Al Imam Mohammad ibn Saud Islamic University College of Computer and Information Sciences Computer Science Department

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Facial Expression Recognition for Investigations

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تعهد

أتعهد بعدم المشاركة بمشروع التخرج أو الرسالة في الفعاليات أو المبادرات أو المسابقات ذات العلاقة في جهات داخلية أو خارجية دون أخذ موافقة خطية مسبقة من الكلية، وأنه عند مخالفة هذا التعهد ستتم محاسبة المخالف حسب اللوائح والأنظمة.

Abstract

Facial expressions are the movement of several muscles to express a person's current feeling. Humans express their feelings in both verbal and non-verbal ways. Facial expression is a non-verbal form of expressing human's feeling of happiness, sadness, surprise, fear …etc. Facial expressions can be indications of a person's status at a setting or situations. In many cases people cannot express their situations in verbal forms either because of disabilities, immaturity or because of fear of speaking. In these situations, many seek assistance of psychologists or body language experts to assist them in understanding a situation under investigation.

One of the most important interviews that seeks understanding of human's facial expressions are interviews by law enforcement. It is important for police investigators to recognize a person's true feeling via facial expressions in order to improve the investigation quality and evaluate the legitimacy of an interviewee's answers. In police interrogations, it is very likely for interrogating people to hide a fact or provide deceiving information. In this project, we investigate the ability of using facial expression analysis in police investigations. We build a system that automatically recognizes human's facial expressions and analyze them to understand the reaction of a person during a police interrogation.

الخلاصة

تعابير الوجه هي حركة بعض العضلات للتعبير عن مشاعر الشخص الحالية. البشر يعبرون عن مشاعرهم في طرق لفظية وغير لفظية. تعابير الوجه هي طرق غير لفظية للتعبير عن شعور الانسان بالفرح، الحزن، المفاجأة، الخوف ...الخ. تعابير الوجه تمكن من معرفه حاله الشخص في مكان او موقف ما. في العديد من الحالات الأشخاص لا يستطيعون التعبير عن حالتهم في صيغه لفظية اما بسبب الإعاقة، عدم النضج او الخوف من التحدث. في هذه الحالات يلتمس الكثيرون المساعدة من علماء النفس او خبراء لغة الجسد لمساعدتهم في فهم الموقف التابع للتحقيق.

واحدة من اهم المقابلات التي تسعى لفهم تعابير الشخص هي المقابلات التي تتطلب تطبيق للقانون. من المهم للمحققين ان يستطيعوا تمييز مشاعر الشخص ليزيدوا من فاعليه وجودة التحقيق وتقييم صحة إجابات الشخص الذي تتم مقابلته. في استجوابات الشرطة من المحتمل جدا ان يقوم الأشخاص بإخفاء حقيقة او بتقديم معلومات خادعة. في هذا المشروع نحقق في إمكانية استخدام تحليل تعبيرات الوجه في تحقيقات الشرطة. نحن نبني نظامًا يتعرف تلقائيًا على تعابير وجه الإنسان ويحللها لفهم رد فعل الشخص أثناء استجواب الشرطة.

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List of Abbreviations

FER	Facial Expression Recognition
FR	Facial Recognition
ML	Machine Learning
AI	Artificial Intelligent
CK+	Cohn-Kanada
JAFFE	Japanese Female Facial Expression
FERET	Facial Recognition Technology
YTF	YouTube Face
PCA	Principal Component Analysis
LDA	Linear discriminant analysis
RGB	red,green,blue
YCbCr	Green “Y”, Blue “Cb”, Red “Cr”
SVM	Support Vector Machine
NN	Nearest Neighbor
K-NN	K-Nearest Neighbor
LS	Linear Regression
PLS	Partial Least Square
CNN	Convolutional Neural Network
DNN	Deep Neural Network
ReLU	Rectified Linear Unit
LBP	Local Binary Patterns
MLP	Multilayer Perceptron
ANN	Artificial Neural Network
LBPH	Local Binary Patterns Histogram
RF	Random Forest
LR	Logistic Regression
BioID	Biometric Identification
FEI	Fédération Equestre Internationale
AU-Coded	Action Unit Coded

CMU	Carnegie Mellon University
MMI	Man Machine Interface
BND	Belfast Naturalistic Database
Ald	Atomic Layer Deposition
SDK	Software Development Kit
Dlib dlib	Digital Library
IIT- Delhi	Indian Institute of Technology Delhi
WLD	Weber Local Descriptor

CHAPTER 1 Introduction

Introduction

1.1 Introduction

Facial expressions are non-verbal communication, and it's a primary act between people to understand each other. Over time, the development of modern technologies in Facial Expressions Recognition (FER) discovery of human emotions has been facilitated for people who cannot express their feelings. Sometimes it is difficult to understanding the real emotions of others which reflects the level of honesty and transparency in human interactions. It is also important to understand people who have difficulties in verbal expression of their emotions such as autistic children and people with some mental issues. Also, it has been used in understanding people's reactions in TV interviews or job interviews to discover the level of comfort or distress of a guest. These applications can be used in many other sectors such as in education, medical, and even in business [1].

A human's face is the first and the main indicator to identify people's emotions and feelings. The amount of information that could be gathered from facial expressions could be more credible than any verbal or written expression of emotions. Using Machine Learning (ML) to understand patterns of facial expressions in humans and then translates them into emotions has been an area of interest in research recently. Although there are some studies and surveys that are interested in the field, the actual applications of facial expression recognition have been limited. Classification of emotions and providing an accurate understanding of human's emotion are some of the major challenges in this field [2]. Through our search for previous studies in (FER), there are few studies related to investigations and the assistance of investigators to that In our project we investigate the use of facial expressing recognition in interrogations in police investigations and judicature [3]. Moreover, we extend our work to see if we can recognize emotions of faces that are not really revealed. With the Covid-19 pandemic, many places require people to wear face masks. Further, in some cultures, such as the Saudi culture, most women

cover their faces with niqab. Therefore, the system should be inclusive and work on several types of faces, either fully revealed or not.

Emotions can be captured from either live streaming videos, or even still pictures. We aim to analyze these pictures by extracting facial features and providing proper 12 classification of a person's emotions.

This chapter will discuss the need for Face recognition and other details Problem Definition and project aim and objective and other.

1.2 Problem Definition

In criminal related investigations, an investigator goal is to collect facts about an issue. Some of the events are collected from witnesses or suspects. In such stressful investigations many people tend to lie or hide the truth. This situation hinders the investigator from understanding the situation to make a decision. If an investigator finds a person under investigation is deceiving the police, this will encourage them to perform more investigation and analysis. If the accused is innocent or guilty, in this project the system can determine the destination and then show the result of the accused's feelings.

Research questions:

- RQ1: Can we use the FER system to assist and improve interrogations in police and social worker investigations?
- RQ2: What is the existing work in FER and how efficient are they?
- RQ3: Can the system Identify feelings of women who wear the Islamic veil (Niqab)?
- RQ4: Can the system Identify the feelings of people who wear the face mask?
- RQ5: Can we use Artificial Intelligent (AI) in FER? Which technique can we use?

1.3 Aim and Objectives

1.3.1 Aim

We aim to develop a FER system to assist in the police and social workers in their interviews for investigating an issue or a crime, in order to understand human emotions using ML and Deep Learning (DL) techniques.

1.3.2 Objectives

- To create a software system that is capable of detecting facial expressions.
- To collect facial expression images from existing databases for system training and testing.
- Use ML and DL to create an algorithm that analyzes facial expressions and then detects human emotions.
- To make the software system capable of recognizing the emotions of a women wearing a niqab.
- To make the software system capable of recognizing the emotions of a person wearing the face mask.
- To evaluation of the system is its ability of recognize at least 70% of a person's emotions.
- The results of sentiment analysis can be used to know whether the accused is lying or not.

1.4 Timeline

Table 1 illustrates the project's timeline. Submitting the proposal, literature review, and methodology will be submitted before summer 2021. The design, implementation, and testing parts will be submitted later this year. There is going to be a gap in this project during summer break.

Table 1: Project Timeline

Task	2021								
	JAN	FEB	MAR	APR	MAY	SEP	OCT	NOV	DEC
Proposal									
Literature review									
System analysis									
Design and implementation									
Testing									
Writing and documentation									

1.5 Team Qualifications

Table 2. shows the qualifications and the skills of the project team.

Table 2: Team Qualifications

Student Name	Qualifications
Hind Ahmed Alharbi	**Programing languages:** Java, Python, Assembly, Database Management. **System:** Apache NetBeans, MySQL, Oracle. **Operating System:** Ubuntu.
Maha Hamoud Alhamoud	**Programing languages:** Java, Assembly, C++, HTML,Database Management .**System**: MySQL, Oracle. **Operating System**: Ubuntu.

Njood Turki Almukirsh	**Programing languages:** Java, Assembly, Database Management. **System:** Apache NetBeans, MySQL, Oracle. **Operating System:** Ubuntu.
Reema Nasser Altammami	**Programing languages:** Java, Python, Assembly. Database Management. **System:** Apache NetBeans, MySQL, Oracle. **Operating System:** Ubuntu.

1.6 Conclusion

Facial expression recognition system helps police, judges, and social workers in their investigations to analyze facial expression. Further, lining in a culture where most women cover their faces wearing niqab . To understand the subject even more, we conducted a background chapter about similar systems in literature.

Literature Review

2.1 Introduction

In this project, our focus is on criminal investigations to help uncover emotions and translate expressions of people interrogated during police investigations. The Facial pictures are acquired, then the system analyzes facial expressions to classify them into different emotions these emotions assist police in understanding the meaning behind a person's facial expressions. If a person is stressed or surprised for instance; the interrogator can predict if a person is telling the truth or not for instance regarding a certain matter. In this chapter, we provide an overview of the fundamental stages of the FER system and recent studies that uses ML techniques in classification and emotion identification. In section 2.2 we provide an overview of the major components of an FER system and the techniques used in Section 2.3 presents the related studies in the field. Finally, we conclude our chapter in Section 2.4.

2.2 Background

The ability to understand a person's facial expressions and feelings is a very important skill and it is used in communicating with others and understanding each other, in this project we can benefit from sociology and psychological studies in understanding feelings and how to classify them, and in sociology, it has been proven that the most important areas of the face for understanding facial expressions are mouth and eye that can be categorized as follows:

Eye

- Wide open (surprise)
- Intensely staring (anger)

- A dropped jaw (surprise)
- Open mouth (fear)
- One side of the mouth raised (hate)
- Corners raised (happiness)
- Corners drawn down (sadness)

Other signals to look for are:

- Lip biting (anxiety)
- Pursed lips (distaste)
- Covering the mouth (hiding something) [7].

The process of FER comprises of following major steps: Facial Acquisition, Facial Feature Extraction and Representation, Facial Expression Classification. We will elaborate further in the following subsections. Research has shown that there are some methods in criminal investigations to reveal the criminal, whether a person is deceptive or not [30] [31], For example, by analyzing the eye movement or change of size or by looking to some signs like if a person looks up to the right while answering a question this could indicate that the answer is a deception.

2.2.1 Facial Acquisition

The first stage of facial acquisition is automatic face detector to locate in the complex scenes with muddled backgrounds. This should consider the complexity of different face appearance caused by illumination change and variations due to change the scale, before proceeding the further analysis. Therefore, it is suggested to do image normalization before classification.

Facial images are obtained from still images or recorded videos. These images are collected to train the system and test its ability to recognize facial features. Many open-source databases provide researchers with images of humans with different expressions and variations.

