARNING ALGORITHMS"** *is a record of the original bona fide work done by* **Mr. *MUROKOZI Jackson Reg. No 219006818*, Mr. *BYIRINGIRO Bertin Reg. No* 21900535, Mrs. *KASINE Peninah Reg. No* 219003832** *in partial fulfillment of the requirement for the award of Bachelor Degree in Computer science with an option of information security in University of Rwanda, college of science and technology during the Academic Year 2021-2022.*

Supervisor **Mr. BIZIMUNGU Theogene**

Signature: Date: --/--/2022

Head of Department of Computer Science Dr. Alfred UWITONZE

Signature……Date: ……. /……./……..

DECLARATION

We do hereby declare that the project work " **CRIMINAL INVESTIGATION USING FACE RECOGNITION BASE ON DEEP LEARNING ALGORITHMS** " submitted in partial fulfillment of the requirements for the bachelor degree in computer science with options information security conducted under the guidance of **Mr. BIZIMUNGU Theogene**, is the record of our own work and has never been presented or submitted for any academic award in any University or Institution as a whole or in part.

Declared By

MUROKOZI Jackson …….....

BYIRINGIRO Bertin .....

KASINE Peninah …….....

University of Rwanda -CST

Date…… /……../…….. And Signature……

DEDICATION

We dedicate this work to:

- The Almighty God,
- Our families,
- Our friends and colleagues,
- Rwanda National Police,
- University of Rwanda,
- Our Lecturers,
- Our supervisor

ABSTRACT

We are all aware that our face is a distinct and important feature of the human body structure that defines a person. With this advantage, we developed a system which use that uniqueness to determine the identity of a criminal. With the advent of technology, the system will use the installed CCTV in numerous public areas to catch criminals. The criminal face recognition system will be created using previously collected faces and criminal photos accessible at the RIB (Rwanda Investigation Bureau). In this paper, we present an android application for criminal investigation using face recognition based on deep learning algorithms to be used by the Investigation Bureau in order to improve and upgrade criminal differentiation in a more effective and efficient manner.

By using the advanced technology, this system will improve the present system while taking criminal detection to a whole new level by automating scanning of human faces to identify criminals. Face recognition technology was used, and the CCTV cameras continuously captures photos and analyze them to detect human faces from the live video. The collected photographs of the person entering that location is compared to the criminal data in our database. If the person's face capture by CCTV cameras matches, the system will display their image on the admin's screen and display a message with their name indicating that the criminal has been located and is present in that specific location. And the system will alert the admins of RIB and also notify the police agents with access to catch the identified criminal.

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LIST OF ABBREVIATIONS

AES:	Advanced Encryption System
AI:	Artificial Intelligence
AIS:	Automatic Identification System
CCTV:	Closed-Circuit Television
CNN:	Convolutional Neural Network
CV:	Computer Vision
IDE:	Integrated Development Environment
JDK:	Java Development Kit
MD5:	Message-Digest algorithm 5
MIS:	Manual Identification System
ML:	Machine Learning
NPC:	National Police College
Open-CV:	Open-Source Computer Vision Library
OS:	Operating System
RIB:	Rwanda Investigation Bureau
RNP:	Rwanda National Police
SDK:	Software Development Kit
SQL:	Structured Query Language

CHAP I: GENERAL INTRODUCTION

1.1 Introduction

Criminal identification is the most vital work for the investigation bureau who are looking for criminals, but it is also the most difficult and time-consuming task since they must locate it everywhere. It is more challenging in densely populated cities or public locations. In certain circumstances, manual identification allows for the gathering of additional information about criminals.

Criminal identification can no longer be a challenge because of existing of advanced technologies in computer vision and images processing where machine learning and artificial intelligence are used with different computer vision algorithms to detect, recognize and identify objects and human faces from a picture or video. As a solution, this research presents an automated criminal identification method based on identifying criminals' faces.

This will help the investigation bureau in identifying and apprehending offenders in public locations [1]. Criminal identification can be accomplished in two methods, as seen in Figure 1.1 Identification in the Manual Identification System (MIS) is done by the investigation bureau officers searching them in public locations. It takes a long time to offer sufficient attention, and it also carries the risk of missing criminals because they would be alerted by seeing officers and quickly escape from there. Because the MIS is taking extra time, we will not be able to adequately focus on everyone. When it comes to an automatic identification system (AIS), however, there is no requirement for public surveillance. All of the processes in this system are automated.

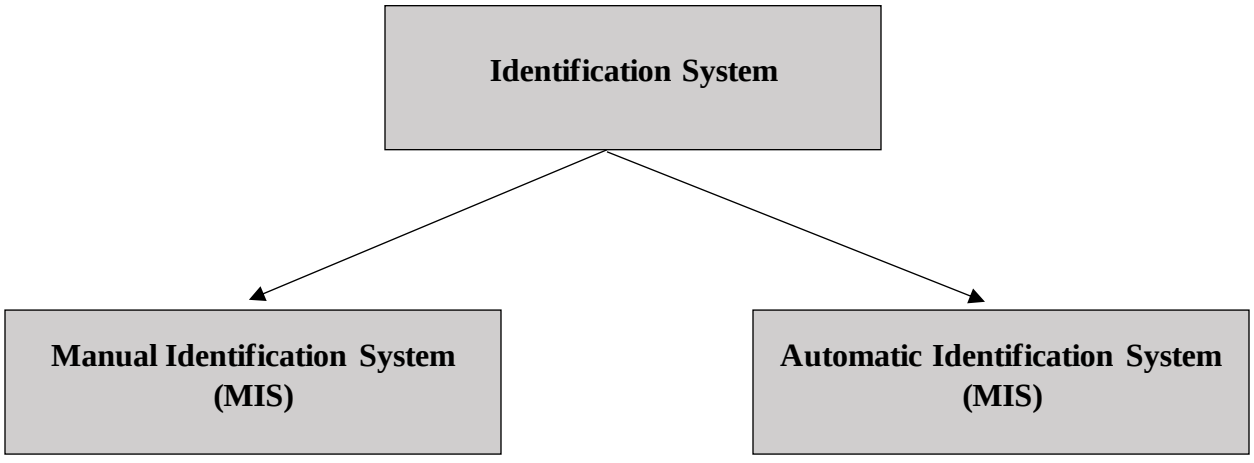


***Figure 1.1**: Types of Identification system*

1.2 Problem Statement

It is still a difficult and challenging for the investigation bureau to track and find people who have committed sins or people who are suspect of a certain crime. There is a burden in using manual or analog ways of posting pictures of criminals on different platforms, social media or in public waiting for someone to recognize and identify a criminal and call the investigators to come to catch the identified criminal. The processing of the current used strategy is very slow, budget and time consuming. As bad results, it takes too long to track and find the criminals which sometimes give a chance to those criminals to commit crimes again resulting to loss of life and properties. The investigation bureau also spends a lot of money during the process which can end up in a loss. On the other hand, criminals can hide or change their identifications and they can no longer be identified easily. These are caused by not using advance technology to support the investigation and criminals' identification such as using Computer Vision, AI (Artificial Intelligence), and Machine Learning.

1.3 Objective of the Study

1.3.1 General Objectives

The general objectives of our project are to develop an advanced system which identify criminals using face recognition technologies provided by computer vision and enhanced by deep learning algorithms. The system capture and analyses images extracted from different real-time surveillance camera and are handled by image processing, and then compared with the images stored in the database. If images match, the alert will be sent to the administration of the system and to the nearest police station so that the identified criminal gets caught.

1.3.2 Specific objectives

The specific objectives of our project are to:

- Develop a system which can help to identify criminals to support the investigation bureau.

- Develop a system which is accurate and fast to be used in criminals' identification.
- Develop a system which uses computer vision technology to identify criminals.
- Develop a system which can automatically adopt to change in behaviours of the environment by using Artificial Intelligence (AI) and Machine Learning (ML).

1.4 General Interests

The interests of our project are:

- Developing a system which can be used by RIB (Rwanda Investigation Bureau)
- Using advanced technologies in criminal identification system.
- Applying knowledge, we covered in information security to give our hands in the existing challenge of identifying criminals in a secured, safe and fast way.
- Extending the application of computer vision technology by implementing it in our developed android based secured criminals' identification system.

1.5 Scope and Limitations of the System

The developed system has some scope and limitation. The area in which our research is based in Rwanda. And our case study focused on conducting a research based on Rwanda Investigation Bureau. We shall investigate the current strategy done by RIB and RNP to track and identify criminals who are suspect of a crime or criminals who have committed illegal activities in a way of improving the current used system.

The function of the developed system is to recognize and identify criminals based on recognizing their faces. The system uses a real-time camera which capture video and the system process it into continuous pictures and the by using computer vision algorithms as Open CV and Convolution Neural Network, the captured pictures are processed and compared with those stored in the database.

In the development of our system, we have used the camera of android devices as CCTV camera in our demonstration and working principle of our system.

1.6 Technologies

To achieve the desired output of the system, it is developed using different technologies, different programming languages, algorithms and security.

Proposed programming languages to use are:

- Python
- Java
- JavaScript
- XML
- HTML
- CSS

Database and query scripts used:

- MySQL
- Firebase

Computer vision algorithms used:

- Open CV
- CNN (Convolutional Neural Network)

The system security measures taken to enforce security on our system by protecting data sent within the system:

- The administration dashboard is secured so that only users with admin privileges can access it through the website dashboard.
- In case a criminal is detected, the system alerts automatically the system admins and the nearest police stations and the policemen so that they can catch the identified criminal.
- The passwords are encrypted using MD5 hashing
- They system uses computer vision technology to detect and identify human face
- The system easily adapts to environment changes with the help of Artificial Intelligence and Machine Learning

1.7 Organization of the report

This document is composed of 5 chapters classified as follows:

Chapter 1, this chapter provides an overview of the entire project where it contains the general introduction, background, statement of the problem, choice and motivation of the study, general objective, specific objectives, scope of the study.

Chapter 2, this chapter focuses on describing the current system environment mentioning the and analyzing how it works and the problems related to it.

Chapter 3, this chapter describes the methodology used by the researcher to achieve the stated objectives and techniques used to collect data. It helped us the researcher by proving real data from documents and people's experience provided guidance to the system solution.

Chapter 4, this chapter presents proposed implementation of the system by explaining how it works, expected results and different diagrams.

Chapter 5, this chapter provide conclusion basing on the conducted research and the outcomes and recommendations to different parties that could be interested in or get advantages from the system.

1.8 Project Gantt Chart

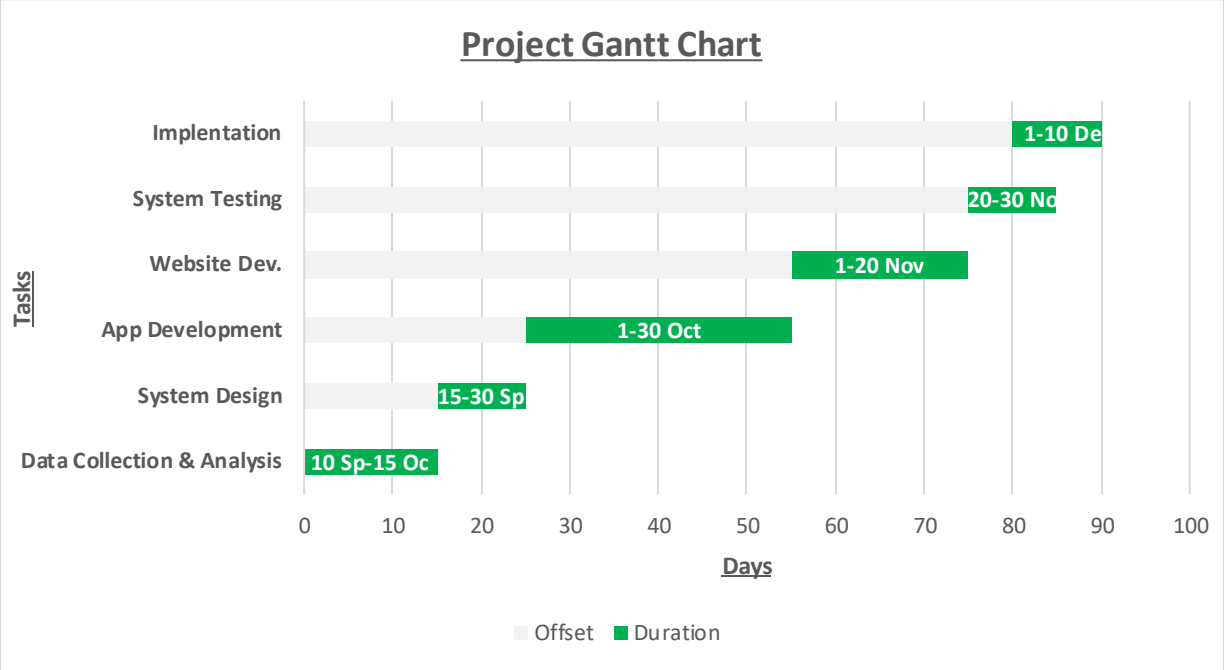


Figure 2: *Gantt chart*

CHAP II: LITERATURE REVIEW

2.1 Definition of Terminologies

2.1.1 Criminal

What qualifies someone as a criminal? A criminal is a common phrase for someone who has committed a crime or has been legally convicted of committing a crime. Criminal also refers to being involved in a crime. Criminal activities or individuals are those who are involved in or connected to a crime. [2]

2.1.2 Face Recognition

A facial recognition system is a technology that can match a human face from a digital image or video frame against a database of faces. It is often used to verify users via ID verification services and works by locating and measuring facial characteristics from a given image. [3]

2.1.3 Open-CV

Open-CV is an acronym for Open-Source Computer Vision Library. The library comprises over 2500 optimized algorithms, including a complete range of both traditional and cutting-edge computer vision and machine learning approaches. It also provides C++, PYTHON, JAVA, and MATLAB interfaces that work with Windows, Linux, Android, and Mac-OS. Open-CV is free to use for both business and non-commercial purposes. Open-CV is used to capture photos and videos in public places. [4]

2.1.4 Convolution Neural Network

CNN is a powerful algorithm for image processing. Their algorithms are currently the best existing algorithms for the automated processing of images. They are being used in different place to do things like identifying the objects in an image.

