THIS FORM IS FOR THE GENERAL PROGRAMME ONLY

Artificial Intelligence P R O J E C T (C O V E R S H E E T)

Discussions Scheduled for Week 12 *(more details will be announced later)*.

- Print 1 copy of this cover sheet and attach it to a printed copy of the documentation *(SRS, … etc.)*. You must also submit softcopies of all your documents *(as PDFs)*; details will be announced later.
- Please write all your names in Arabic.
- Please make sure that your students' IDs are correct.
- Handwritten Signatures for the attendance of all team members should be filled in before the discussion.
-

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Biometrics: Automated Face Recognition using Artificial Neural Networks.

Project Id : 18

Team Id : 79

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1.Project idea in details

The face recognition/detection process is considered one of the most popular applications in image processing and biometric pattern recognition systems. Although the face recognition approach improves the authentication procedure, many challenges still appear due to diversities in human facial expression, colossal image size, background complexity, variation in illumination, poses, blurry, etc. Therefore, the face detection procedure is classified as one of the most challenging tasks in computer vision. We will review the implementation of image processing based on the Artificial Neural Network approaches. ANNs represent it as a potential capability to enhance the method of extracting face patterns through an adaption of various ANN topologies. Furthermore, it means fundamental phases associated with the construction of any facial recognition system. Finally, it provides a comparison of different literature studies related to face recognition based on varying ANN approaches and critically analyzed them.

1.1.Introduction

Many organizations draw their attention to maintain high information security level and control the grant access to the system by authenticating the individual's identity to evade cybercrime issues. On the other hand, standard authentication techniques such as PIN, password, username, ID card number, etc., become inefficient techniques. With the excessive advances in software computing and image processing, many emerging

methodologies appeared mainly to improve the authentication procedure (Bhattacharyya et al., 2009). The "Biometric" word is constructed through combing "Bio" and "metrics" words which refer to useful sciences that concern is analyzing and measuring biological information through adapting intelligence machine learning and various mathematical algorithms. Nowadays, Biometrics Pattern Recognitions (BPR) methodologies are widely useable systems. It was defined as an efficient information system that is mainly employed to detect, verify, and authenticating individuals' identity based on some of its behavioral characteristics like body movement, keystroke writing style, and unique physiological factors such as fingerprint, eye retina, or eye iris, voice pattern, DNA, facial pattern and handshape (Bhattacharyya etal., 2009).

The recent development in machine learnings and technologies; makes it possible to generate an intelligence system based on statistical learning methodologies as a Facial Recognition (FR). Although, the FR system is considered one of the significant applications in image processing. However, this form of recognition may deliver great challenges in computer vision and pattern recognition due to many reasons such as diversities in facial expressions, orientation problems, illumination effects, and image size and background complexity (Khan et al., 2019).

Although many researchers place considerable efforts in this area to overcome the limitations of FR through the use of the Artificial Neural Network approach, many issues are still required to be solved. In general, the FR system analyzes the individual's facial characteristics from an image that is entered as input into the system. This image will go through a reprocess phase to extract all

essential information based on using specific algorithms like the Deep Learning Algorithm (DLA) to recognize the target individual at the end (Khan et al.,2019).

1.2. Structure of Face Recognition System

The construction of any Biometrics Recognition system like face recognition consists of four main contemporaries phases: face detection, preprocessing, feature extraction, and face recognition (Shaaban, 2021; Hassin & Abbood, 2021). It serves individuals' verification and identification purpose. The image acquisition is made through a video camera or importing it from a database, and then this image goes further over different phases.

1.2.1. Face Detection Phase

Detecting the target face image from a captured image or selected image from the DB is considered as the core function of this phase. Actually, the main purpose of the face detection process is to make sure and verify whether a given image has a face image region or not. When finish segmenting and detecting the target face area or region of concern, this output will be delivered into the preprocessing phase for further progressions (Zhao et al., 2003).