2.2.2 Facial Feature Extraction and Representation

After the images are acquired, facial feature extraction should be performed. Many methods are characterized based on whether they focus on faces, movement, or deformation of face acts that are local or holistic. In feature processing by holistic face are treated as a whole, but in local feature processing the focus in the districts which are prone to change. Further if an approach focuses on a neutral face in order to extract facial features it falls under the category of deformation-based approaches such as wrinkles due to age. On the other hand, motion-based approach has to count on the facial changes occurring due to facial expressions not neutral face such as optical flow and feature point tracking. Facial structures can be described based on their 2-D and 3-D models as model-based approaches. Amongst deformation methods, feature extraction methods that do not rely on extensive information about the region of interest are categorized as image-based methods. They have the advantage of being fast and simple but may become unrealizable when there are different views to be examined for the same image. Facial structures can also be described based on their 2D and 3D models; they are categorized as model-based approaches as well.

FER systems can be either static or dynamic based on an image. Static FER considers only the face point location information from the feature representation of a single image, whereas the Dynamic Image FER considers the temporal information with continuous frames with a description of steps as follow:

1. Dataset: A dataset must have well-defined emotion tags of facial expression is essential for testing, training, and validating the algorithms for the development of FER.
2. Pre-Processing: This step pre-processes the dataset by removing noise and data compression. The various steps involved in data pre-processing:
    a. Facial detection is the power to detect the location of the face in any image or frame.
    b. Dimension reduction is used to reduce the variables by a set of principal variables.
    c. Normalization of the features, reduced features are normalized without distorting the differences in the range of values of features.

3. Feature Extraction: It results in smaller and richer sets of attributes that contain features like face edges, corners, diagonal, and other important information such as distance between the lips and eyes, the distance between two eyes, which helps in speedy learning of trained data.
4. Emotion Classification: It is the algorithms to classify the emotions based on the extracted features. The classification has various methods, which classify the images into various classes [14].

2.2.3 Facial Expression Classification

The last stage in the system FER is classification. FER deals with the classification of the face based on visual information which might not disclose the human emotions. In contrast to FER, the interpretation attempt often demands understanding of the context of situations is the emotion recognition. Some of the most prevalent classification methods are Support Vector Machine (SVM), Nearest Neighbor (NN), k-NN, linear regression (LS), partial least square (PLS) and rule-based classifiers. Even though lots of investigation has been done, the exploration is still going on for the expansion of new methods, that need less memory whilst being easy in the computations as compared to preceding methods.

Recently, ML algorithms have produced performances in various fields such as image classification, object detection, and face recognition. The most prominent being the Convolutional Neural Network (CNN). CNN is a specialized neural network for processing data that has an input shape like a 2D matrix images. CNN's is typically used for image detection and classification. Images are 2D matrix of pixels on which we run CNN to either recognize the image or to classify the image. Identify if an image is of a human being, or not Like Neural Networks.

Inception-ResNet-v2, a CNN, built with the ability to identify or recognize images. It was trained using images from the ImageNet database which contains more than one million images and still counting. The ImageNet database is the standard for the well-known Large-Scale Visual Recognition Challenge .

The ML in face recognition systems is the key to have an accurate system. Starting with face feature extraction methods such as, LBP, Gabor, etc. The feature extraction method's output will

be the input to the deep neural network, so that the network starts training on the data, then by using a database the data on it is send to the network so that it could be tested to classify the faces. Famous face recognition ML classifiers are SVM, Multilayer Perceptron (MLP) and CNN.

2.3 Related Work

We investigated the historical progression of related work fields at each stage of this work. In the following subsections we will see the development in research in face three basic areas: Face Recognition, Emotion Recognition, and Limitation of Feature Extraction.

We gather the related work papers by title, then we did snowballing and skimming of the papers. As a group of four researchers we voted on selecting a set of papers that are closely related to our field or research.

Table 3 summarizes the related studies that have been published in peer reviewed venues and journals that have been conducted using Google Scholar and IEEE research engine. The table also presents the methods used in each of these studies, the results and the research gaps. We will further elaborate on these papers in the sections below according to their focus.

Table 3: Related work summarizing

Reference	Technique of recognition	Classification	Database	Result of recognition	Research gap
[17]	Gabor	Face recognition	CK+	93%	They use a number of features for classification
[18]	Viola Jones	Face recognition	100 color images	98%	Not applied on the well-known databases
[19]	viola-Jones algorithm, PCA And ANN	Face recognition	BioID Face	94%	Doesn’t detect important face part such as eyebrows
[20]	Eigenfaces and LBPH algorithm	Face Recognition	LFT and YTM	96.5%	Doesn't recognize face expression

[21]	KNN, SVM, RF, and LR	Face Recognition	FEI, SCIEN and Asian Star Face	90 – 99.2 %	Only detect a gender of a person from a picture
[22]	KNN	Emotion Recognition	CK+ And AU-Coded Facial Expression	80% + 3%	There are deficiencies of the proposed approach, such as the image database to further examine. The proposed method is also limited
[23]	Neutral Networks and PCA	Emotion Recognition	JAFFE, CMU, MMI and BND	85.3%	the limitation is that the input image must be clear if it is to normalize eastward
[24]	OpenEar toolkit	Emotion Recognition	Ald and SDK	96.6%	Doesn't detect simultaneously mixed feelings
[25]	Dlib,dlib face detector	Emotion Recognition	JAFFE	-	dlib can detect the face only if the person's face is facing in front of the camera and cannot detect the face if the person's face or head is facing to the right or left
[33]	OpenCV library and CNN	Emotion Recognition	set of data (FER2013)	65%	problems of brightness, also the problems related to face pose

[26]	PCA	Limitation of Feature Extraction	IIT-Dehli	99.20%	problem Noise created by illumination normalization algorithm this problem is reduced but not completely resolve
[27]	SVM RBF and SR	Limitation of Feature Extraction	T1-w	93.8% +0.3+-	a cluster occlusion dictionary for better modelling contiguous occlusion
[28]	PCA	Limitation of Feature Extraction	Yale Faces	98.18%	feature extraction technique cannot give satisfied recognition rate for Illumination problem
[29]	SVM	Limitation of Feature Extraction	Yale Faces	97.78%	image preprocessing so for better illumination and scaling invariance

2.3.1 Face Recognition

Vukadinovic and Pantic [17] Presented a method that detected faces using 20 facial feature points which dived the face into 20 relevant regions using the Gabor algorithm. El Maghraby et al. [18] used genetic algorithms to detect face parts from images. Deshpande and Ravishankar [19] Presented two stage methodology that detected a face, then recognized it using (PCA) to Feed Forward Neural Network. Ali et al. [20] used Local Binary Pattern (LPB) with processed data to recognize faces using her cascade files that used skin detection, eye detection, and nose detection as an input to the LBP to upturn the accuracy of the system. Lin and Xie [21] used a classification, gender detection algorithm, using facial feature recognition. Table 4. shows the similarities, differences in researches of a Face Recognition domain.

Table 4: similarities, differences of Face Recognition domain

Reference	Year	Located face parts	Gender detection	Works on Image/Video	Techniques of detecting facial feature point	Database	Accuracy of the detecting method
[17]	2005	Eyes, Nose, Mouth, Eyebrows and chin	No result	Image	Gabor	CK+	93%
[18]	2014	Eyes, Nose and Mouth	No result	Image	Viola Jones	100 color images	98%
[19]	2017	Eyes, Nose and Mouth	No result	Image	viola-Jones algorithm, PCA and ANN	BioID Face	94%
[20]	2019	Face, Skin, Eyes and Nose	No result	Image/ Video	Eigenfaces and LBPH algorithm	LFT and YTM	96.5%
[21]	2020	Eyes, Nose, Mouth and Eyebrows	detected	Image	KNN, SVM, RF, and LR	FEI, SCIEN and Asian Star Face	90 – 99.2 %

2.3.2 Emotion Recognition

Ou et al. [22] conducted this research in 2010. Methods of extracting facial features and recognizing facial expressions were studied. The method used to determine emotional facial expressions was KNN. This technology is very good, effective, and achieved high efficiency in its performance, and a database was used Cohn-Kanade AU-Coded Facial Expression.

In 2011, Parthasarathi et al. [23] The focus was on how to identify facial expressions and their results (such as angry, happy, and others). Neural networks were used to know facial expressions and it was tested and the efficiency was good up to 85%. In 2017, Patwardhan et al. [24] developed a method to understand emotional and psychological facial expressions. It used both a video channel to conduct 3D visual data, and OpenEar toolkit to conduct audio data in order to recognize expressions using audio and video. The databases used are Ald and SDK.
In 2018, Anas et al. [25] focus was on understanding facial expressions to understand what a person thinks about, such as whether or not they like the product, via a webcam. Ousmane et al. [33] developed an automatic emotion recognition system to assist in the judicial police and job interviews. A set of FER2013 data was used for recorded expressions and the face was captured by the camera and the OpenCV library was used. In this paper they did not take into account the problems of brightness and occlusion with the capture of the face, but we can take into account the problems of brightness and occlusion with the capture of the face and we can solve low-resolution images this is what distinguishes our project. Table 5. shows the similarities, differences in researches of Emotion Recognition domain.

Table 5: similarities, differences of Emotion Recognition domain

Reference	Year	Techniques	Database	Accuracy
[22]	2010	KNN	CK+ and AU-Coded Facial Expression	80% + 3%
[23]	2011	Neutral networks and PCA	JAFFE, CMU, MMI and BND	85%
[24]	2017	The video channel used for 3D data and the OpenEar toolkit used for audio data	Ald and SDK	96.6%
[25]	2018	Dlib,dlib face detector	JAFFE	-
[33]	2019	OpenCV library and CNN	set of data (FER2013)	65%

2.3.3 Limitation of Feature Extraction

Sharif et al. [26] This paper describes an illumination normalization technique, which works on the pre-processing first-stage where the face image is divided into equal sub-regions. The second stage Each sub- region is processed separately for illumination normalization third stage the segments are joined back followed by further processing like noise removal and contrast enhancem ent. Wei et al. [27] used the minimum number of clusters which only involved the training images from the most probable classes to represent a face image. The experimental results show the proposed approach showed improvement in handling multiple influence of illumination changes and occlusion technique using WLD for handling severe illumination variations. Vyas and Shah [28] they found Face recognition Rate can be improved with the hybrid preprocessing technique for PCA and LDA, and Both feature extraction technique cannot give a satisfied recognition rate for the Illumination problem so it can be improved because that PCA and LDA can be combining with other techniques as LBP, etc. for improving the face recognition rate. Anand and Shah [29] used technique PCA to reduce the dimension of the image form 2-dimensional to 1-dimensional vector. LDA was used for classification and discrimination. LDA is a technique that used for supervised learning which depends on class labels. It is appearances-based method and gives good result for face recognition. Table 6. shows the similarities, differences in researches of Limitation of Facial Feature Extraction domain.

Table 6: similarities, differences of Limitation of Facial Feature Extraction domain

Reference	Year	Limitation of feature extraction							Other techniques	Database	Result
		illumination	facial expression	ageing	noise	contrast	occlusion	Multidimension model			
[26]	2010	✓	✓	✗	✓	✓	✗	✗	LDA	IIT-Dehli	99.20 %
[27]	2012	✓	✗	✗	✗	✓	✓	✗	SR and WLD	T1-w	93.8% +0.3+ -
[28]	2012	✓	✓	✓	✗	✗	✓	✓	LDA	Yale faces	98.18 %
[29]	2016	✓	✓	✗	✗	✗	✗	✗	SURF	UMIST and Yale faces	97.78 %

Through our research in the papers, we are found some gaps such as in Face Recognition they don't detect important face part such as eyebrows and doesn't recognize face expression. In Emotion Recognition they don’t detect simultaneously mixed feelings, also they don’t detect the emotions if the person is wearing a face mask or niqab. And in Limitation of Feature Extraction the noise problem is created by illumination, that is some of the gaps.