2.2 Existing System

Normally the current system in Rwanda, we have RIB (Rwanda Investigation Bureau) which is the agency responsible to tracking and finding criminals who have committed illegal activities and it can assign tasks to RNP (Rwanda National Police). The way criminals' identification is

performed, is that RIB posts the picture of criminals on the platforms, social media and also, they put different publication in the news, and post banners of their faces in different places so that when someone recognize a criminal basing on the posted photo, he/she can call the investigation bureau. In this case, there can be no accuracy because it is hard to remember someone you saw in a picture, memorize him/her and be able to match the identification with someone you saw in the public. Also, the identification can take to long to find the criminals. [5]

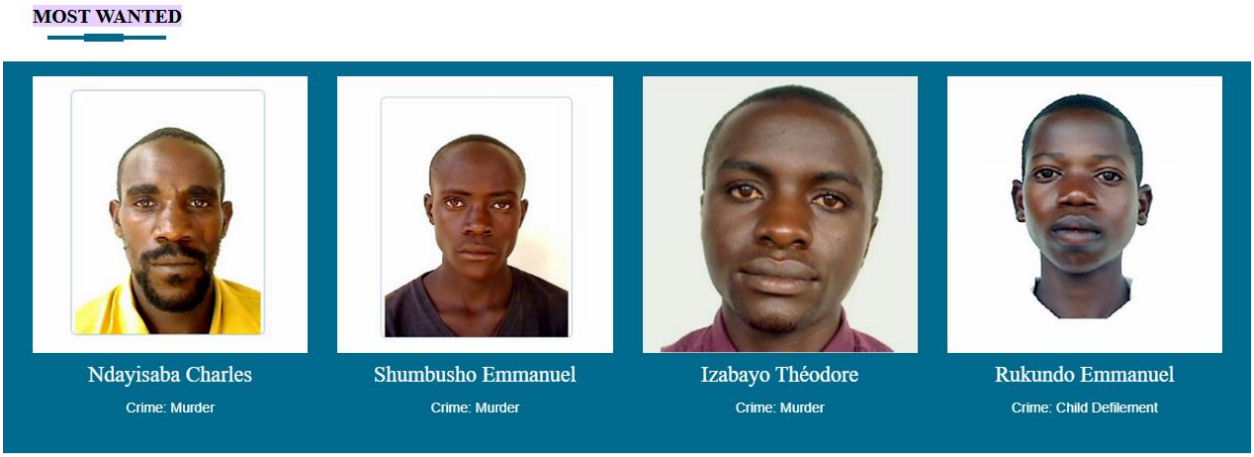


***Figure 3**: Existing System*

2.3 Proposed System

In this paper, we use CCTV cameras that are always recording in a public setting. During the system's implementation, we will save criminal photos data with their names on photographs in the database. We will process those photos and extracting features from them, and during feature extraction, and we will be grabbing the face encodings from the current images and storing them into a single file using Android device technology. Using open-CV while capturing CCTV footage and captured images face encodings are placed and compared with our saved face encodings of the criminal database if any match is found then automatically on screen it will display an image of that criminal whose face matches and display the message with his name that criminal found and give an alert to the concerned agency of investigation bureau and also notify the nearest policemen so that they can catch the identified criminal.

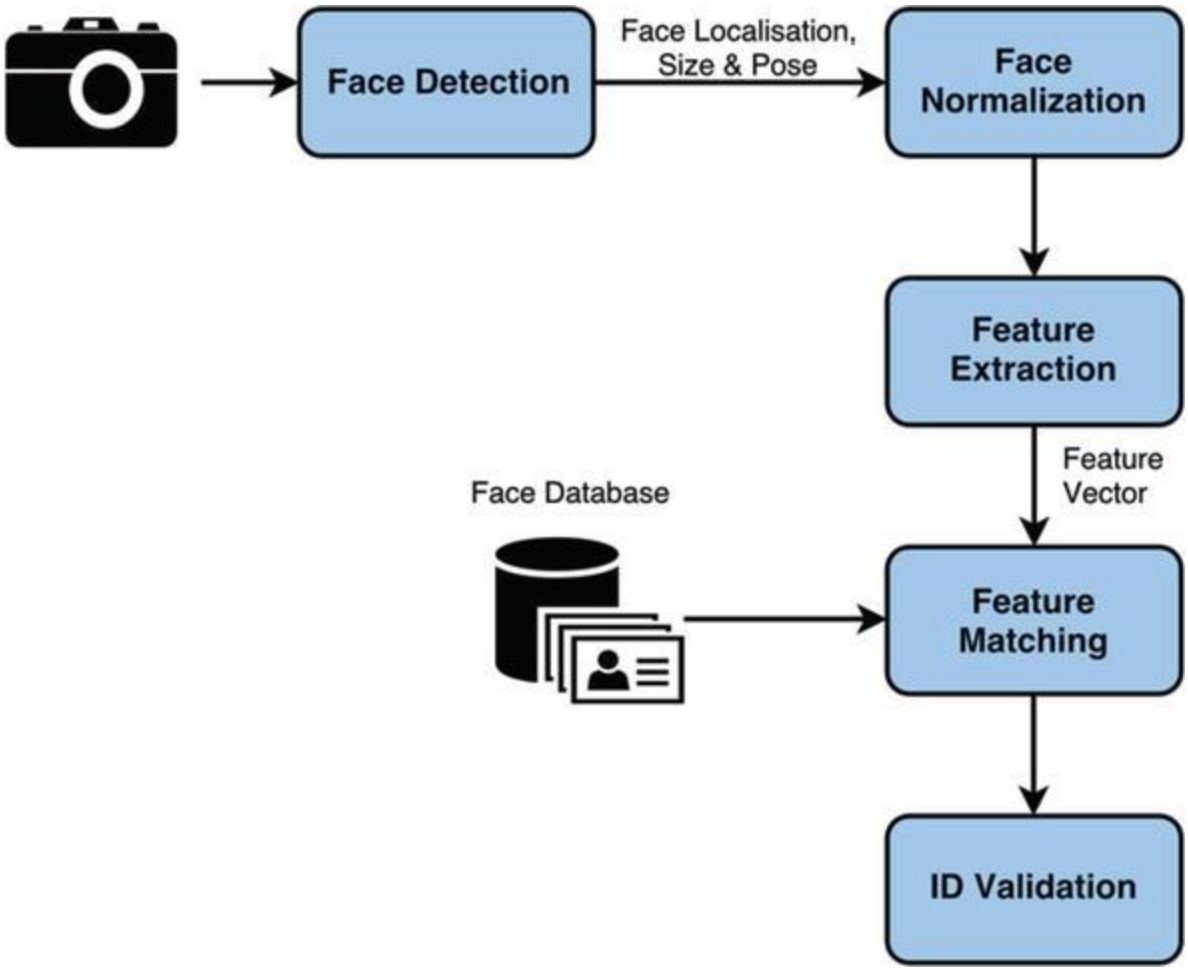


Figure 4: *Proposed System*

CHAP III: RESEARCH METHODOLOGY

3.1 Introduction

A research method is a specific process or method used to identify, select, process, and analyze information about a topic. Scientifically it must be forced to be analyzed and consider their causes, solutions, explanations and applications. Analysis in particular helps us to understand nature and natural phenomena. And we use "qualitative research".

This chapter describes the development side of “Criminal Investigation Using Face Recognition Based on Deep Learning Algorithms” it encloses a brief overview of the technologies used to make our system, tests have been applied. And also specify software compatibility requirements.

3.2 Methodological Approach

A methodology is a broad research approach that describes how the study will be carried out and, among other things, specifies the method to be employed. Methodology describes these approaches, which specify the means or method of data gathering or the way of obtaining a certain outcome. The methodology does not identify a specific methodology, but significant emphasis is placed on the type and type of process, or objective, to be followed in a certain procedure.

In our study we are expecting to use the following data collection methods:

1. Documentation

2. Sampling

3.2.1 Documentation method

Documentation, as you know, is the process of reading a library book and browsing the Internet. Information about them relevant to our topic or inquiry. To obtain a bibliographic search on a topic, use this procedure. Some researchers are interested in researching on a subject that shares some similarities with ours. The information gathered will assist us in developing your project.

3.2.2 Sampling method

Specifications for selecting the population to be included in the survey. As a general rule, use the sampling method. Sampling can be defined as the process of selecting a sample from a particular species or group of people for research purposes. Sampling is the process of dividing a population into a series of parts called sampling units. This sample deals with a population reference to our topic. For example, the scope we have covered is detecting criminals using face recognition.

3.3 Requirement Analysis

Software Development Life Cycle

The process that serves as the framework for software development is known as the SDLC, or software development lifecycle. The SDLC serves as a guide for project managers and business organizations as they complete each phase of the software development lifecycle. A phase is the name for each stage of the SDLC. The SDLC's initial step is the requirements collecting and analysis phase.

Waterfall model

The waterfall approach was the first SDLC model widely used in software development to ensure project success. The "waterfall" approach divides the entire software development process into individual phases. In this waterfall model, the result of one phase typically serves as the input for the next sequential phase.

The following figure shows the different phases of the waterfall model.

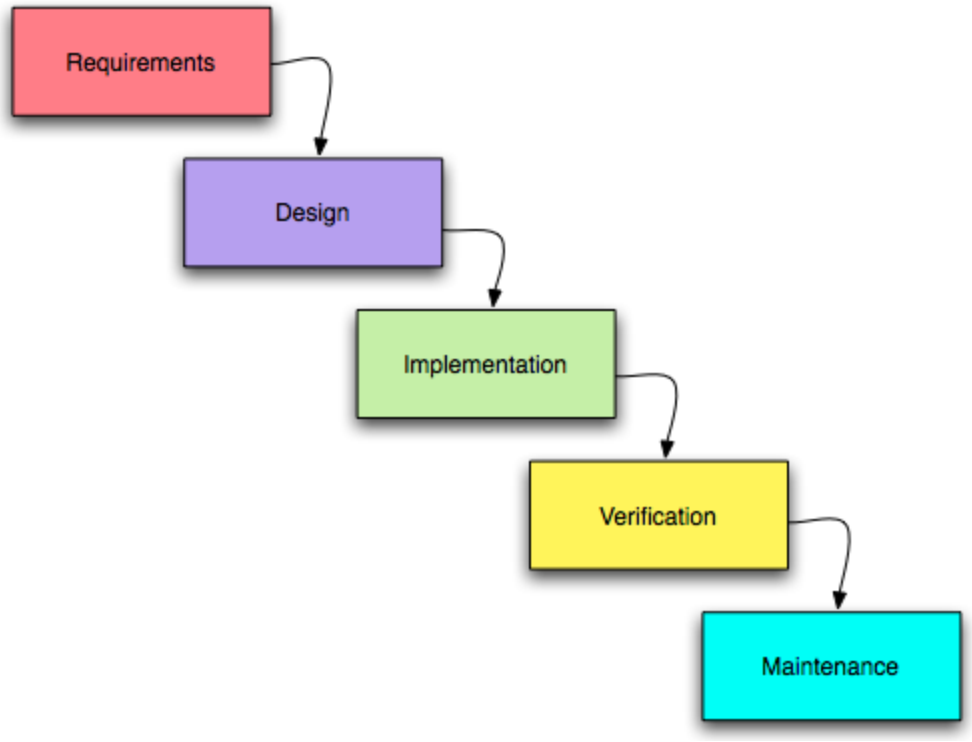


Figure 5: *Waterfall model*

The successive phases of the waterfall model are 7:

- ✓ **Requirements extraction and analysis**: In this phase, all possible requirements for the system to be developed are recorded and documented in the specifications.
- ✓ **System design**: In this phase, the specifications of the first phase are investigated and the system design is prepared. This system design helps specify hardware and system requirements and helps define the overall system architecture.
- ✓ **Implementation**: With input from the system design, the system is first developed in small programs, so-called units, and integrated in the next phase. Each unit is developed and tested for its functionality. This is called a unit test.
- ✓ **Integration and testing**: All units developed during the implementation phase will be integrated into the system after each unit has been tested. After integration, the entire system is tested for errors and failures.

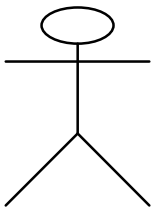
- ✓ **System offering**: As soon as functional and non-functional tests are completed. The product is used in your environment or put on the market.
- ✓ **Maintenance**: There are some issues with the client environment. Patches have been released to address these issues. Also, some better versions will be released to improve the product. Maintenance is performed to bring these changes to your environment.

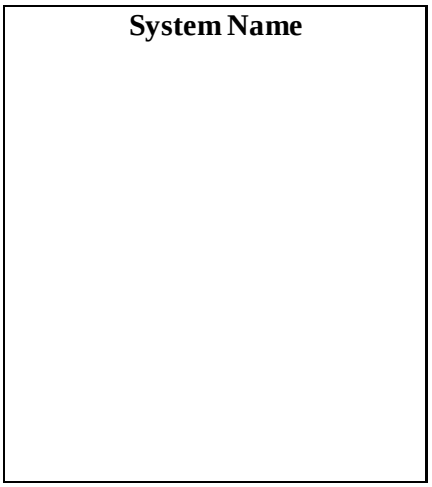
All of these phases are cascaded and progress is considered to be steadily flowing downwards (like a waterfall) through the phases. The next phase is named "Waterfall Model" because it only starts when the goals defined in the previous phase are achieved and approved. In this model, the phases do not overlap.