2.4 Conclusion

In this chapter, we discuss the background of FER. The first stage of a FER system is facial acquisition where the face is captured or exposed from pictures or video clips. Then comes facial feature extraction and Representation to identify and extract facial features. Lastly, is facial expression classification, using machine learning to recognize faces and facial expressions, using classification methods such as DNN and SVM. These expressions are translated into emotions to assist officers in recognizing the meaning behind the words of the person interrogated.

We conducted a study of the related work in this field. We briefly described the most important studies in facial expression recognition, facial feature extraction, limitations and emotion identification. We then summarized and compared the key study related to our work to find their focus and gaps.

We found that there are not studies that focused on using facial expression recognition in criminal investigations in the field of computer science and also there are not studies identify feeling of women who wears niqab. In addition, many papers rely on high resolution images to perform facial expression recognition. This could be solved by pre-processing of an image with low resolution to be used in FER. In the next chapter, we will discuss our System Analysis.

System Analysis

3.1 Introduction

The previous chapter provides an overview of the system's main components, and the different techniques used in different studies in the same field and comparing them with each other, In this chapter the system will be analyzed in terms of system and user requirements. UML diagrams will be used to clarify requirements, the system allows such as, managing the organization that uses the system to access the system settings and control what the system will provide to the investigators, the investigator who can use the system to assist him in the investigation. In this project we will be building a FER system to assist police officers in interrogations and criminal investigations. This system should help a police officer identify the emotions of a person under investigation in order to understand the emotions, research has shown that there are some methods in criminal investigations to reveal if a person is deceptive not [30] [31].

The system should uncover the expressions and feelings of criminals by recognizing facial expressions even with low resolution.

HaarCascade algorithm is a classifier with an effective object detection, it can detect face with good accuracy will be used. The CNN method will be used to train the model on recognizing facial emotions since it has achieved great success in many applications of computer vision. For this project we will be using the FER2013 database since it has 7 classes classified as (happy, angry, sad …etc).

The contents of this chapter are organized as follows: Section 3.2 discusses and analysis the system and its users. Section 3.3 shows the timeline of the project. Section 3.4 summarizes this chapter.

3.2 Software Requirements Specification

The following section presents the software requirements specifications.

3.2.1 User Characteristics

There is one user in the system:

- Investigator User: They can use the system to help them analyze the facial expression of people under investigation.

3.2.2 Specific Requirements

User Requirements

- **Investigator User (IU)**
    1. The IU shall be able to log into the system
        - The user will be logged in by entering (email and password)
        - The user must verify his data entered
        - After logging in, the user can access the system functions
    2. The IU shall click on the start recording button
        - Recording will begin and the feelings of the person being investigated will be revealed
    3. The IU can press the Stop Recording button
    4. The IU should View the data of person's who have been investigated by the investigator
    5. The IU shall see the results of the analysis of the feelings of the person being investigated
    6. The IU should review the videos recorded during the investigation from the "Videos" list
    7. Create profile

- **Functional Requirements**

    - IU enter username, email and password
    - IU view the previous videos of the investigation
    - IU view results of the analysis

- **Non-Functional Requirements**

- Investigator User (IU):
    1. Capacity
    2. Security

System Requirements

- **Functional Requirements**

    1. The system should access to OS system settings
    2. The system must allow the user to create profile and login into the system
    3. The system should allow the IU to find persons in the system
    4. The system must analyze a person's feelings
        - The result of the feelings of the person who was investigated
    5. The system must allow the IU to start recording the video
    6. The system should allow the IU to save the video
    7. The system must allow the IU to view the results of the analysis
    8. The system must allow the IU to end video recording
    9. The system should allow the IU to view the data of persons have been investigated by the IU

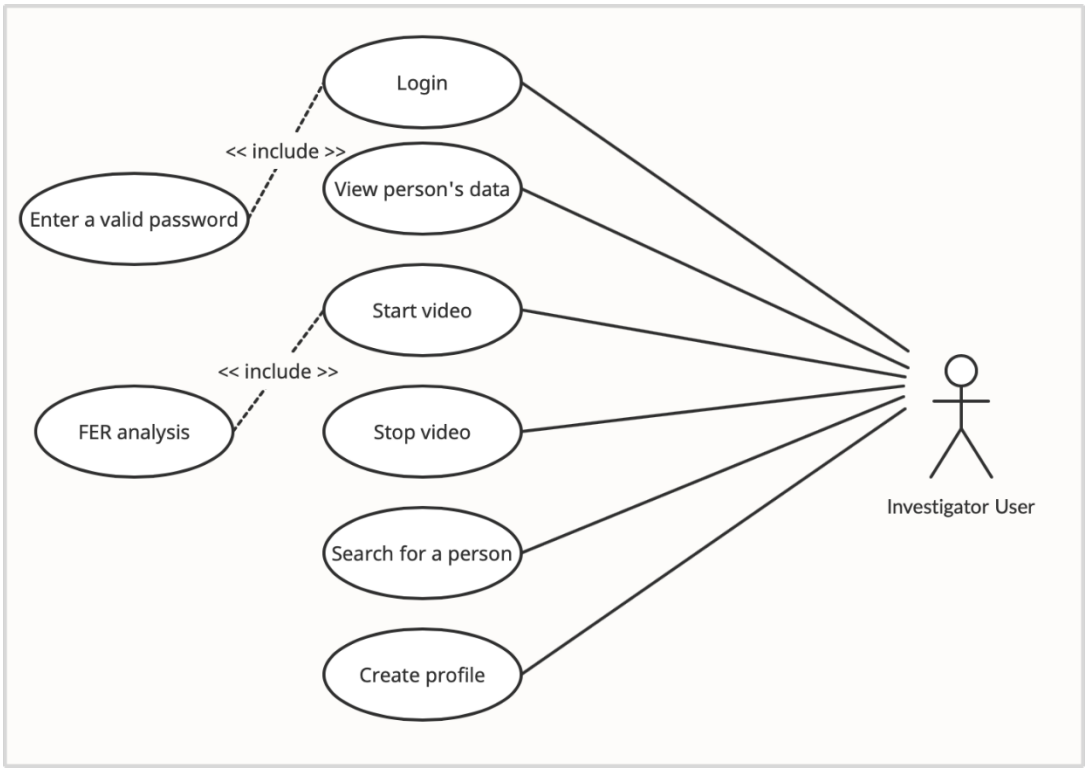


Figure 1: Use Case

Sign-up - Use case

Table 7: Sign-Up Use Case description

Use Case Name	SignUp
Goal	Allow the CU and IU to create an account
Actors	IU
Pre-condition	Download and Install system
Main Success Scenario	• Open system • Make register user request • Fill all required data • System validate entered data • If all data is validated, the account is created
Alternate Scenario	If entered data not validated, displays an error message to user. “try again”
Post-Condition	The account is created for users.

Login - Use case

Table 8: Login Use Case description

Use Case Name	Login
Goal	Allow the CU and IU to log in the system
Actors	IU
Pre-condition	Create a valid account
Main Success Scenario	• Enter the username • Enter the email • Enter the password • If forget the password set a new password via email • Press enter button • System validate entered data • If all data is validated, main page of system appears
Alternate Scenario	If entered data not validated, the system displays an error message to user. “Please verify username or password”
Post-Condition	User logged in the system

Create profile - Use case

Table 9: create profile Use Case description

Use Case Name	Create Profile
Goal	View the previous videos of the investigation, View results of the analysis
Actors	IU
Pre-condition	open system
Main Success Scenario	• Press the Create profile label • Enter the username • Enter the email • Enter the password • If all data is validated, the profile is created
Alternate Scenario	If the profile is not created, a message will appear to the user "Please make sure that the information entered is correct."
Post-Condition	The profile is created for users

Search for a specific person - Use case

Table 10: Search for a specific person Use Case description

Use Case Name	Search for a specific person
Goal	Allow the IU to search a specific person
Actors	IU
Pre-condition	IU must have a valid account
Main Success Scenario	• IU Login in the system • IU enter the person's ID in the search box • Press the search button • System displays the search result
Alternate Scenario	Research result is not available, or research parameter is wrong
Post-Condition	Get a person’s data into a table

FER analysis - Use case

Table 11: FER analysis Use Case description

Use Case Name	FER analysis
Goal	Allow the IU to view the results of the FER analysis
Actors	IU
Pre-condition	IU must have a valid account
Main Success Scenario	• IU Login the system • IU must start recording the video • The FER analysis will be shown in the recording screen • IU view the results of the FER
Alternate Scenario	If the results of the analysis do not appear
Post-Condition	IU can view the results of the FER analysis

View person's data - Use case

Table 12: View person's data Use Case description

Use Case Name	View person's data
Goal	Allow the IU to view person's data
Actors	IU
Pre-condition	IU must have a valid account
Main Success Scenario	• IU can view a person's data
Alternate Scenario	If the system can't link a person to IU, IU can't view a person's data
Post-Condition	IU view a person's information

End video - Use case

Table 13: End video Use Case description

Use Case Name	End video
Goal	Allow the IU to end the video
Actors	IU
Pre-condition	IU must have a valid account
Main Success Scenario	• IU put camera setting • Start video • Video start recording • End video • IU can delete or save the video
Alternate Scenario	If IU can’t start a video, he can’t stop it
Post-Condition	Video is ended

- **Non-Functional Requirements**

1. Reliability
   - In the system, the feelings will be analyzed, and the result will appear, the result must be reliable and correct, and the error rate that may occur does not exceed 30%
2. Capacity
   - The system can store many investigative videos on the cloud and has the ability to increase the storage area
3. Security
   - When logging in or creating an account by system users, the password must contain at least five capital letters, six lowercase letters, and seven numbers, and there must be no duplication of letters, and in this case, it can be ascertained that the password is difficult to predict by non-system users
4. Maintainability
   - The system should perform successful functions and responds to do changing on it and fixing problems

3.3 Conclusion

This chapter analyzes the system from different perspectives. First, it defined the user characteristics for controller user, investigator and their functional requirements. Then, both a functional and non-functional system requirement have been explained. In addition, a detailed scenario of the use case has been provided. Finally, a project management plan has been presented.

This system will be completed in next chapters. The methods of implementing the system, the programming languages used, and databases will be presented. Also, the system

interfaces will be designed, the system will be tested, its results will be presented, and in the end the conclusion of the system and future work.

Design

4.1 System Architecture

The hardware of the system is the computer that will have the program, the camera that will be with the computer or outside camera which connected to the computer, the wires may be needed depending in the camera. The investigator will execute the system when the person is ready to be captured by the camera. Therefore, the system will capture the face and analysis the expressions then translate it as text emotions. See Figure 2.

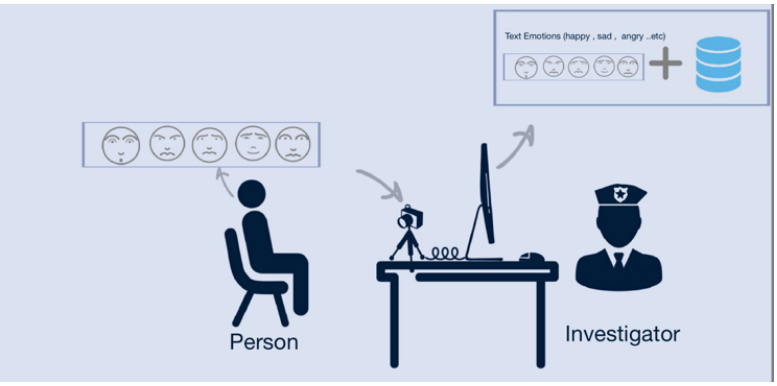


Figure 2: System Architecture

4.2 Database Design

Entity relation diagram (ERD) represent the entities and relationships between them. For the information of the accused and the investigator in system FERFI. See Figure 3.