3.4 Class diagram

A class diagram in the Unified Modeling Language is a form of static structural diagram that illustrates a system's classes, their properties, operations, and relationships between objects in order to describe the system's structure.

3.4.1 Symbol Used for Class diagram

An actor: ➢ Is a person or system that derives benefit from and is external to the subject. ➢ Is depicted as either a stick figure (default) or, if a nonhuman actor is involved, a rectangle with "Actor" in it (alternative). ➢ Is labeled with its role. ➢ Can be associated with other actors using a specialization/super class association, denoted by an arrow with a	 Actor Name

hollow arrowhead. Is placed outside the subject boundary.	
A subject boundary: ➢ Includes the name of the subject inside or on top. ➢ Represents the scope of the subject, ○ e.g., a system or an individual business process.	

An include relationship: ➢ Represents the inclusion of the functionality of one-use case within another. ➢ It has an arrow drawn from the base Use Case to the used Use Case.	<<include>> 
An extend relationship: ➢ Represents the extension of the Use Case to include optional behavior. ➢ Has an arrow drawn from the extension Use Case to the base Use Case	<<extend>>
A generalization relationship: ➢ Represents a specialized Use Case to a more generalized one. ➢ Has an arrow drawn from the specialized Use Case to the base Use Case?	
An association relationship: ➢ Links an actor with the Use Case (s) with which it interacts.	

Table 1: *Use Case tools description*

Design of the diagram: Use Case

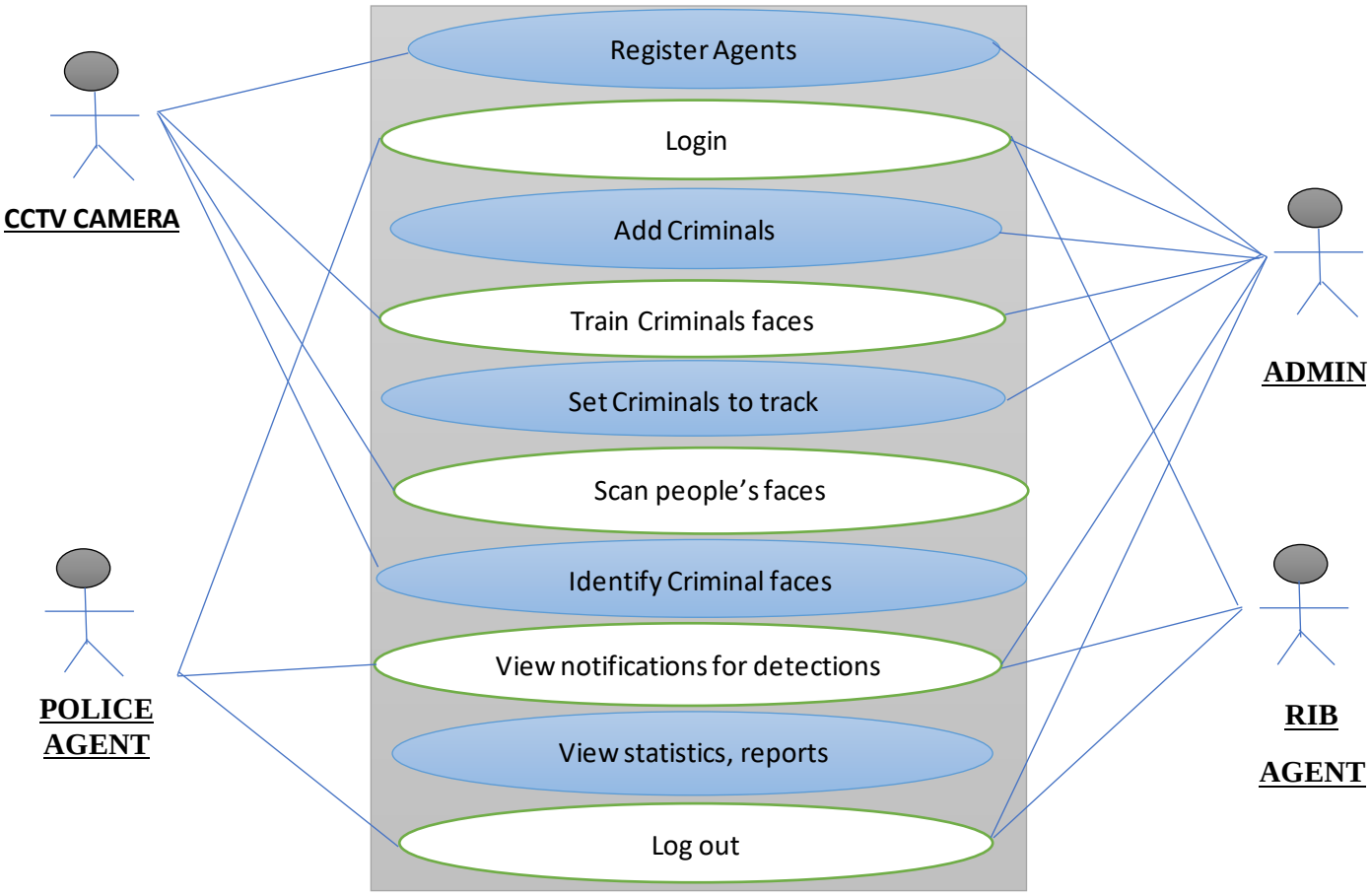


Figure 6: *Use Case diagram*

3.5 Sequence Diagram

The Sequence Diagram model is the collaboration of objects based on a time sequence. That shows how the objects interact with others in a particular scenario of a use case. With the advanced visual modeling capability, you can create complex sequence diagram without an obstacle.

This figure explains the sequence of user interaction with a system

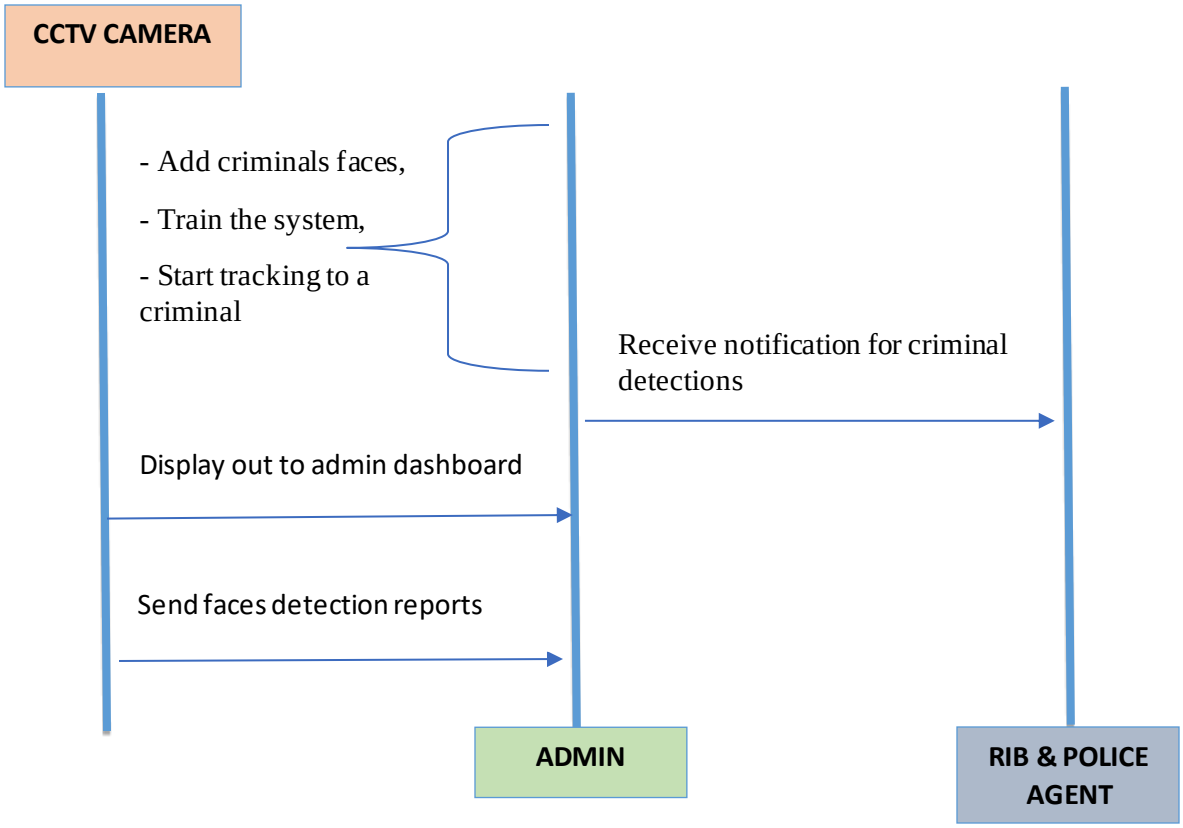


Figure 7: *Sequential diagram*

3.6 System Requirements

3.6.1 Hardware requirements

The system hardware required are:

- Computers such as laptops, desktop, android phones
- RAM with 4GB minimum
- Processor: Intel core or i3 of 2.9HZ minimum, etc
- Hard Disk with 500GB minimum

3.6.2 Software requirements and development tools

The software required are:

- Android studio

- Android SDK
- Open-CV library
- JDK
- WampServer or XAMPP, MySQL
- Text editor like VSCode
- Firebase
- System type 32 bit or 64bit
- Operating System (OS): Windows 8,8.1,10, and windows 11

CHAP 4: ANALYSING, DESIGN, AND IMPLEMENTATION OF THE PROJECT

4.1 Introduction

This chapter contains two main parts: the design and implementation of the criminal investigation using face recognition based on deep learning algorithms for RIB as the administrators and the CCTV application for scanning. This chapter explains and demonstrate the projects using screenshots and diagrams including user case diagrams, ER diagrams, and user interfaces.

4.2 Entity relationship diagram

This entity relationship diagram details the tables in the database, the entities, and a description of each table.

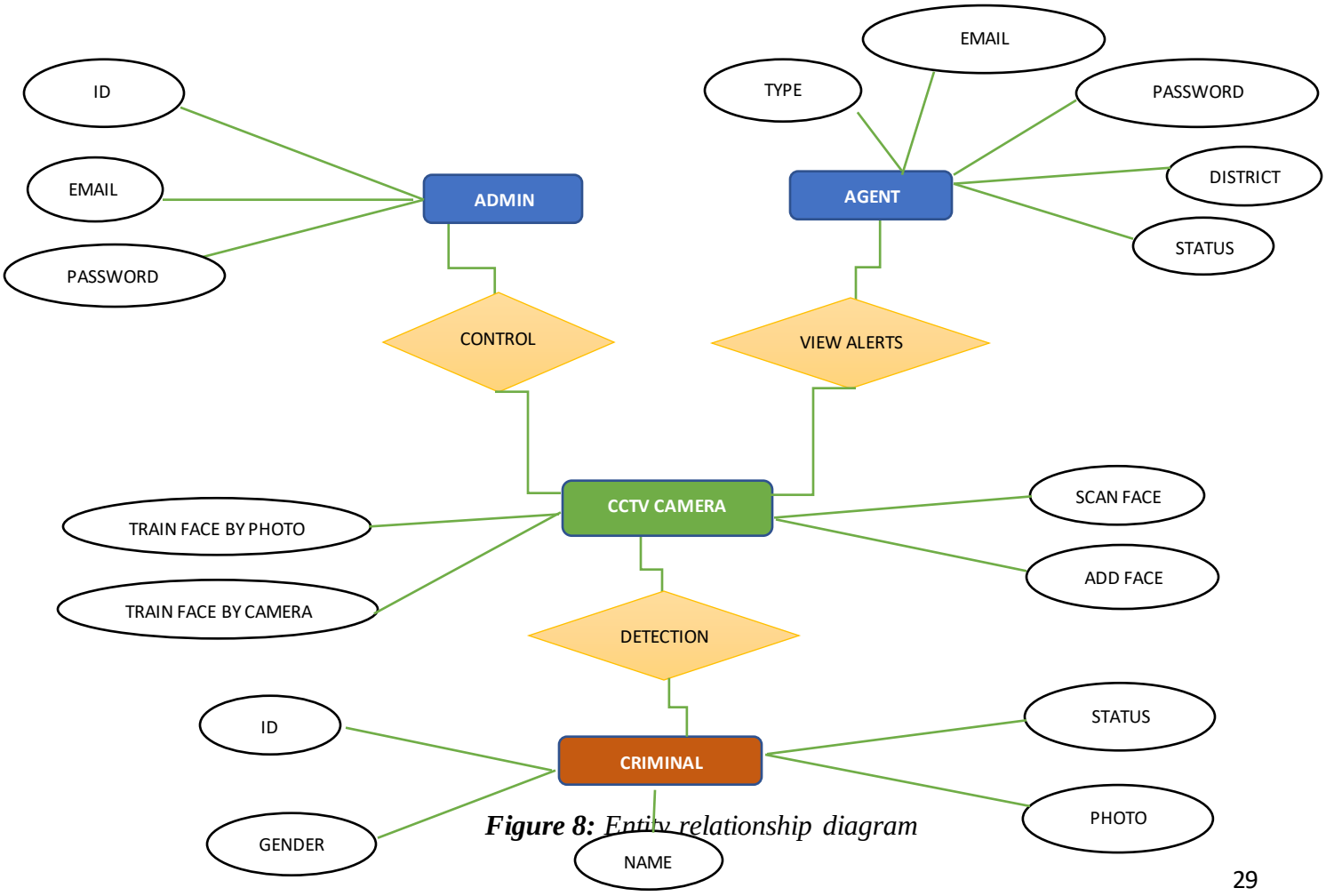


Figure 8: *Entity relationship diagram*

4.3 Database schema

A database schema is the logical representation of a database, which shows how the data is stored logically in the entire database. It contains list of attributes and instruction that informs the database engine that how the data is organized and how the elements are related to each other.