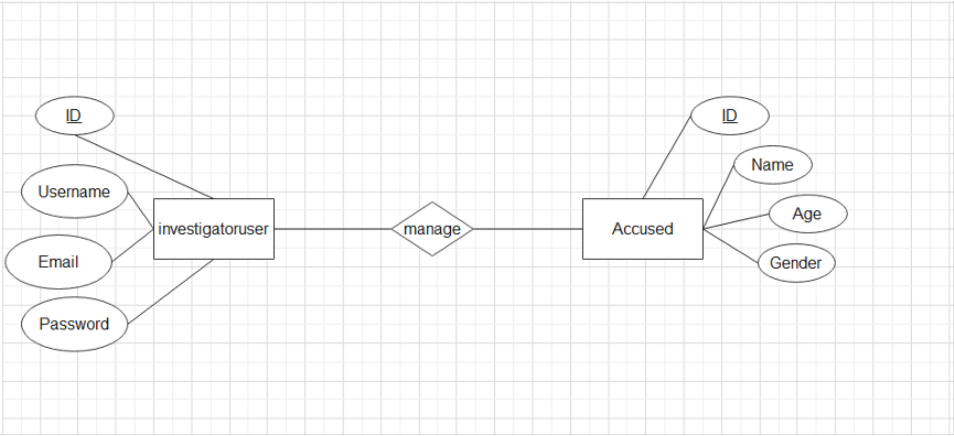


Figure 3: Database Design

4.3 Modular Decomposition

Class Diagram

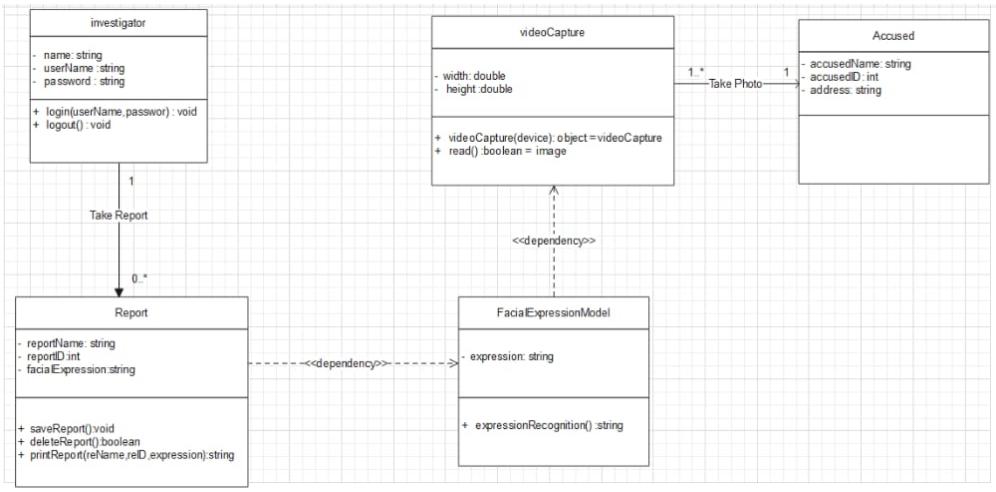


Figure 4: Class diagram

4.4 System Organization

4.4.1 Flowchart

- Data flow

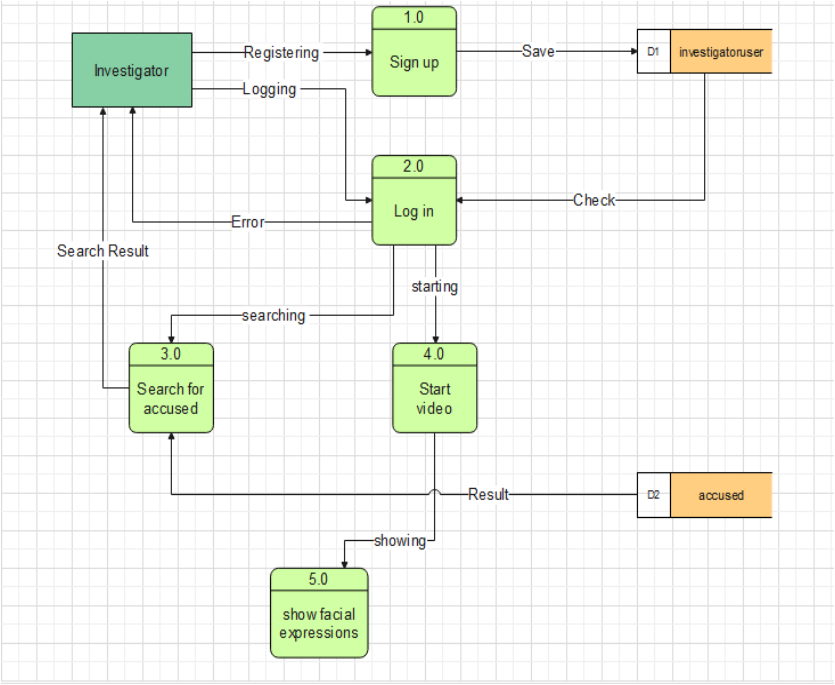


Figure 5: Flowchart of the data Flow

- Flowchart of Building the Facial Expression Recognition model

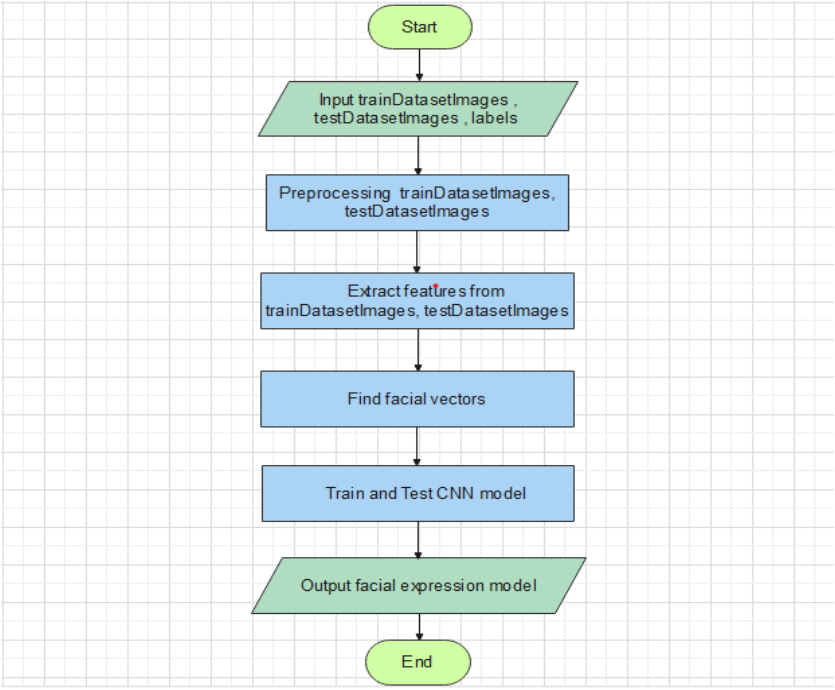


Figure 6: Flowchart of building the FER model

- **Flowchart of Facial Expression Recognition**

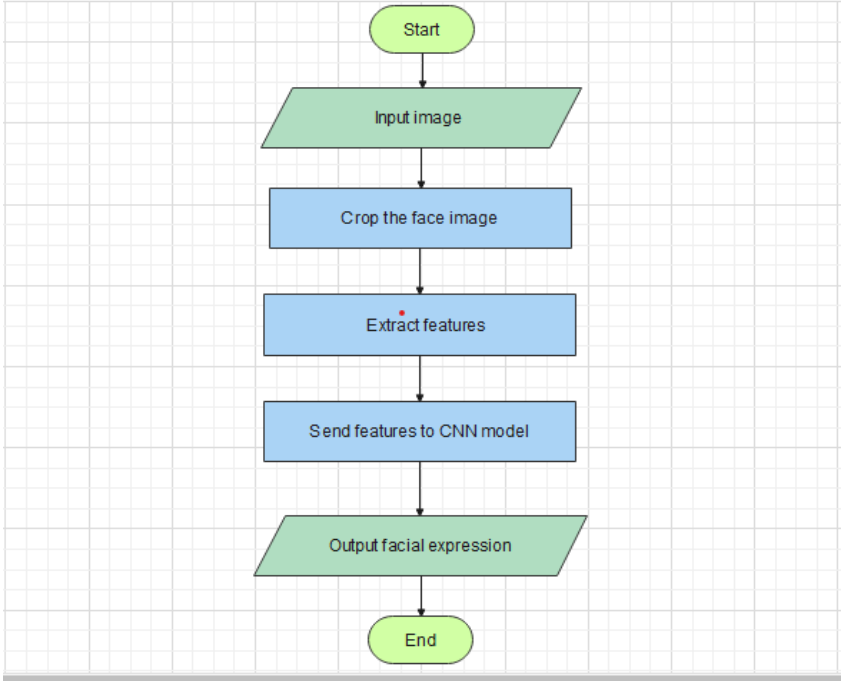


Figure 7: Flowchart of FER

4.4.2 Sequence diagrams

- Create Profile

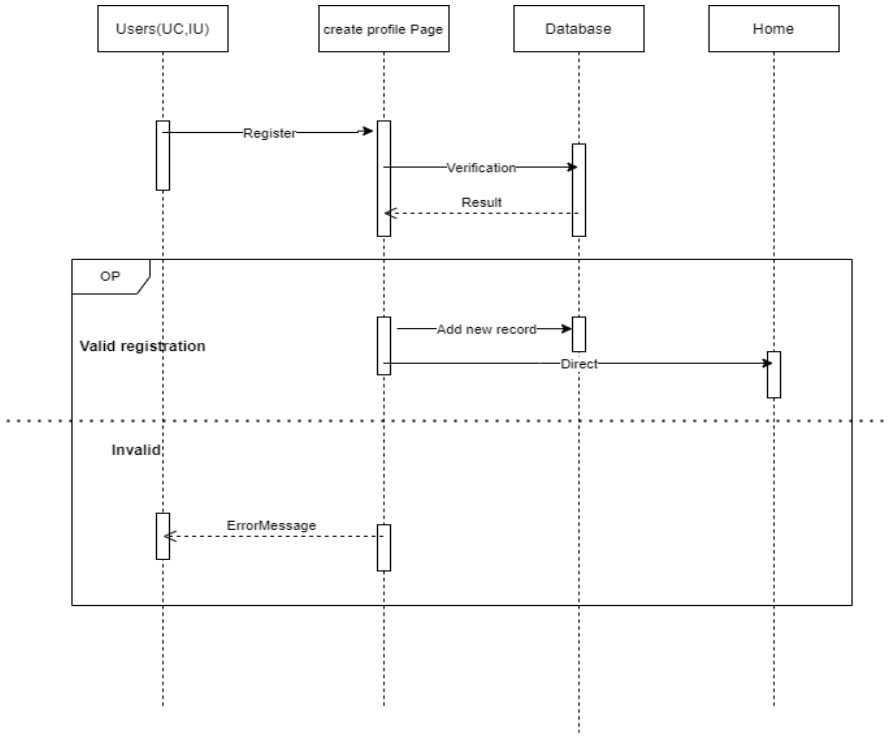


Figure 8: Create profile sequence diagram

- Whole System

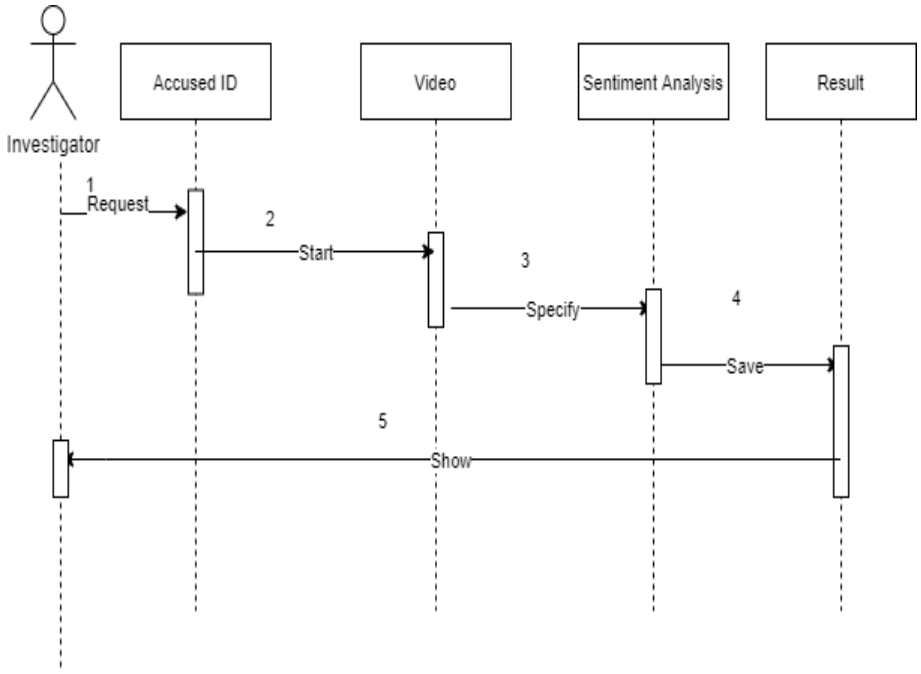


Figure 9: Whole system sequence diagram

4.4.3 Object State Diagram

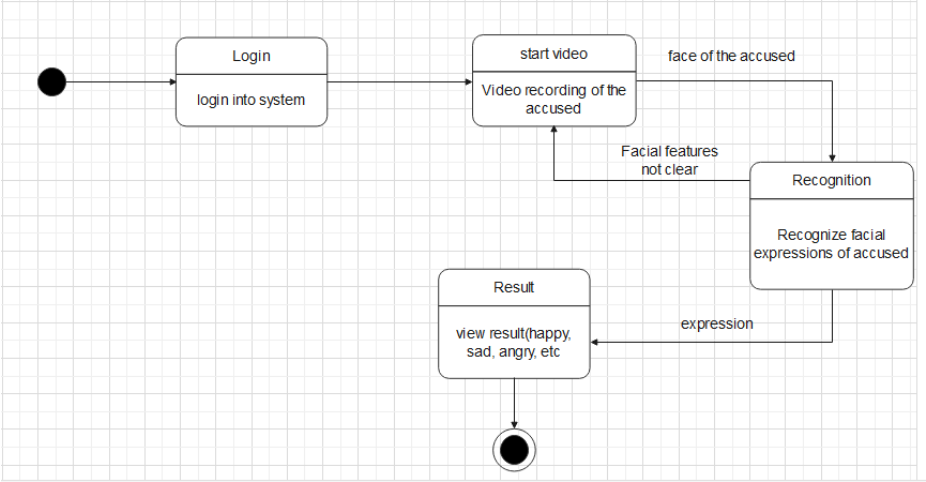


Figure 10: Object state diagram

4.6 Algorithms

- Pseudo code

Algorithms 1: Building the CNN model

Input: Train images dataset

Test images dataset

Class labels of dataset

Output: CNN Model

Begin

Read train and test images from dataset

Read labels

Preprocessing train and test images

Extract features from images

Find facial feature vectors

Train and Test CNN model

Save CNN model

End

Algorithms 2: validation CNN model

Input: Image

Output: Facial Expression

Begin

Read image from real time video

Crop the face image

Send face to CNN model

Print facial expression

End

4.7 Graphical User Interface Design

- Login

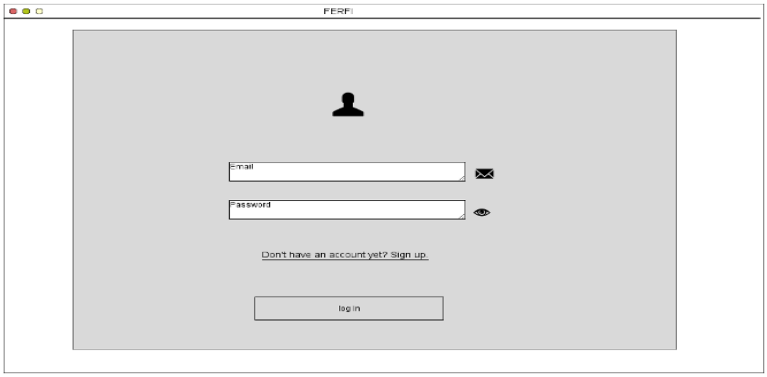


Figure 11: Login GUI

- Create Profile

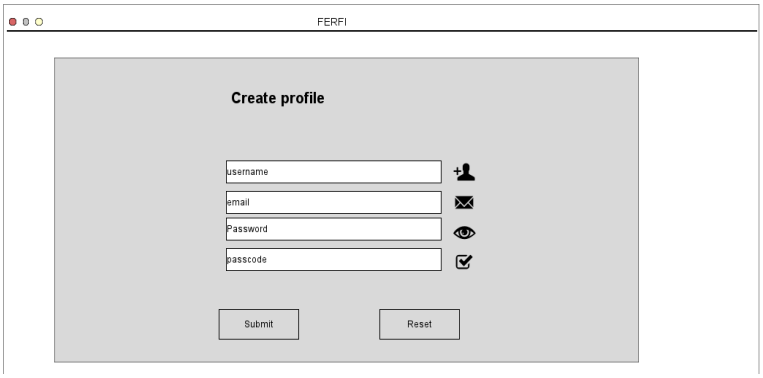


Figure 12: Create Profile GUI

- Person ID

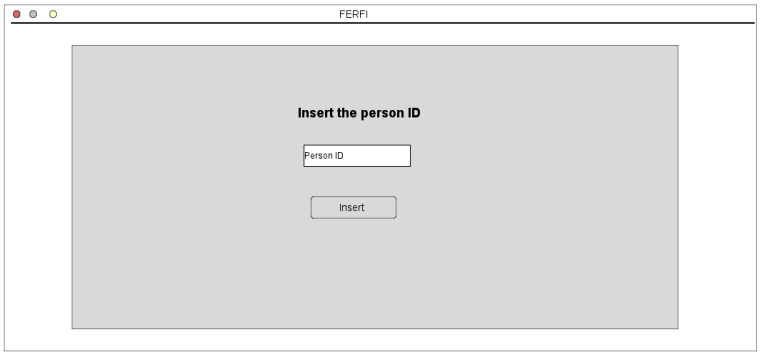


Figure 13: Person ID GUI

- Information for Person

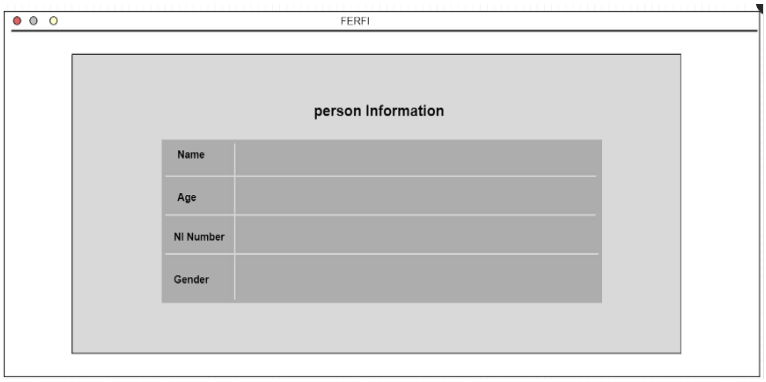


Figure 14: Information for Person GUI

- Start the Video

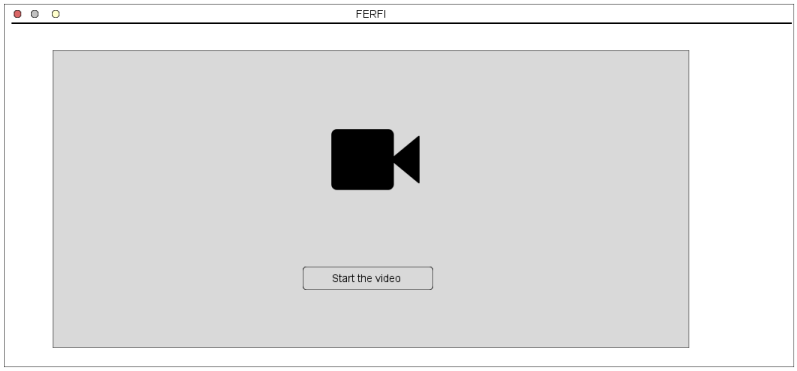


Figure 15: Start the Video GUI

- Video Recording

Figure 16: Video Recording GUI

Implementation

5.1 Introduction

The implementation phase is the most important phase in any project because it determines the success or failure of the project. Which system implementation is the fourth phase in the system life cycle for successful new system design. The project takes shape during the implementation phase. This phase involves the construction of the actual project results. It is during this phase that the project becomes visible to outsiders. At the end of the implementation, the result is evaluated according to the list of requirements that was created in the definition phase. It is also evaluated according to the designs.

In this chapter, we will discuss the implementation requirements, which shows the requirements for hardware, software, tools, and techniques used in the FER system. We will also discuss implementation details, which shows deployment and installation details, main and base user interface details, and dataset details.

5.2 Implementation Requirements

To complete this project, we were used different software and hardware tools. In this section we will report about the tools that we use to implement this system.

5.2.1 Hardware Requirements