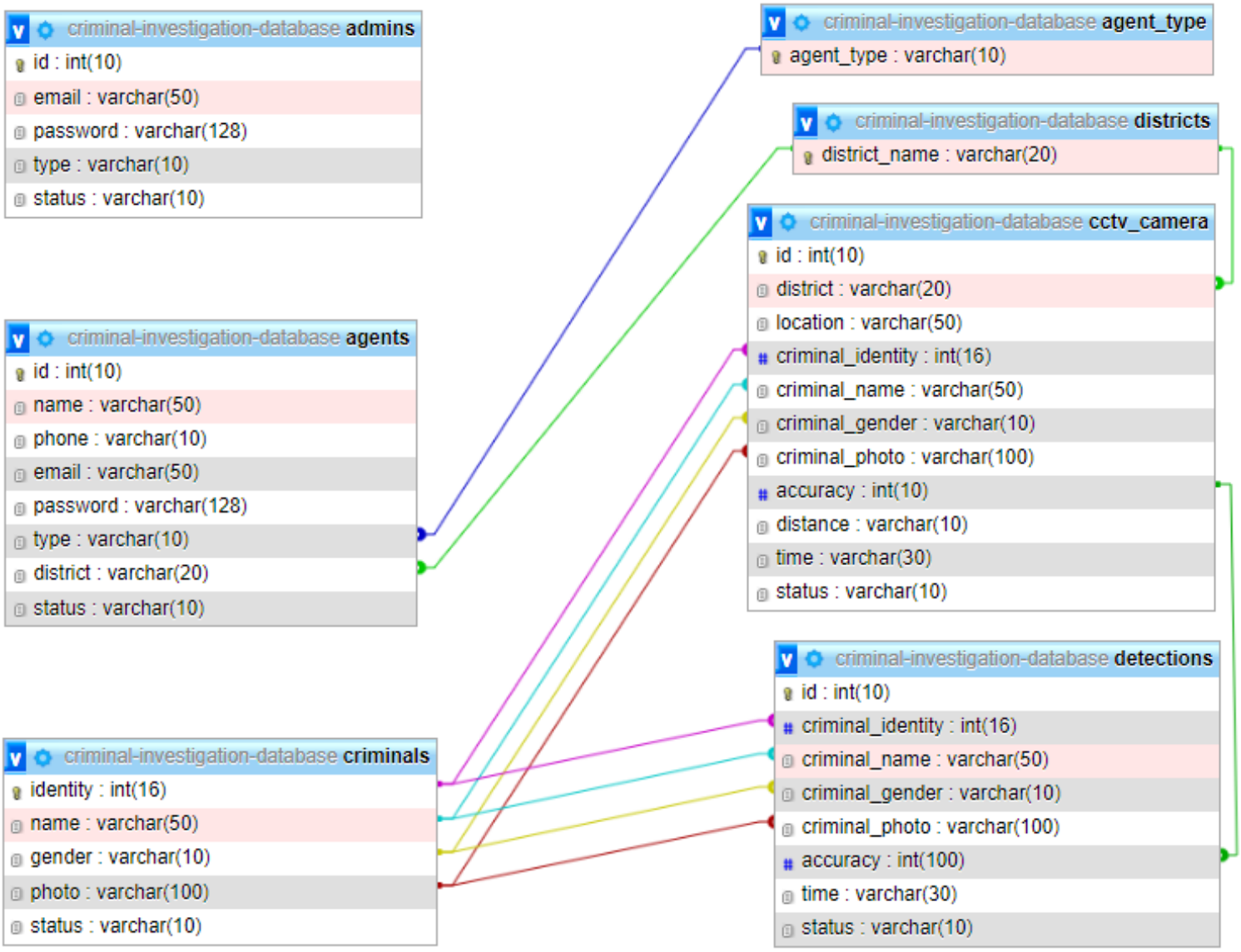


Figure 9: *Database Schema diagram*

4.4 System Analysis

Criminal enrollment is the first stage in recording criminal information in the criminal database. Criminal identities, names gender and images are recorded in the database then face recognition and identification is conducted using the recorder images and information. Using the face detection algorithms, picture of criminals' face encodings will be used. The database procedure is criminal enrollment, but the major step begins with facial detection. As seen in Figure below, face detection takes into account 68 landmarks on the face. CCTV camera collected film or picture is saved, and its properties, such as encodings, are extracted before being compared to image encodings in the database. The face will be matched in the database, and the name and the criminal detected message will be shown beside the criminal image on the screen in the CCTV Room.

Figure 10: *Landmarks on Every Face*

4.5 Working Principle of the System

We are employing CCTV cameras to capture photographs of members of the public in order to identify the appropriate person who has a criminal record in the database to apprehend.

1. First, we extract the facial encodings from the criminal database photos and save them in one list, while dividing the name recorded with the criminal image into another list.

2. Then the CCTV Camera are deployed to collect public pictures in order to identify and easily apprehend criminals who are present in public places.

3. Taking the acquired photos' face-encodings and extracting the features from them.

4. Using our database image encoding values to compare captured picture encoding values.

5. If the encoding values match those of the taken image, the criminal image, name, and message are shown on the screen.

6. The image of that individual are saved to a separate folder, allowing investigation bureau to readily identify the criminal whose identification matches.

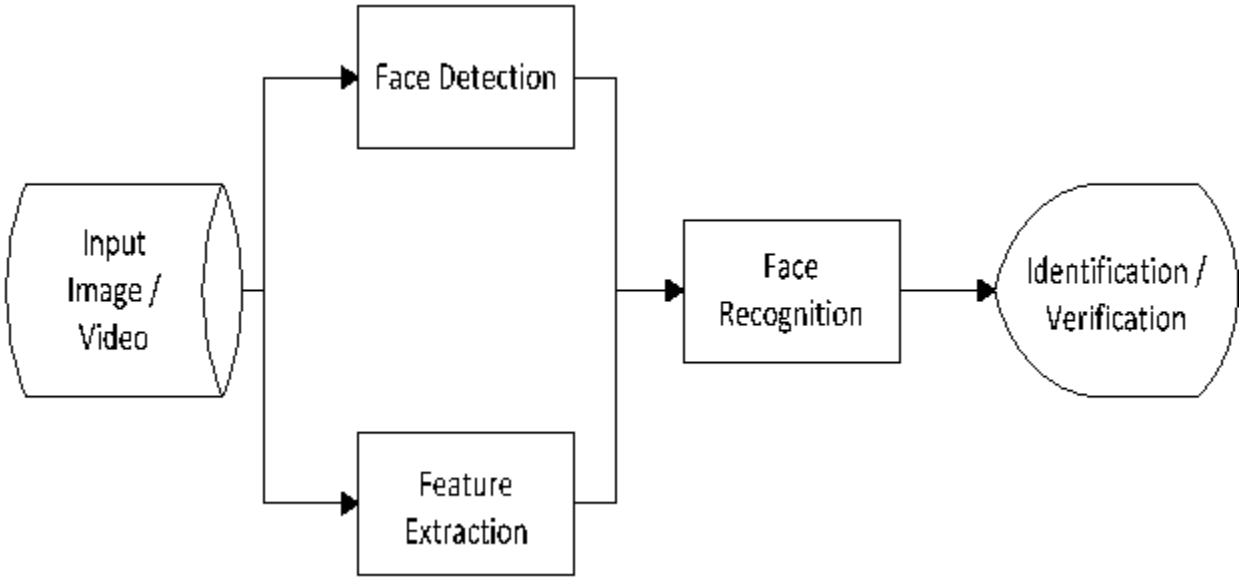
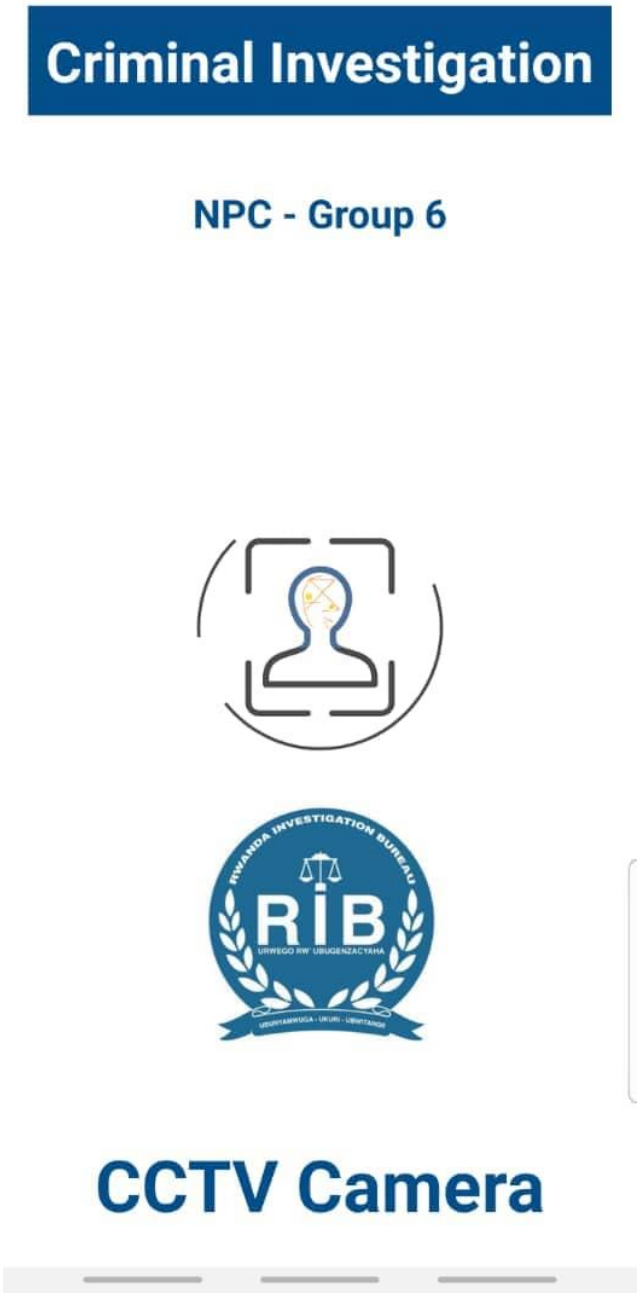


Figure 11: *Block Diagram of face recognition*

4.6 System Implementation

4.6.1 Overview of system interface for CCTV Camera application

The interfaces to be demonstrated are implemented in the android mobile application which act as a CCTV camera device. It is used to capture people's faces and use the computer vision algorithm to identify and recognize criminals.



CCTV Camera – Options

The CCTV Camera provide different options mainly its purpose is to train criminals face for further recognitions and saving recognitions data in the database.