The hardware specifications required to implement this project are a Dell computer with an Intel Core i7 processor, 8 GB RAM, windows 10 pro, and an Intel Iris Xe graphics card. See Table 14. The reason for choosing this device is that artificial intelligence and deep learning projects need high-quality devices in order to train the neural network model faster and get good results in a shorter time.

Table 14: Hardware requirements

Computer type	Dell XPS
Processor	Intel Core i7-1165G7
RAM	8 GB
operating system	Windows 10 pro
Camera Type	The camera that inside Dell XPS

5.2.2 Software Requirements

a. **Google Colab**: Which it's the best for developing the Python programming language. Which it's allowing the programmer for combining the executable code and also for dealing with images, which it is allowing the programmer to writing and execute the Python programming language in the browser. Colab helps us to make our worker easier. Which it's also easy for sharing.

b. **Visual studio code**: We used this program to design user interfaces for the site in the languages: HTML, CSS, JavaScript

c. **Microsoft Word**: Which we need that for typing any comments or documentation associated to the project.

5.2.3 Programming Languages

The programming languages used to implement the FER system are the Python programming language, which was used to build and train the neural network model. This model was trained and tested on the "FER2013" dataset, which was downloaded from the "KAGGLE" website, where the Python codes were implemented on the "Google Colab" platform. We have used it because it's easy to learn and we have found it's easy to find online videos for learning Python, and also because it's the most programming language that is have a pre-built library for image processing, data processing, deep learning, machine learning and more.

We also used Hyper Text Mark-up Language (HTML) to design and build user interfaces in addition to JavaScript and CSS to add interactivity and functionality to the system.

5.2.4 The Used Dataset

We have used the dataset FER2013, which we have downloading that from the website Kaggle [34].

5.3 Tools and Technologies

The used libraries

CV2: The used library is CV2, which it's the name of OpenCV. Its library used by the programming for real-time computer vision. And we have used that at our project for determining the shape of the face, and also for dealing with the images.

The used tools

- **Deep learning:**
    - Deep learning is part of a broader group of machine learning methods based on artificial neural networks with representational learning. Learning can be supervised, semi-supervised, or unsupervised.
    - It’s a class of machine learning algorithms that uses multiple layers to progressively extract higher-level features from the raw input. For example, in image processing, lower layers may identify edges, while higher layers may identify the concepts relevant to a human such as digits or letters or faces.
- **Computer version:**
    - Its Software versioning is a way to categorize the unique states of computer software as it is developed and released.
- **CNN:**
    - A Convolutional Neural Network (CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other.
    - The importance of CNN is to reduce the images into a form which is easier to process, without losing features which are critical for getting a good prediction.