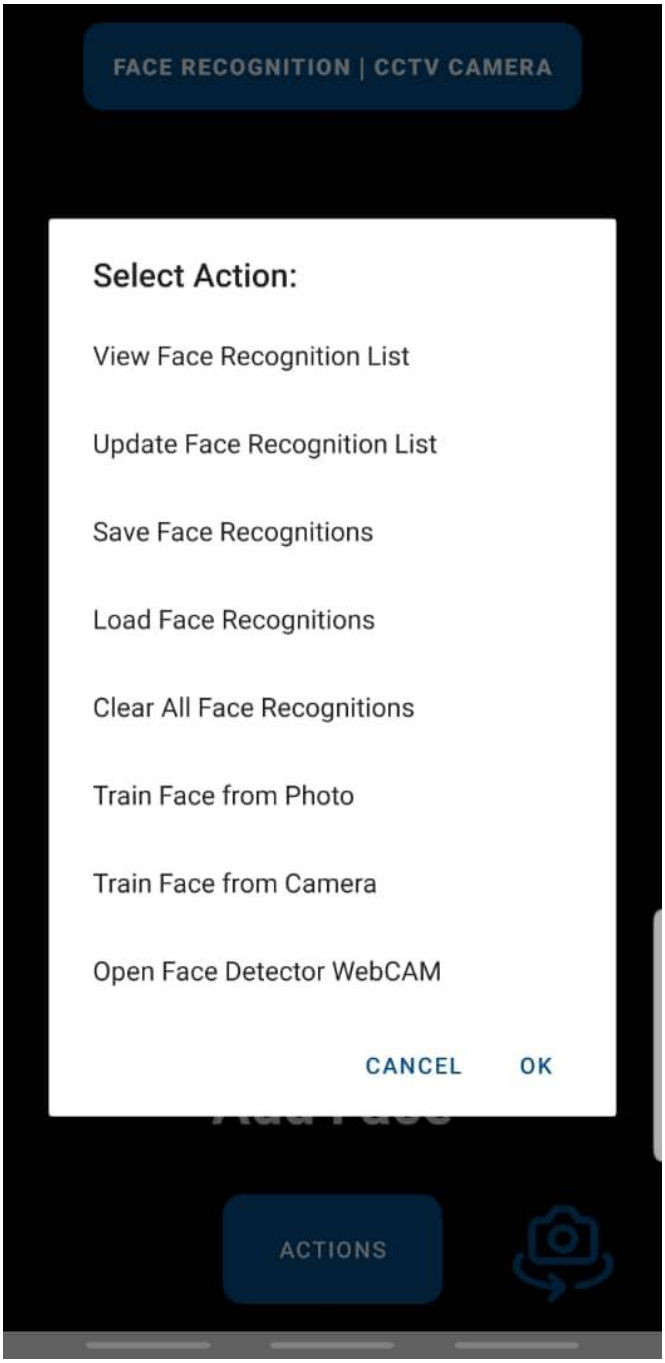
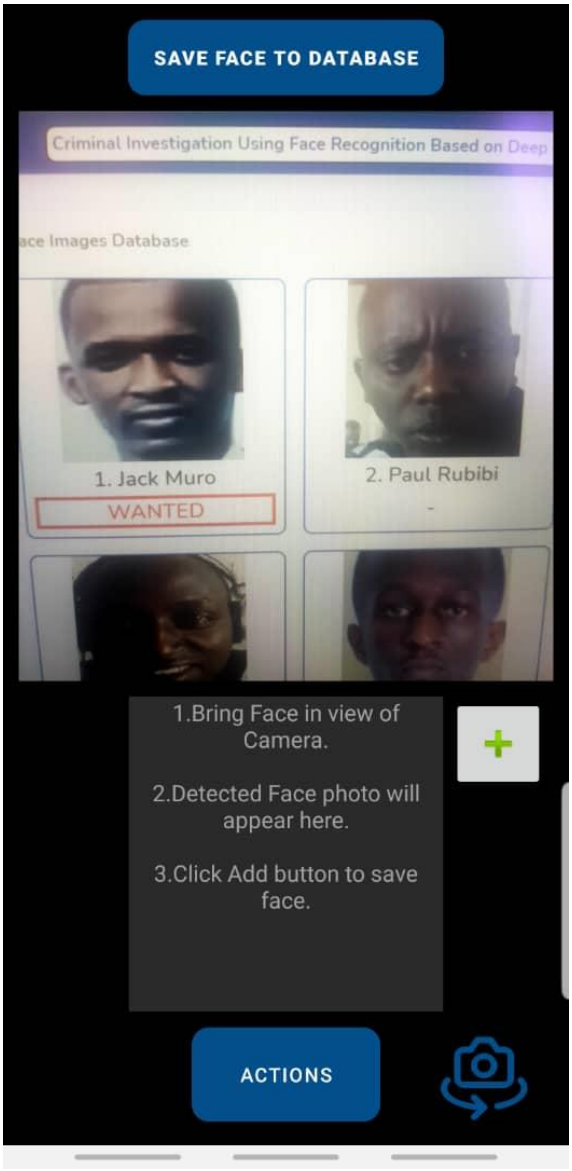
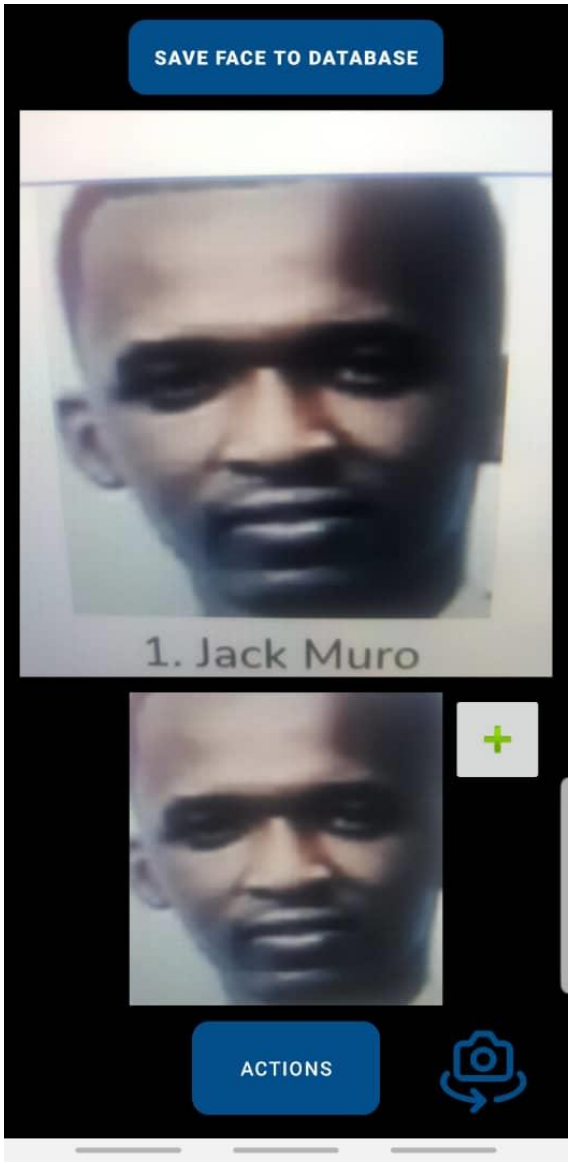


Figure 12: *CCTV Camera - Options*

CCTV Camera – Training

From the CCTV Camera, that's where the admin can register faces of criminals either by using a camera or saved photos. After training the criminal, you provide the information corresponding to the trained face such as the identity, the name and the gender to be saved in the database.


SAVE FACE TO DATABASE
Criminal Investigation Using Face Recognition Based on Deep
ace Images Database
1. Jack Muro
WANTED
2. Paul Rubibi
1.Bring Face in view of Camera.
2.Detected Face photo will appear here.
3.Click Add button to save face.
ACTIONS


SAVE FACE TO DATABASE
1. Jack Muro
ACTIONS

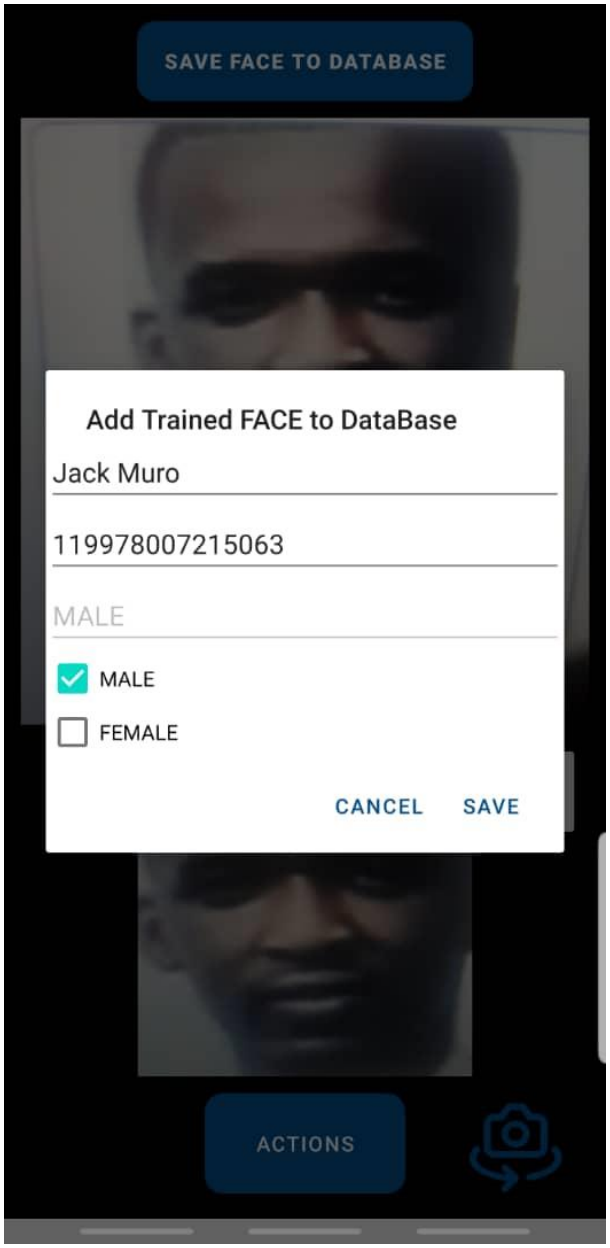
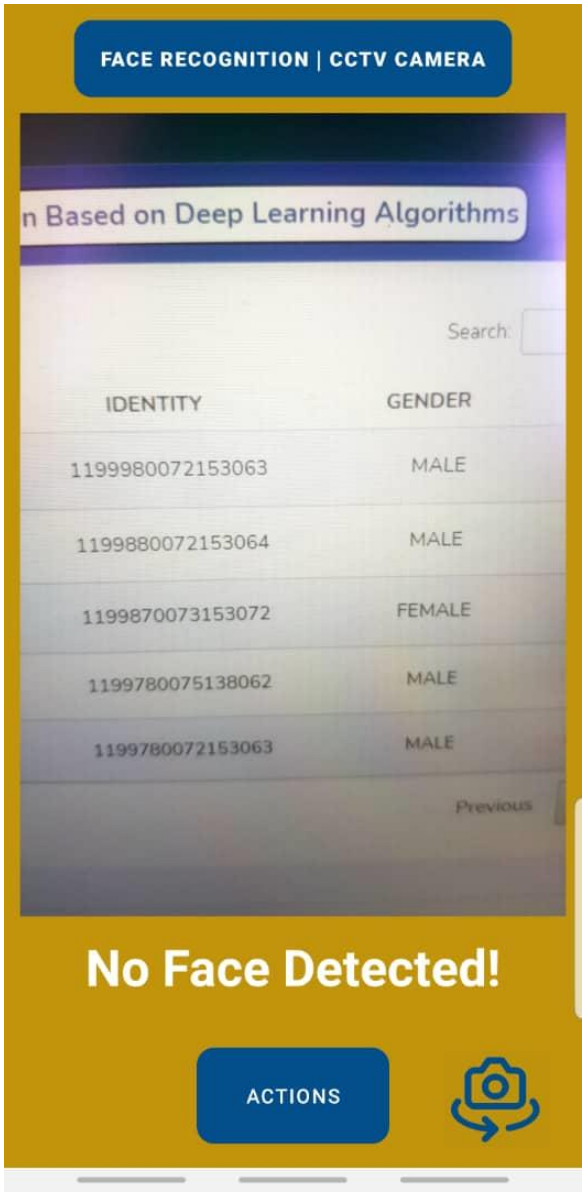


Figure 13: CCTV Camera - Training

CCTV Camera – Scanning

The CCTV Camera also performs the scanning of people face with a live video scanning, and by using computer vision algorithm, it is able to identify a human face and compare it with the registered faces in the database and hence it recognizes criminals and send the information to the administration dashboard.


FACE RECOGNITION | CCTV CAMERA
Unknown
ACTIONS


FACE RECOGNITION | CCTV CAMERA
n Based on Deep Learning Algorithms
Search:
IDENTITY
GENDER
1199980072153063
MALE
1199880072153064
MALE
1199870073153072
FEMALE
1199780075138062
MALE
1199780072153063
MALE
Previous
No Face Detected!
ACTIONS

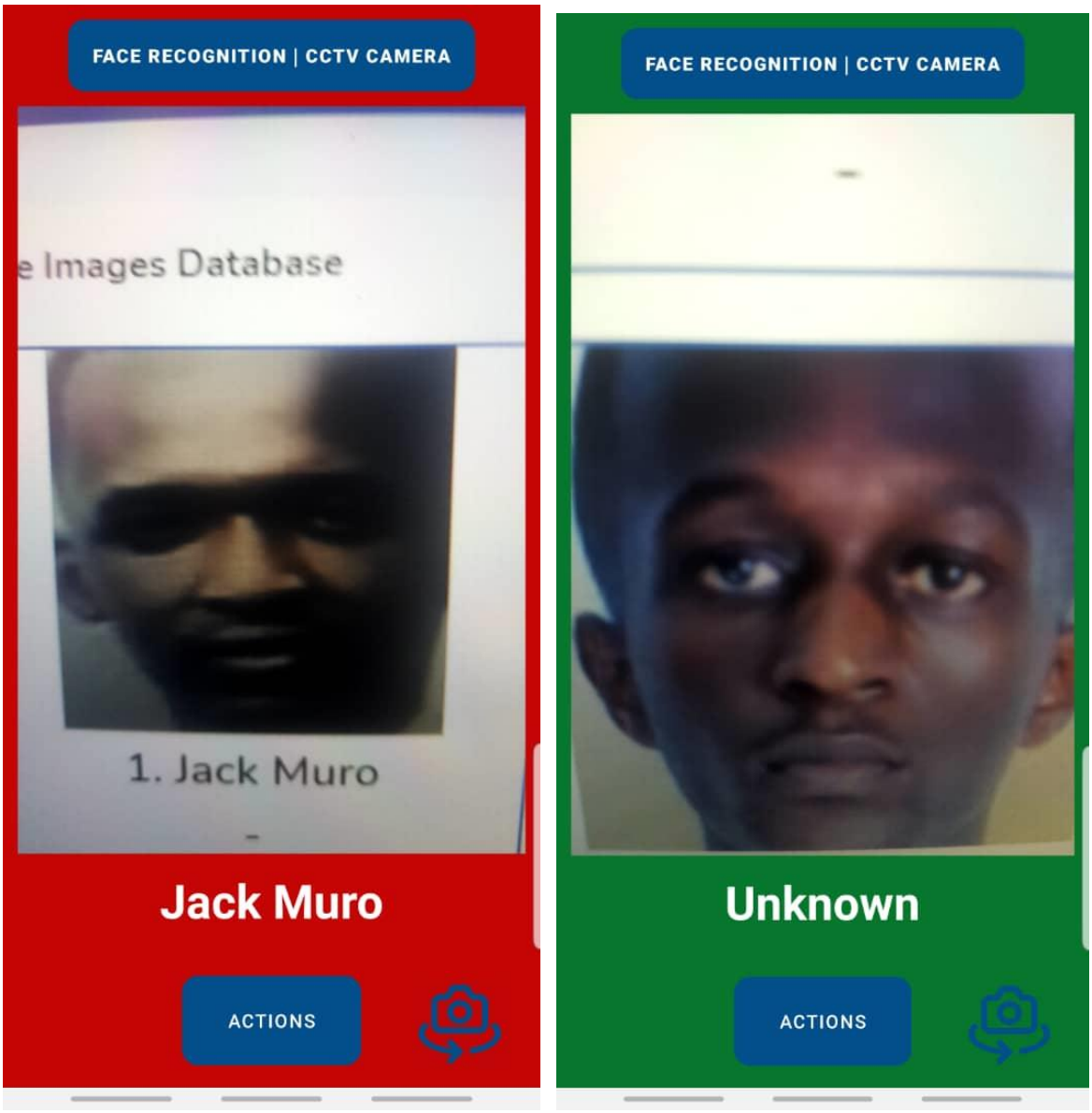


Figure 14: *CCTV Camera - Scanning*

4.6.2 Overview of system interface for agent's android mobile application

The interfaces to be demonstrated are implemented in the android mobile application of the agents, which is gives registered and authorized RIB and police agents to access information in the system.