- We have used Keras model to do the pre-processing step.
- The extracted features are face edges, corners and diagonal distance Between the lips and the eyes.

So, we can abbreviate the used programming languages and tools as the following Table 15.

Table 15: Programing languages and tools

Programming languages	Python, HTML, CSS, JavaScript, php
Platforms	Google colab, visual studio code
Dataset	FER2013

5.4 User Interface Implementation

The interfaces of the FERFI system were created using HTML and CSS because together they have greater consistency in the design interfaces and the ease of presenting different styles to different viewers, in addition to the JavaScript language, which makes the interfaces dynamic and allows the system to open the camera. The interfaces of the system are designed using basic colors that are comfortable to the eye in order not to disturb the investigator or the accused while using the system. The FERFI system has many interfaces. The first interface in the system is the main interface of the system, through which it is moved to the login page of the investigator or the page for creating the profile. See Figure 19 and 20. The next interface is the interface for entering the personal number of the person. See Figure 21. The next interface is the person's personal information interface, in which the person's information is entered through the investigator. See Figure 22. Finally, the last interfaces are for opening the video camera and analyzing the person's facial expressions and stop the video. See Figure 23 and 24.

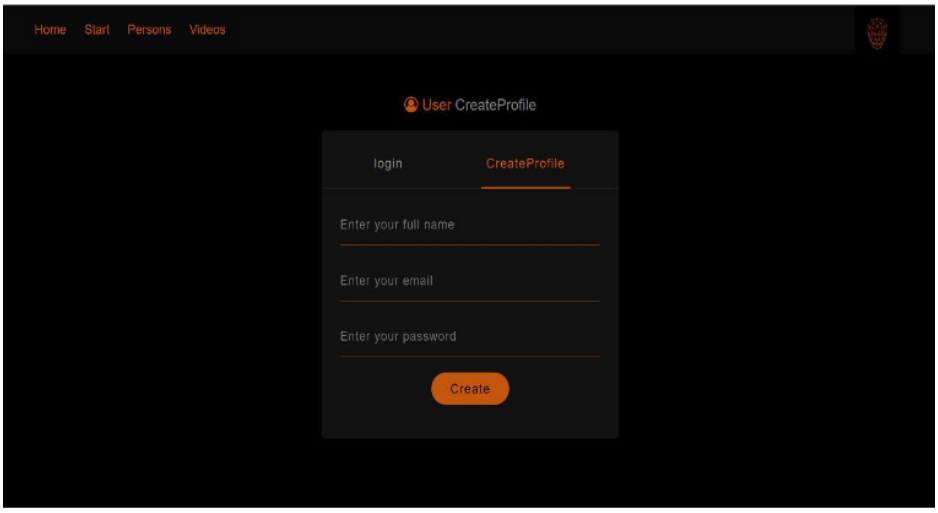


Figure 17: Create profile interface

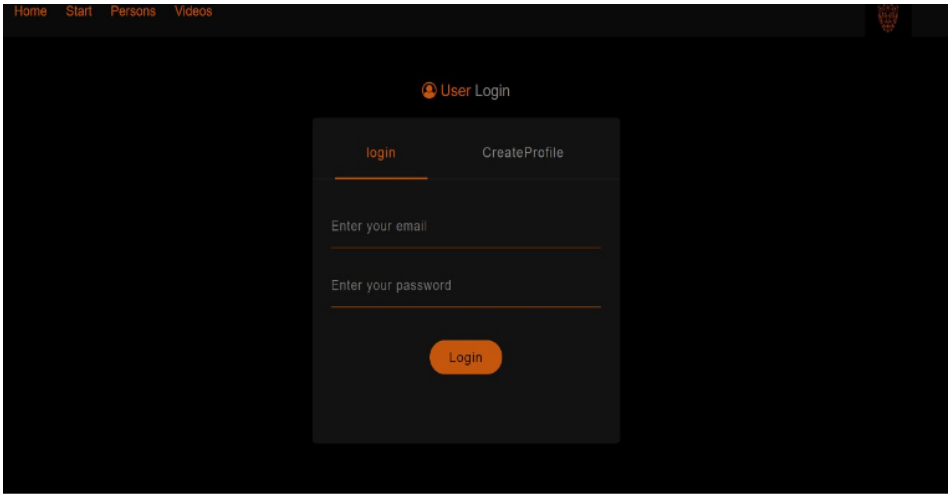


Figure 18: Login interface

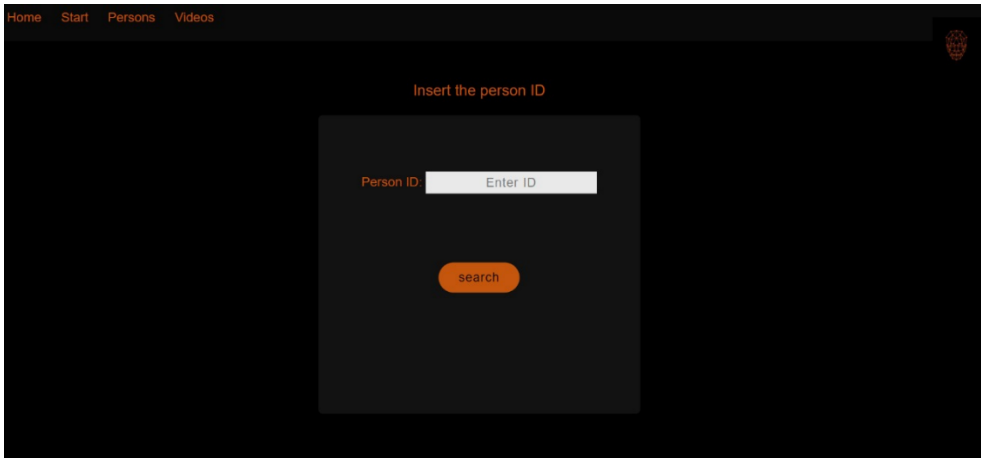


Figure 19: Insert person ID interface

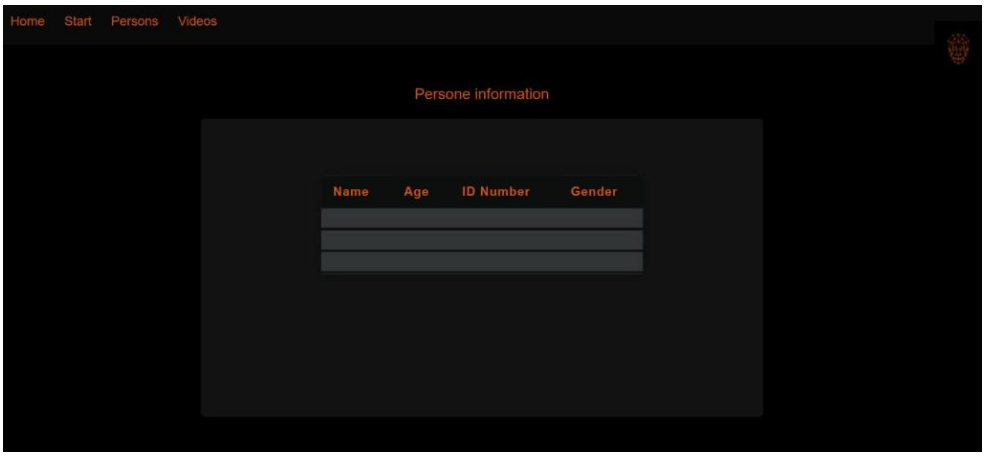


Figure 20: Accused Information interface

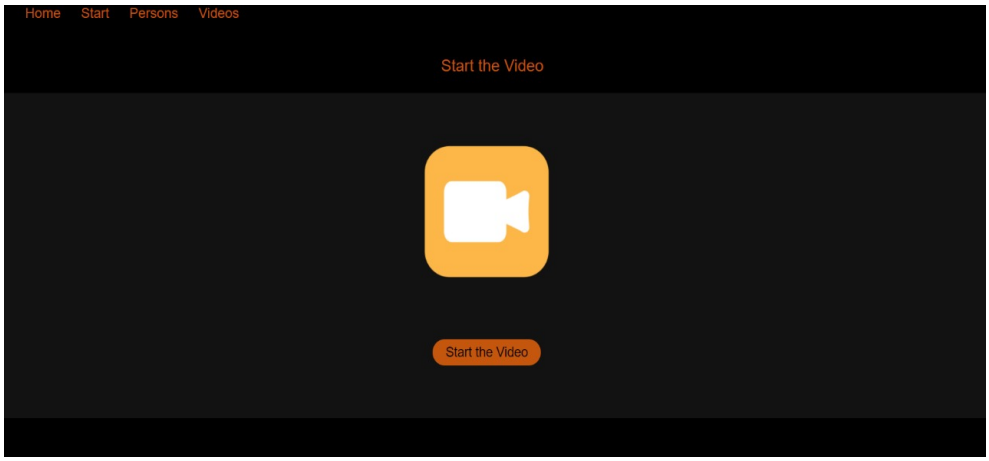


Figure 21: Open Video Camera interface

Figure 22: Analysing person's FR and stop video interface

5.5 Database Implementation

The CNN model of the FERFI system was trained on FER-2013 dataset for Emotion recognition from images. The model of the FERFI system is capable of recognizing seven basic emotions as following:

1. Happy
2. Sad
3. Angry
4. Neutral
5. Disgust
6. Fear
7. Surprise

The FER2013 dataset consists of 28,709 images in the training set and 7,178 images in the test set. See Figure 25. Each image is labeled as one of seven expressions (Sad, Happy, Surprise, Angry, Disgust, Fear, and Neutral).

Figure 23: FER2013 dataset

This dataset has two steps to implement:

Step 1: upload dataset file to Google colab. See Figure 26.

```
#upload dataset file from my local file system
from google.colab import files

uploadFile = files.upload()

for fn in uploadFile.keys():
  print('User uploaded file "{name}" with length {length} bytes'.format(
      name=fn, length=len(uploadFile[fn])))
```

Figure 24: Upload dataset

Step 2: extract all images from dataset file. See Figure 27.

```
#extract all images from dataset file zip
from zipfile import ZipFile
fileName = "archive.zip"

with ZipFile(fileName, 'r') as zip:
  zip.extractall()
  print("Success")
```

Figure 25: Extract all images

We have also used MYSQL database for building some tables for users' login which we preview in the tables as the following Figure 28 and 29.

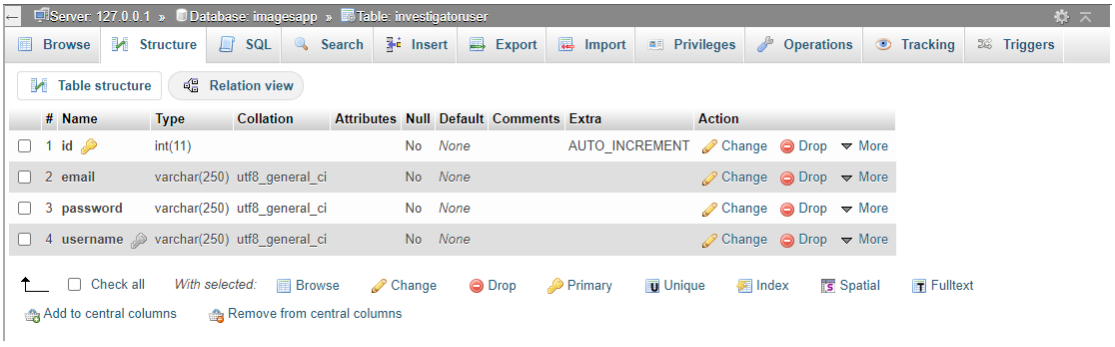


Figure 26: Investigator table

And at the previous table, we have made the investigator table for the login users into the system, which we need for that table the username, email and password of the users.