Agent – Login screen

For the agents to access the agent mobile application, they have to be registered by the admin and verify their email and also get approved by the admin. To be authenticated, the agent must provide their email and password.

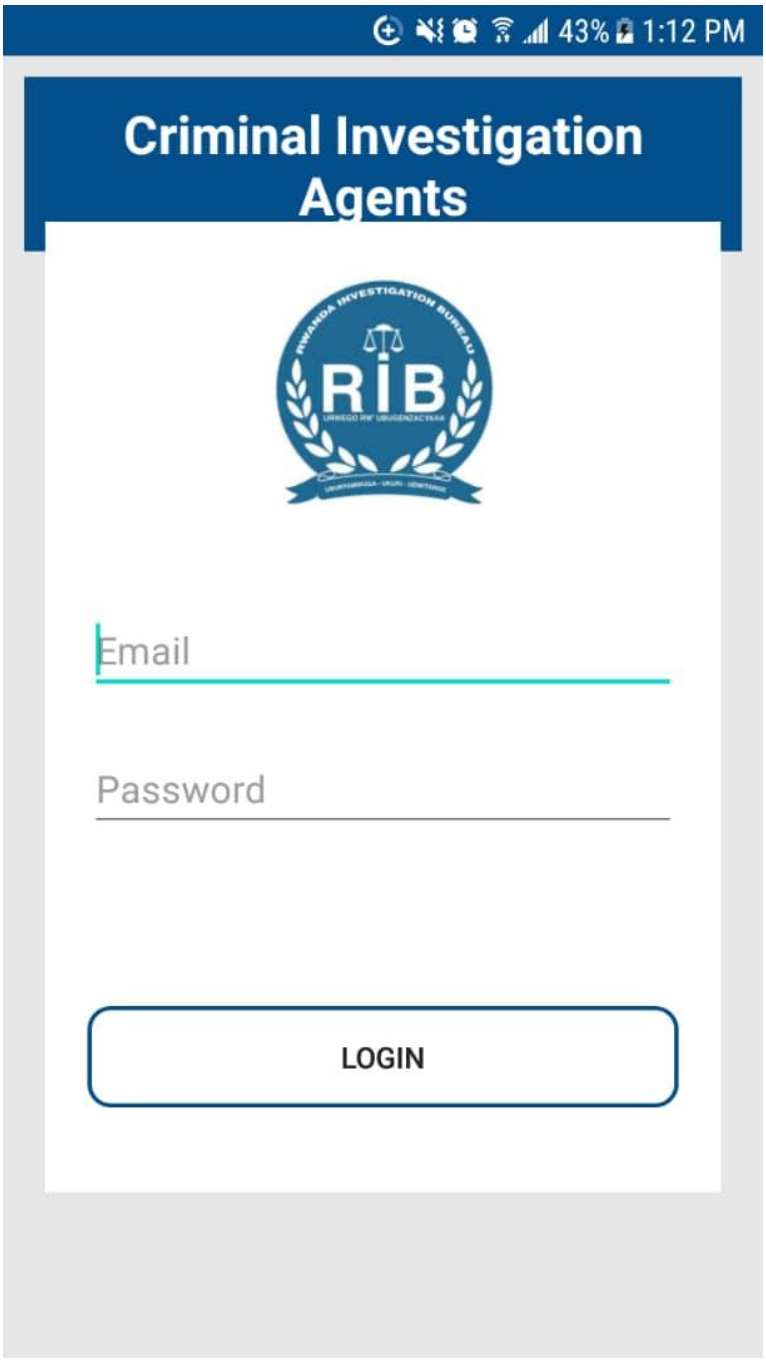


Figure 15: *Agent - Login screen*

Agent – Dashboard screen

After logging in, the agents are taken to their dashboard screen in the application where they can be able to view data captured by the CCTV Camera is the location that are assigned to. In case a tracked criminal is detected, the agents of RIB or Police are be able to see it on their smartphones.

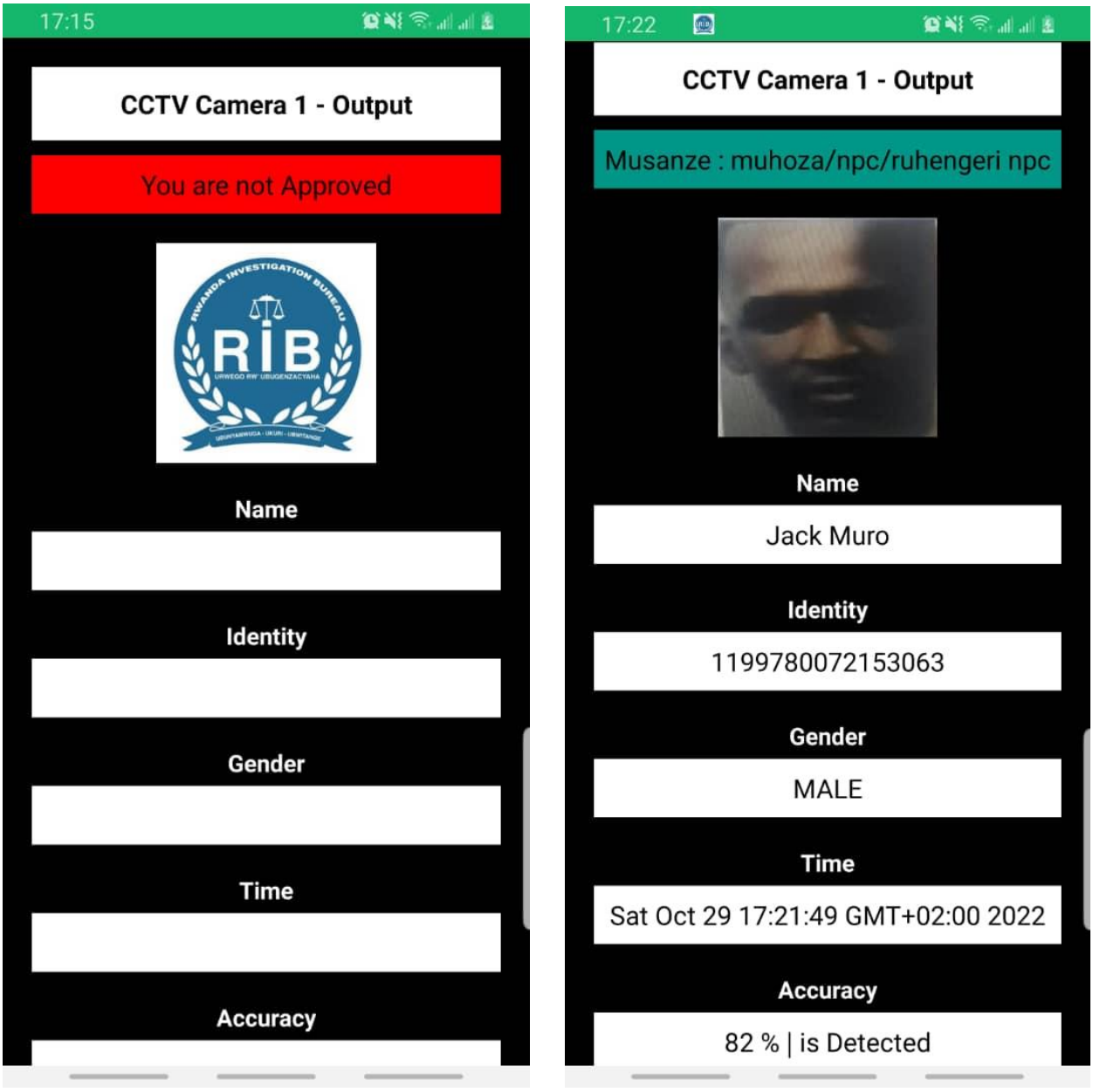


Figure 16: *Agent - Dashboard screen*

Agent – Notification alert

On the agent application, once a criminal who is being tracked is detected and recognized, a notification alert is sent to all approved agents with in the CCTV Camera location.

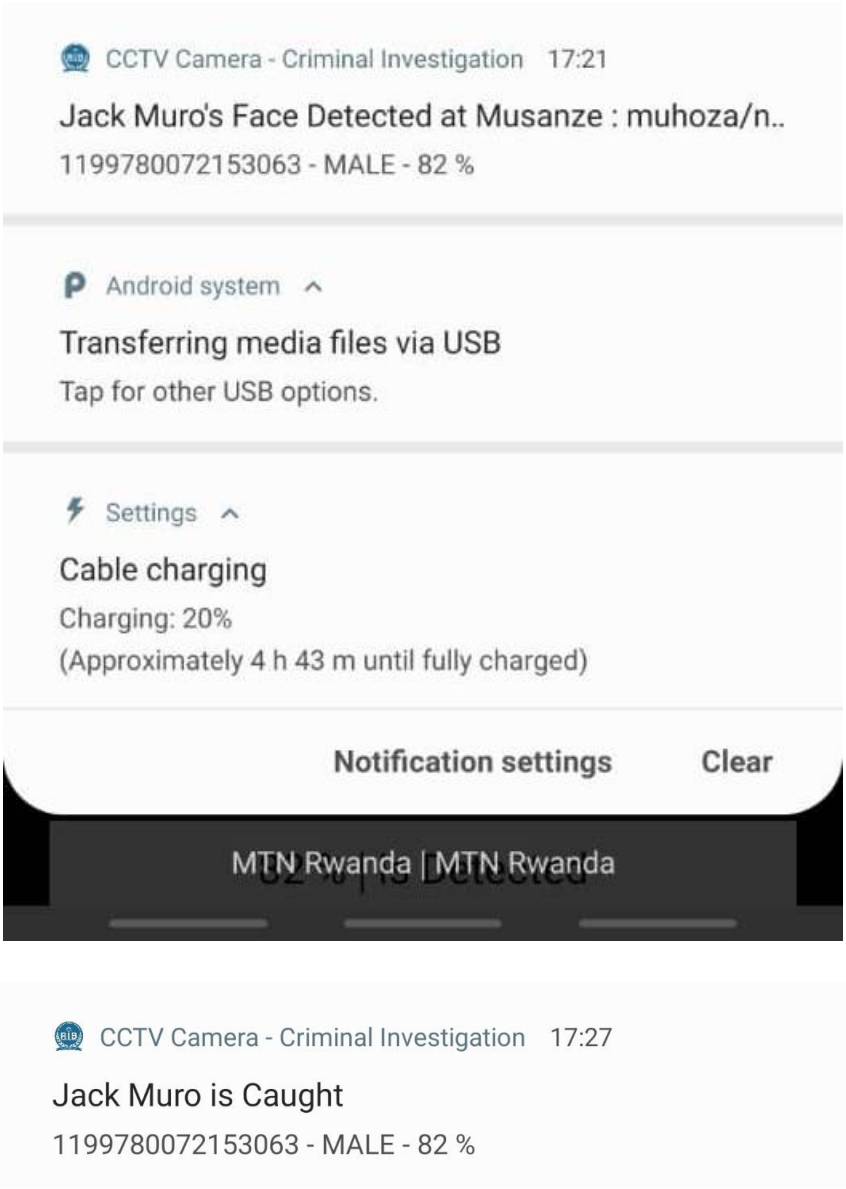


Figure 17: *Agent - Notification alert*

4.6.3 Overview of system interface for admin's website dashboard

The interfaces to be demonstrated are implemented in the website dashboard which is used by only the administrators of RIB to select criminals to be tracked, to view reports of tracked and detected criminals and other statistics.

Admin – Login page

This is the entrance page for the administration of the system, where the admin must provide a valid email address and a security password to be able to login in the dashboard. And only registered emails with admin privileges can have access to the dashboard. In case an admin forget the password, there is also an option to reset the email where a rest password link is sent to the entered admin email address.