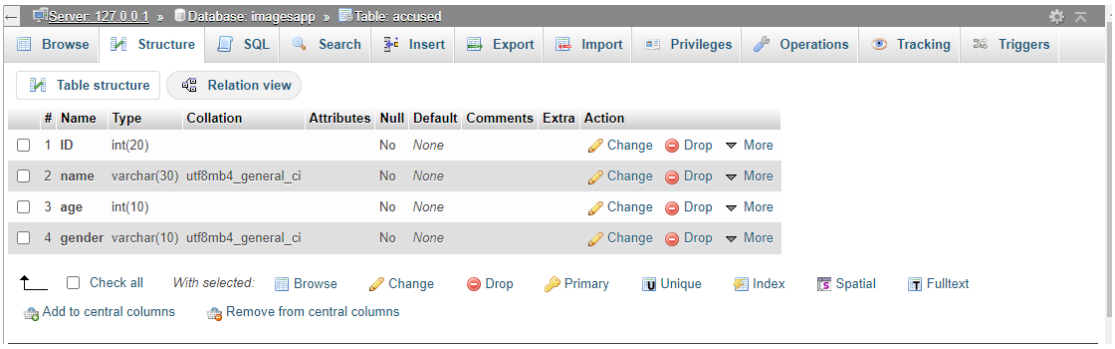


Figure 27: Person's table

And at the previous table, we have made the person's table to register the person users into the system, which it has the id as primary key, and the name of user, age, and gender.

5.6 Procedures Description

5.6.1 Import Packages

The FERFI system uses many of the AI and deep learning packages built into the Python language. See Figure 30. This section will explain main packages and functions. See Table 16.

```
from keras.preprocessing.image import ImageDataGenerator
from IPython.display import display, Javascript, Image
from keras.preprocessing.image import img_to_array
from keras.layers import Dense, Dropout, Flatten
from tensorflow.keras.optimizers import Adam
from google.colab.patches import cv2_imshow
from google.colab.output import eval_js
from base64 import b64decode, b64encode
from keras.layers import MaxPooling2D
from keras.preprocessing import image
from keras.models import Sequential
from keras.layers import Conv2D
from keras.preprocessing import image
import matplotlib.pyplot as plt
from time import sleep
import numpy as np
import cv2
import PIL
import io
import html
import time
```

Figure 28: System packages

Table 16: Main packages and functions

	Name	**Description**
Packages and libraries	OpenCV	is an open-source computer vision and machine learning software library which is easy to import in Python
	Keras	It is an open-source neural network library written in Python. It contains ready-made modules for many of the basic components used in building neural networks such as layers, target functions, activation functions, optimization methods, and a set of tools to make working with image and text data easier to simplify the coding required for deep neural network programming
	NumPy	It is an open-source Python library used for large, multi-dimensional arrays and matrices
	Face-api-js	For face recognition
Classes and methods	ImageDataGenerator ()	It is a function in the keras library. This function helps us to improve the data in the batch, and to expand the size of the data set
	Save ()	Function to save the model
	Compile ()	Function to compile and training the model
	load model ()	Function to load model

5.6.2 Building and Training CNN Model

The FERFI neural network model was built and trained using the keras library. See Figure 31 [35].

```
#Building the CNN Model
expression_model = Sequential()
expression_model.add(Conv2D(32, kernel_size=(3, 3), activation='relu', input_shape=(48,48,1)))
expression_model.add(Conv2D(64, kernel_size=(3, 3), activation='relu'))
expression_model.add(MaxPooling2D(pool_size=(2, 2)))
expression_model.add(Dropout(0.25))
expression_model.add(Conv2D(128, kernel_size=(3, 3), activation='relu'))
expression_model.add(MaxPooling2D(pool_size=(2, 2)))
expression_model.add(Conv2D(128, kernel_size=(3, 3), activation='relu'))
expression_model.add(MaxPooling2D(pool_size=(2, 2)))
expression_model.add(Dropout(0.25))
expression_model.add(Flatten())
expression_model.add(Dense(1024, activation='relu'))
expression_model.add(Dropout(0.5))
expression_model.add(Dense(7, activation='softmax'))
```

```
#Compiling and Training the Model
expression_model.compile(loss='categorical_crossentropy',optimizer=Adam(lr=0.0001, decay=1e-6),metrics=['accuracy'])
expression_model_info = expression_model.fit_generator(
        train_generator,
        steps_per_epoch=28709  // 64,
        epochs=100,
        validation_data=validation_generator,
        validation_steps=7178  // 64)
```

Figure 29: Building and training for CNN model

5.6.3 Connect CNN Model

After we finished building and training the neural network model, we connected this model to the website using JavaScript. See Figure 32.

```
async function models_load() {
    await faceapi.nets.ssdMobilenetv1.loadFromUri('/cnnModel')
    await faceapi.nets.faceExpressionNet.loadFromUri('/cnnModel');
    opent_video_stream();
}

models_load()
```

Figure 30: Connect CNN model

5.6.4 Connect Camera

The camera used is the laptop camera and we connected to it through JavaScript. See Figure 33 [35].

```
function startVideoStream() {
    if (navigator.mediaDevices.getUserMedia) {
        navigator.mediaDevices.getUserMedia({ video: true })
        .then(function(stream) {
            video.srcObject = stream;
        })
        .then(makePredictions)
        .catch(function(error) {
            console.log(error);
        });
    }
}
```

Figure 31: Camera connect

5.6.5 Face Detection and Expression display

After we finished writing the codes to connect to the camera, we used the codes shown in Figure 30 [36], which we copied from "Github". These codes we used to detect the face and display expressions.

```
const cnvas = document.getElementById('canvas');
const display_size = { width: videoLive.width, height: videoLive.height };
faceapi.matchDimensions(cnvas, display_size);
setInterval(async function() {
    const detections = await faceapi.detectAllFaces(videoLive).withFaceExpressions();
    const resizedDetections = faceapi.resizeResults(detections, display_size);
    cnvas.getContext('2d').clearRect(0, 0, cnvas.width, cnvas.height);
    faceapi.draw.drawDetections(cnvas, resizedDetections);
    faceapi.draw.drawFaceExpressions(cnvas, resizedDetections);
}, 100);
```

Figure 30: Face detection and expression display

5.7 Conclusion

The system was built and implemented by doing four tasks which are building and training the CNN model, database, interfaces, and the camera. Each of these tasks is considered an important part of the system and performs specific functions, we did try to make the system capable of recognizing wither the person is lying or not, but we couldn't, therefor this capability will be considered as a future work of the system.

In this chapter, we discussed languages, software tools used, database implementation details, interfaces, packages, and libraries used, in addition to Procedures Description. The next chapter is the chapter test will discuss test methods and how to test the FERFI system.

Testing and Results

6.1 Introduction

Testing consider an important process of the project. It shows whether the system is capable of performing the desired results. We test the system to find errors, defects, flaws, bugs. We may test the system in the last stage or perform it after each stage of the implementation. In our Facial Expression Recognition for Investigations project, we test the system after the implementation. In our project we use four testing techniques, Unit Testing, Integration Testing, System Testing and Test Cases. In this chapter we briefly discuss our system testing and the testing results.

6.2 System Testing

6.2.1 Unit Testing

- Hardware component: camera within a laptop works successfully.
- Software: implement the programming languages that been demonstrated in the previous chapters. See Table 17.

Table 17 : Implement the programming languages

Components	Considerations	Pass/Fail
CSS	A professional layout	Pass
HTML	Good visualization Effective navigation	Pass
PHP	Correct connection Retrieve from Database when needed	Pass

Python	Train the CCN model	Pass
JavaScript	Import face-api library Use library modules/weight in correct manner Implement face detection function Translate detection function to correct labels Create live video stream using a webcam	Pass

6.2.2 Integration Testing

First, we start with **HTML and CSS** integration which was excellent, we make sure that the design is constant and has an appropriate appearance for the user, also we ensure an easy navigation on the web pages. **PHP** integration with HTML and CSS, we link our website with phpMyAdmin Xampp server and the integration was successful. See Figure 32 – Figure 36.

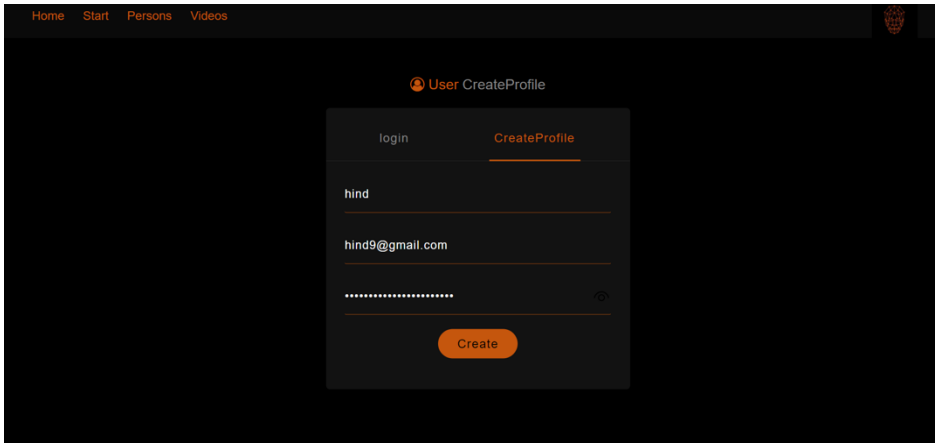


Figure 32: Create profile for a new user

Figure 33: The new user is successfully inserted in the table

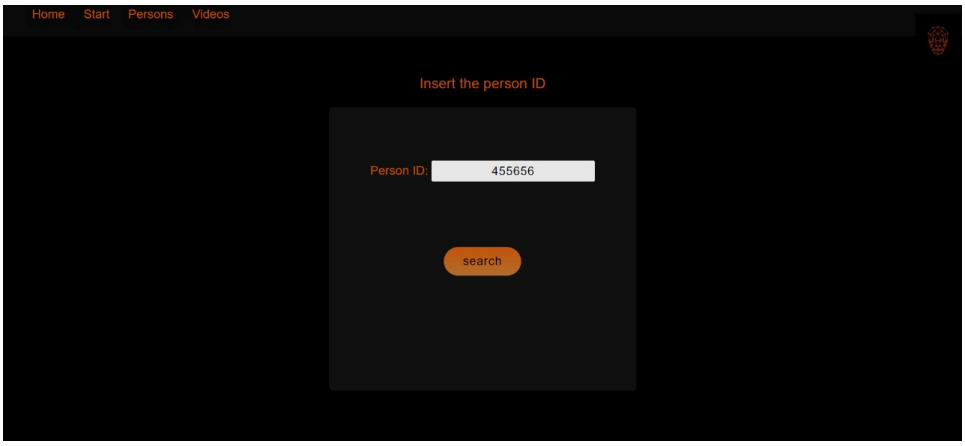


Figure 34: Search for a person information by the ID

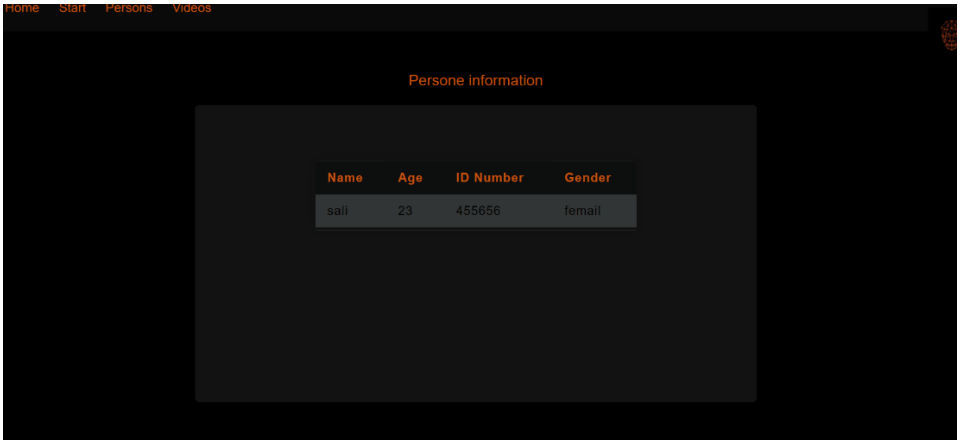
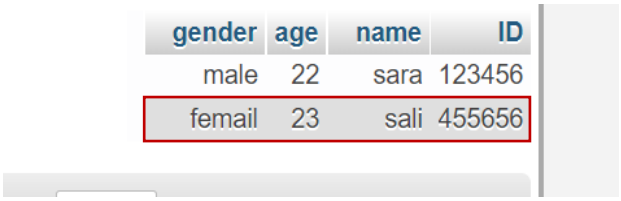