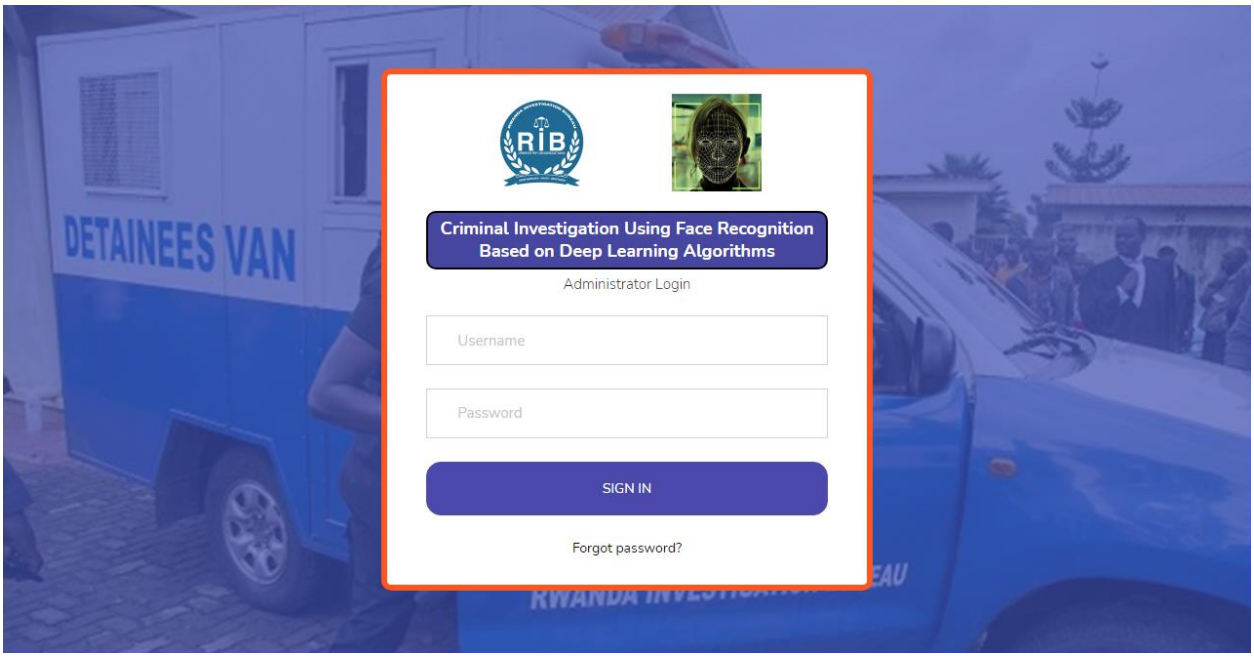


Figure 18: *Admin - Login page*

Admin – Dashboard page

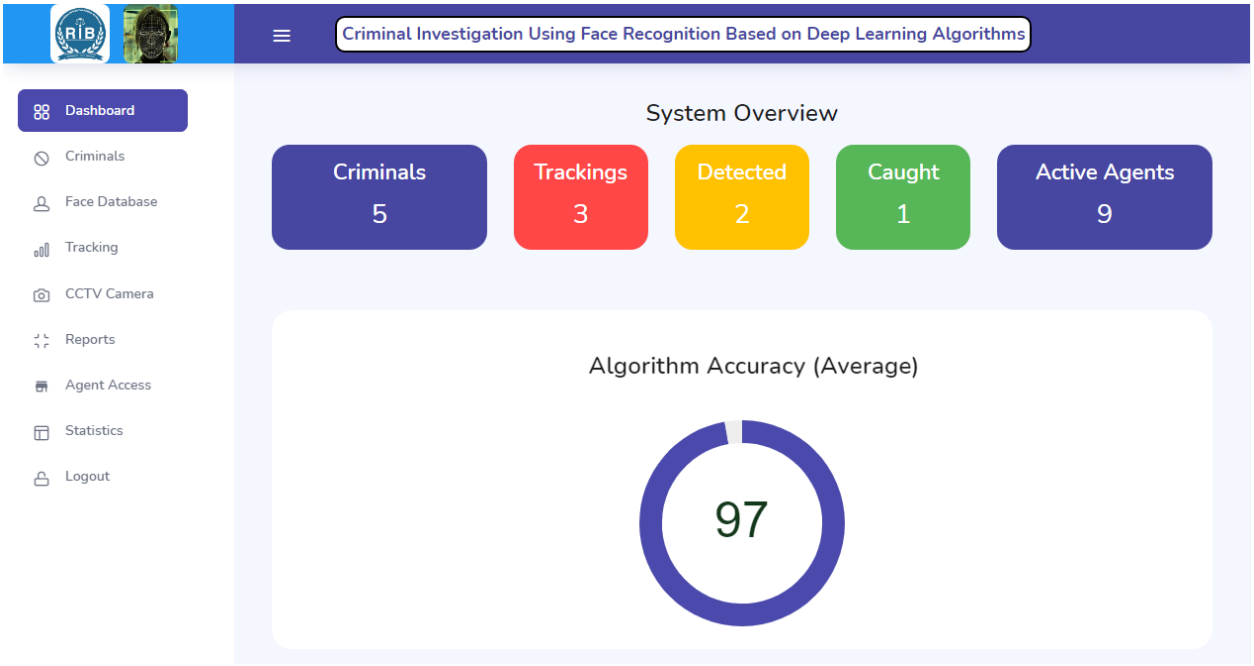


Figure 19: *Admin - Dashboard page*

Admin – Criminals' list page

This is the page which list all registered criminals and their information like the photo, name, identity, the gender with an option r

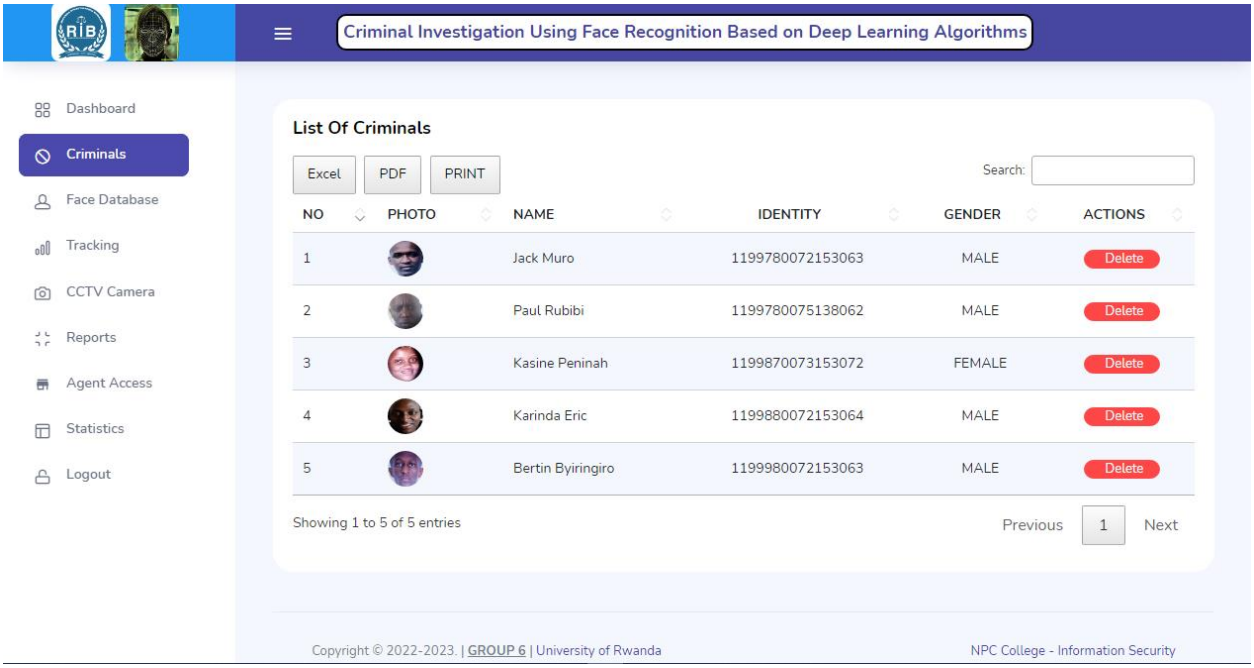


Figure 20: *Admin – Criminals list page*

Admin – Face Database page

The face page retrieves all faces of the registered criminals in the database by showing the last trained picture of each criminal, the name and the status whether a criminal is wanted or not.

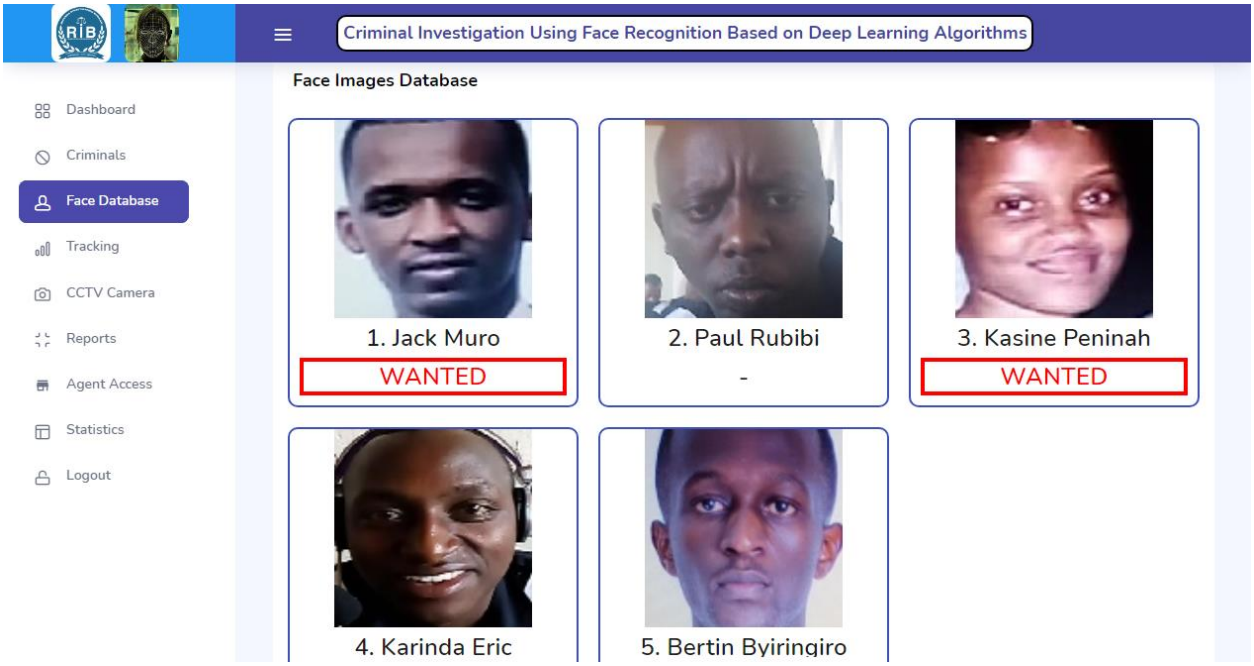


Figure 21: *Admin - Face Database page*

Admin – Tracking page

This a page which gives the administrator the option the start tracking a criminal and to view the status of criminals where is being tracked, detected or found.

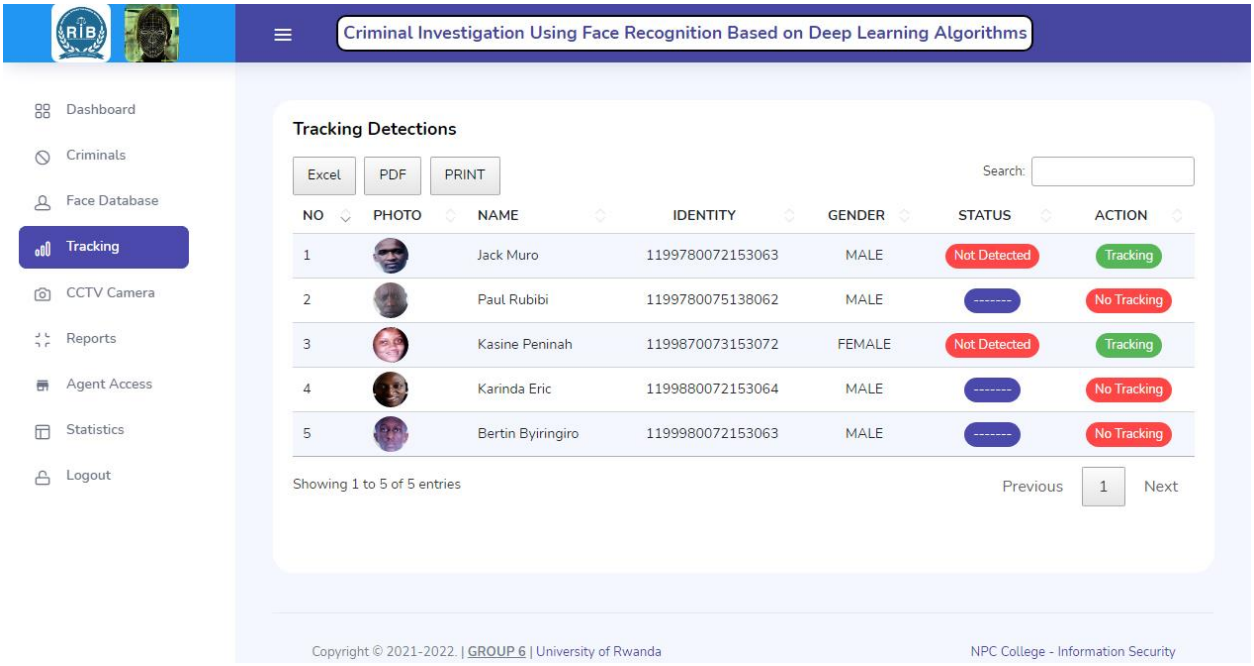


Figure 22: *Admin - Tracking page*

Admin – CCTV Camera page

This page shows the live output the CCTV Camera by showing the last time of detection and the information of the last recognized person like the name, gender, identity, photo and more importantly the accuracy at which the algorithm has detected and recognized that person on.