Figure 35: Successful retrieve of the person information



gender	age	name	ID
male	22	sara	123456
femail	23	sali	455656

Figure 36: Person information in person table

Python integration is done using google collab, we train the model using CNN, we face some problems in the CNN as we were training the model the accuracy was low, therefor we solve this problem by increasing the number of training times for the model, it went from 50 to 100 training times. **JavaScript** integration was to detect the face and emotions. Implementing

the face-api library has shown good results in detecting the face. The model faceExpressionNe also perfume an excellent emotion detecting. See Figure 37 – Figure 39.

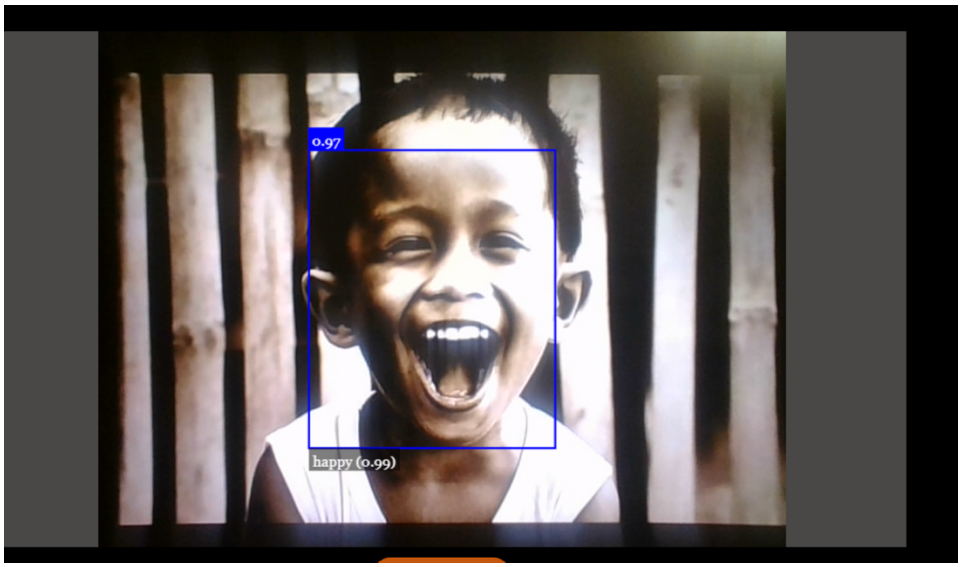


Figure 37: Happy emotion test

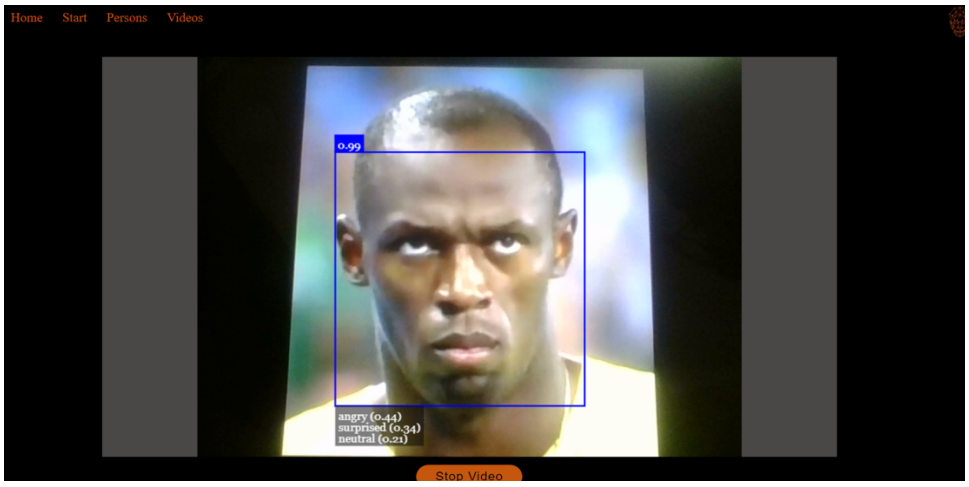


Figure 38: Angry emotion test

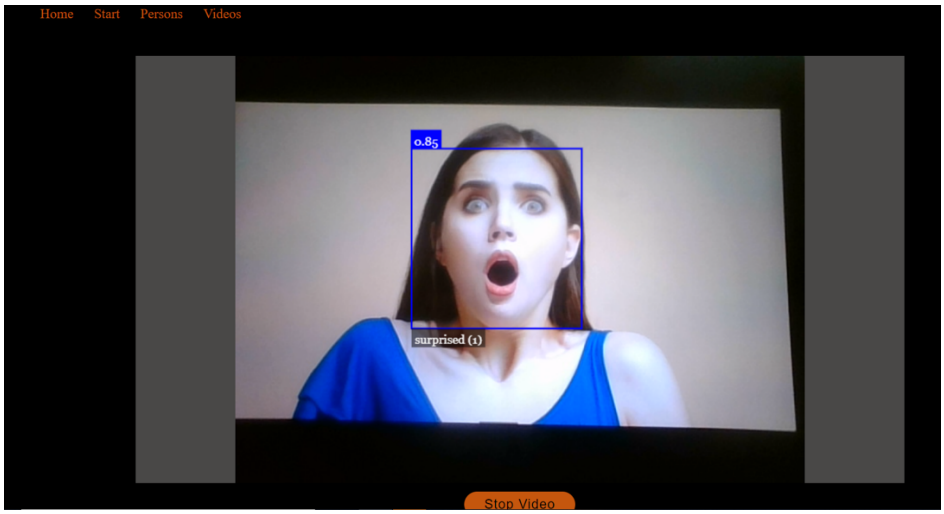


Figure 39: Surprised emotion test

We had difficulty about the mask and niqab part, we couldn't find a database that serve our purpose which is people wearing mask or niqab classified upon their emotions, therefor we create our own database, and we try to increase the accuracy in this part as much as we can. See Figure 40 and Figure 41.

Figure 40: natural emotion test with mask

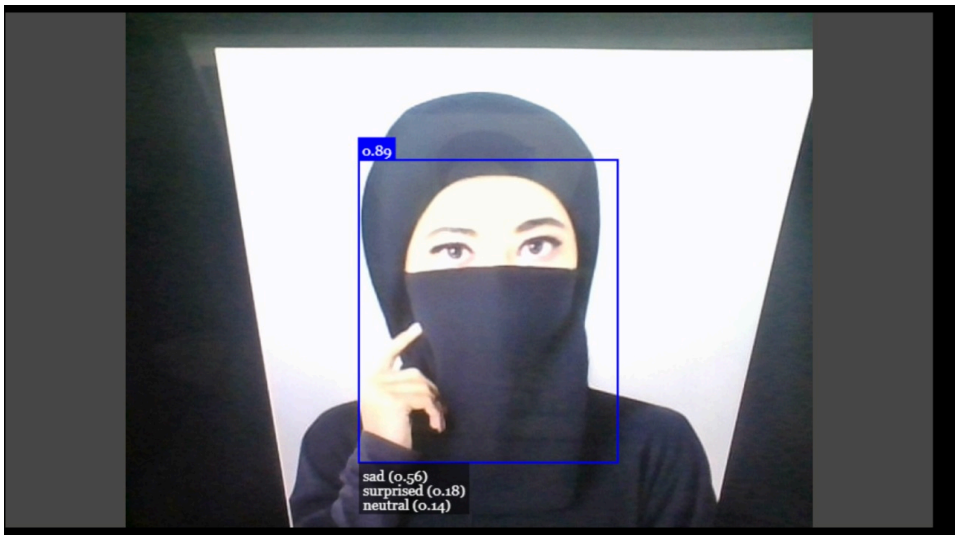


Figure 41: natural emotion test with niqab

6.2.3 Test Cases

We test our Facial Expression Recognition for Investigations system by various test cases which are shown in the tables below. Table 18 – Table 22.

Table 18: Create profile test case

Create profile	
Input	• User's name • User's email • User's password
Expected output	The account is created
Output	The system let you in
Pass/Fail	Pass

Table 19: Login test case

Login	
Input	• User's email • User's password
Expected output	Enter the system
Output	Enter the system
Pass/Fail	Pass

Table 20: Search for a specific person test case

Search for a specific person	
Input	Enter the person's ID
Expected output	A table containing the person's data (ID, name, age, gender)
Output	The system views the person's table with its information
Pass/Fail	Pass

Table 21: Start a video test case

Start a video	
Input	The investigator clicks the start video button
Expected output	The video start

Output	The browser asks to allow the webcam to record, then the video started
Pass/Fail	Pass

Table 22: Analyzing person's emotions test case

Analyzing person’s emotions	
Input	A live video of the person
Expected output	Labels showing the person’s emotion
Output	Emotions of the person are shown at the screen
Pass/Fail	Pass

6.3 Conclusion

This chapter discuss the testing of the system, it starts with the unit testing which test main component for the system such as the hardware and software used. Then the integration test that test the implemented languages and the error we faced during the implementation along with their solution. Last, we consider some test cases with their input, output and expected behavior.

In the next and last chapter, we will discuss the Conclusion and Future Work.

Conclusion and Future Work

7.1 Conclusion

Facial expression recognition for investigations (investigators' camera) is a project to identify expressive situations that a person shows feelings (sadness, happiness, ... etc.), which helps the investigator to detect a person's feelings during investigation faster and more FERFI aims to help the investigation field to detect the feelings of the person who cannot show them, by revealing his feelings by opening the camera and starting the live video, the result will be shown through the live video relatively (0.99 happy, 0.88 angry…..etc.).

This project starts by turning on the camera to start the live video. When the live video starts, the face is determined and the result of the sentiment analysis is acquired: happy, angry, surprised, sad, fearful, neutral, disgusted. The system will recognize the emotion even if the person is wearing a mask or a niqab.

The investigator can see the data of the person being investigated through the person's information page, where it displays the person's personal information, and the FERFI team has dealt with and faced artificial intelligence obstacles in dealing with live video, face aspects, and changes. Status (emotion) in time.

The project can be developed later, adding other features, or using other languages to recognize faces or increase accuracy. This application is built using several languages: HTML, CSS, and JavaScript for web design. The site is linked to PHP to connect to the database.

7.2 Future Work

Due to the lack of sufficient resources for women wearing niqab in the future, it is possible to develop the system to increase the accuracy of detecting the feelings of women wearing the Islamic headscarf. Also, a website can be developed, where a summary of the result of sentiment analysis can be shown after the end of the video to concludes wither the person is lying or not, and the live videos of the investigation can also be saved and reviewed through the site.

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