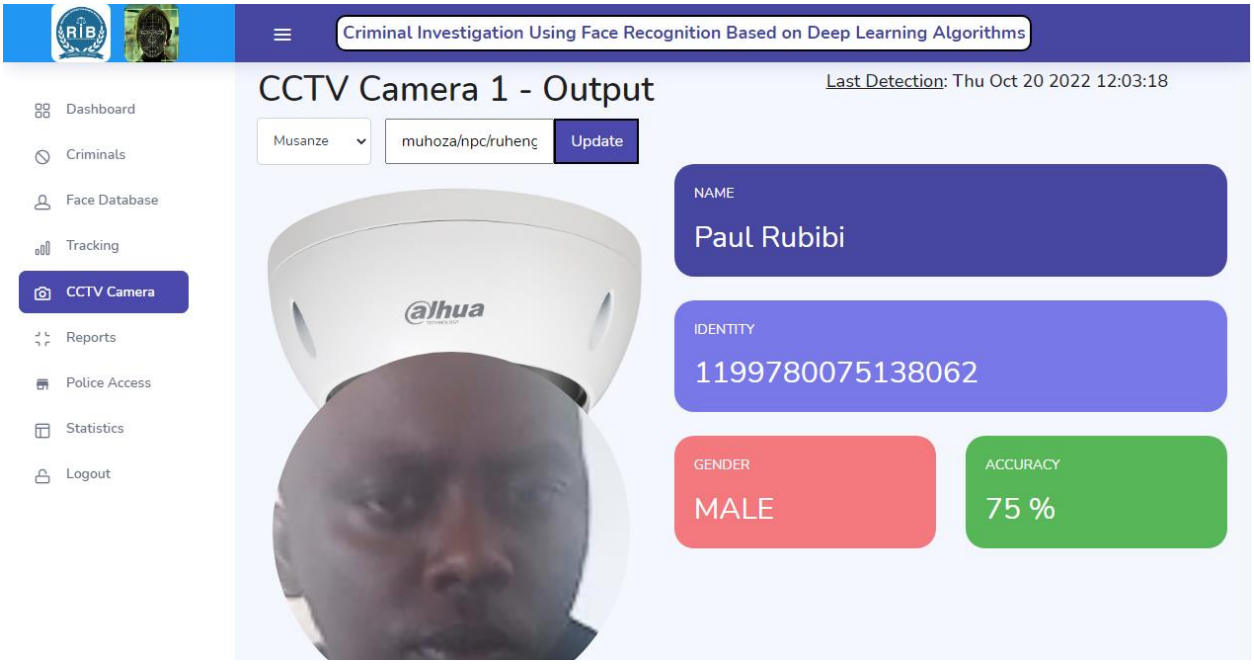


Figure 23: *Admin - CCTV Camera page*

Admin – Reports page

The reports page show a list of all occurred detections from the CCTV Camera by showing all retrieved information of the person or the criminal including the photo, the name, the identity, the gender, the time & date of detection and the accuracy at which the algorithm recognized the face on.

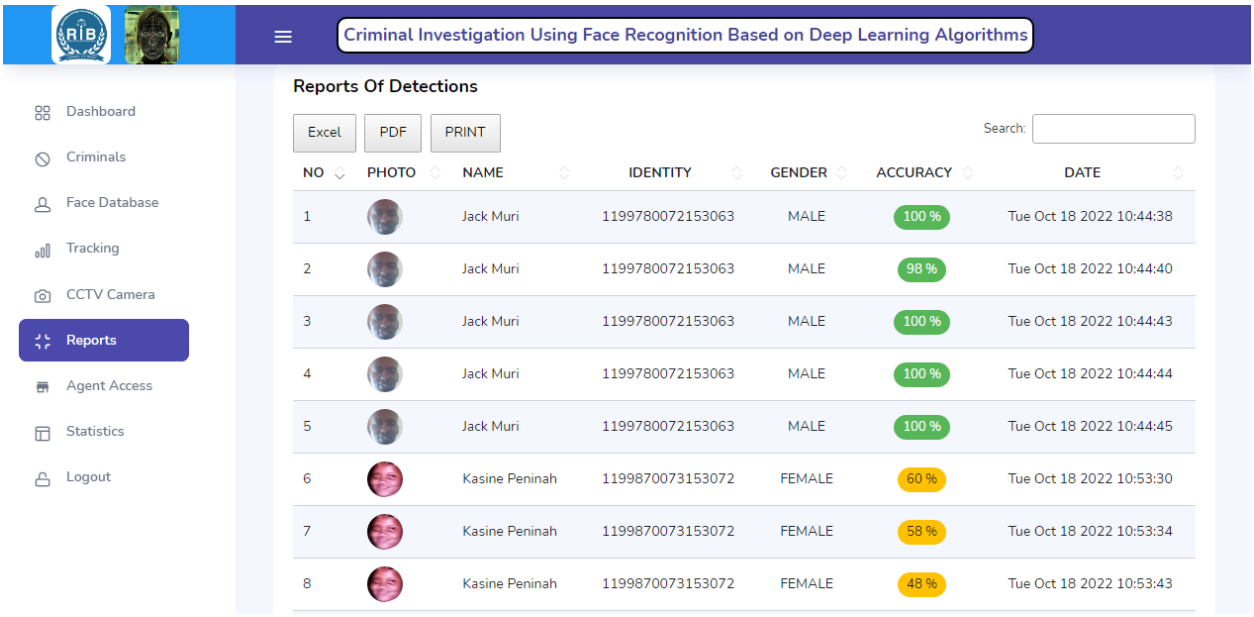


Figure 24: *Admin - Reports page*

Admin – Agent Access page

The agent access page shows a list of registered agents with their email, type and DPU with an option to active each agent as a way of giving them access to the agent mobile application.

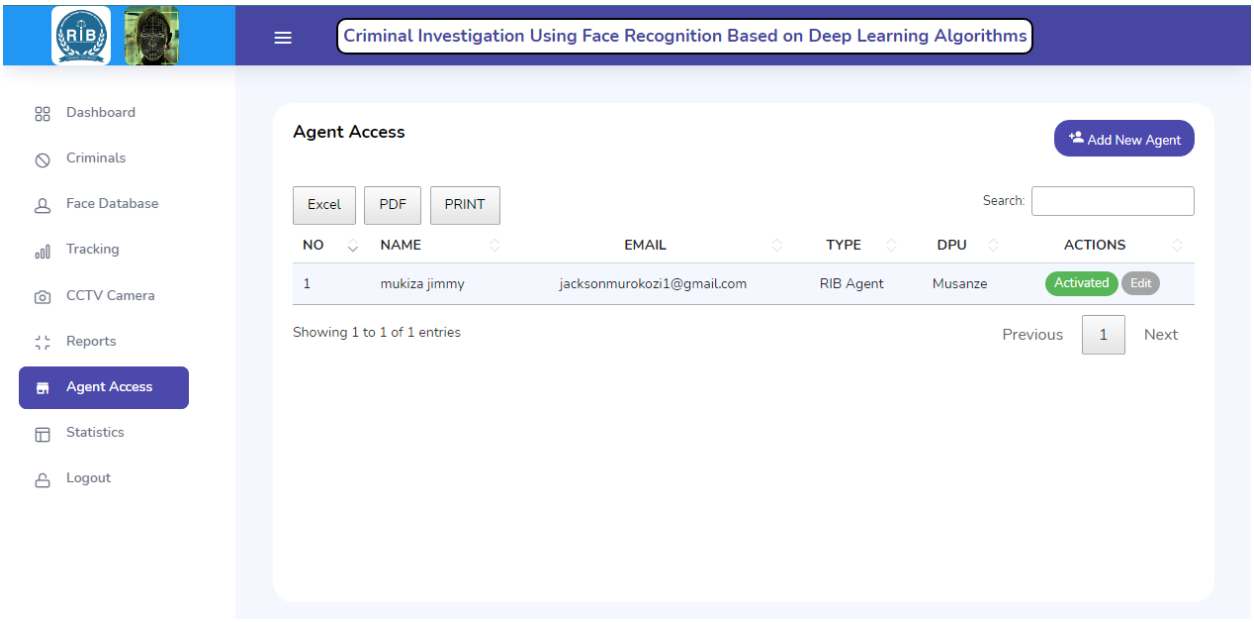


Figure 25: *Admin - Agent Access page*

Admin – Add/Edit an Agent

This page gives the admin an option to add a new agent by providing the agent's name, email, type, DBU and the password. And then the system sends a rest email link for the agents to change to their own password. The admin can also use this form to modify data of an existing agent.

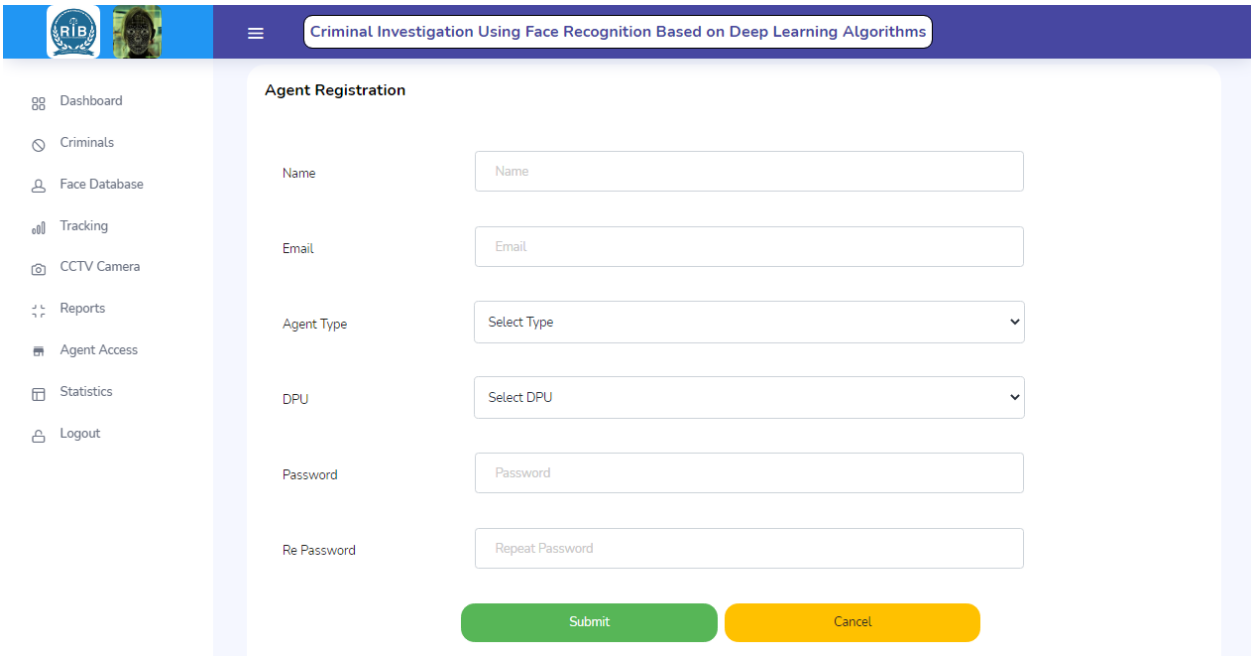


Figure 26: *Admin – Add/Edit an Agent*

Admin – Statistics page

The statistics page provide an overview of the system in form of graphs and analytics for instance here the pie chart show the accuracies of the algorithm where as the line graph show the rate at which the system is detecting on.

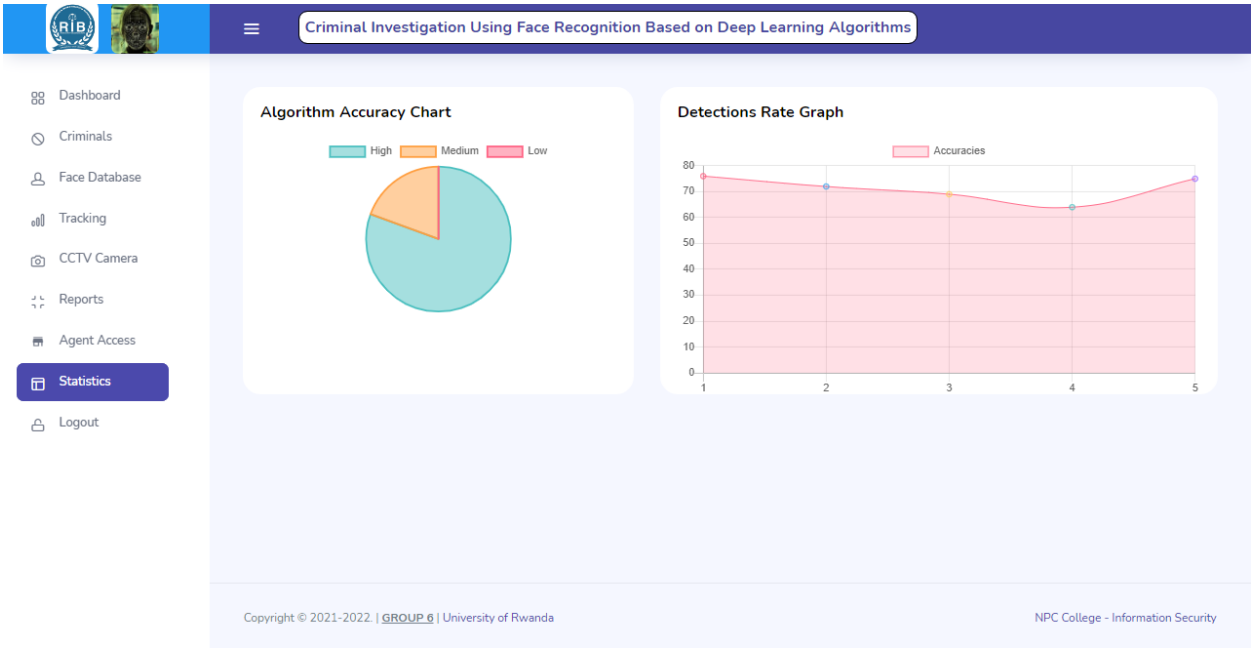


Figure 27: *Admin - Statistics page*

CHAP V: CONCLUSION & RECOMMENDATION

Face Recognition Technology has the ability to aid in the resolution, prevention, and prosecution of crimes. More precisely, it might be beneficial for a variety of investigations, such as determining the identity of an ATM fraud suspect, searching for a terrorist in public places, combating child abuse, or even locating missing individuals. On the other hand, early evidence suggests that without sufficient control, face recognition technology might result in human rights violations and hurt civilians. That is why the government must be involved to ensure that it is used legally.

This improved version of the criminal detection system not only makes it easier for the investigation bureau to identify criminals, but also saves them time because the processes are automated in the system. Face detection utilizing Face Encodings is the innovative aspect of this Research Paper.

For further research, we recommend that, because CCTV are static and not dynamic, we can incorporate drones which have camera to support the tracking and they might be moving around scanning people instead of waiting for the criminals to reach the place where CCTV are statically installed.

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