1.2.2. Preprocessing Phase

The image pre-processing steps usually forms as a combination of three important modules which are: histogram equalization, detection of edge, and matching of token that applied to enhance image quality, identify the edge point in the digital image, and finally perform removal and normalization based on specific

algorithms (Al-Hatmi & Yousif, 2017; Hasoon, 2011). Through preprocessing technique, all undesirable image effects can be removed such as image noise, distortion, blur, shadow, or filters and it will make normalization for the image to generate smooth face image as an output which then will be utilized in extraction phase (Saudagare & Chaudhari, 2012)

1.2.3. Feature Extraction Phase

This stage will receive the detected face image region as an input. Through using feature extraction algorithms,
all face characteristics will be extracted effectively from the face region such as the distances among eye, lip, and nose features (Saudagare & Chaudhari, 2012). The main purposes of feature extraction process are to perform specific functionalities including packing of information, cleaning of noise, and do salience extractions. After that, the obtained information is transferred into a vector for the subsequent process and use like comparison of obtained feature with stored data (Bhele & Mankar, 2012).

1.2.4. Face Recognition Phase

This is the last phase, and it is utilized to achieve automatic authentication and identification of the individuals.
To achieve this goal, each face recognition system should maintain a face DB that stores information about all extracted faces features in which for each individual several images should be taken and then extracted features stored in this dedicated DB (Bhele & Mankar, 2012). Consequently, the extracted features information that is received from the previous phase will be compared to each face class that stored in DB to perform authentication and

recognize the person and the algorithm return the identity (Raheja & Kumar U, 2010).

1.3. Artificial Neural Network Background

In the last decade, various models and architectures of Artificial Neural Network (ANN) have been developed and widely utilized for face detection and recognition based on the neural network (Kasar et al., 2016). An Artificial Neural Network (ANN) is an information processing paradigm that behaves like biological nervous systems. ANN is a powerful mathematical tool that processes input information to efficiently simulate or predicate the desired output data (Yousif & Sembokb2006a; Yousif & Sembokb2006b). Many ANN models are adapted in the development of different multi-view face recognition systems because these models have great ability and essential roles to efficiently simulate the methodology of neurons work and structure like in the human brain (Boughrara et al., 2012). Therefore, a Neural network (NN) is considered a robust classification methodology that works correctly in non-linear or linear datasets. It had been employed not only for face recognition applications but also in diverse areas such as fingerprint recognition, voice recognition, iris recognition, Natural Language processing, etc. (Yousif & Sembokb2005; Yousif & Fekihal 2012).

The effectiveness of NN and its increased use could be due to its ability to work in a non-linear network (Boughrara et al., 2012). Therefore, the feature extraction phase of face characteristics through using NN is more effective and efficient than using the

linear karhunnen-loeve technique (Lawrence et al., 1997). The first ANN technique utilized for face recognition is a single-layer adaptive network known as "WISARD" (Stonham et al., 1986). The WISARD comprises a distinct network for each stored person. Constructing the NN structure is critical for making a successful face recognition system, and the model that should be applied depends on the intended application objectives (Stonham et al., 1986). Commonly, Convolutional Neural Network (CNN), as well as Multi-layers Perception (MLP) structure, have been employed for the aim of face detection (Sung & Poggio,1995). On the other hand, the Multi-Resolution Pyramid structure has been applied efficiently for face verification purposes.

In normal, ANN is formed as a base of Deep Learning and subset of Machine Learning where the algorithms are inspired by the structure of the human brain and it is made up of many layers of neurons known as "artificial nodes" (Yousif et al., 2017). These neurons are core passing units of the network. ANN is composed of three fundamental layers. The first layer is the input layer which receives the pixels as input, in between exist the hidden layers which perform most of the computation required by the network, and the final layer is the output layer that anticipates the ultimate output (Lawrence et al., 1997). In generic representation, ANN takes a set of data, train themself to recognize the parent that available in this data, then predict the output or new set of similar data (Tolba et al., 2006). The digital image is composed of many pixels; each pixel expresses a numerical value that is fit as input to each neuron in the first layer. Neurons of one layer are connected to the subsequent layer through "channels" that sign specific numerical value known as "weight"(Agarwal et al., 2010). In case of

the wrong predication, the information will be passed back to neurons via the "backpropagation" process with adjustment of inputs and weights in which these passes continue until the network predicate and recognize the face correctly (Agarwal et al., 2010).

2.Main functionalities

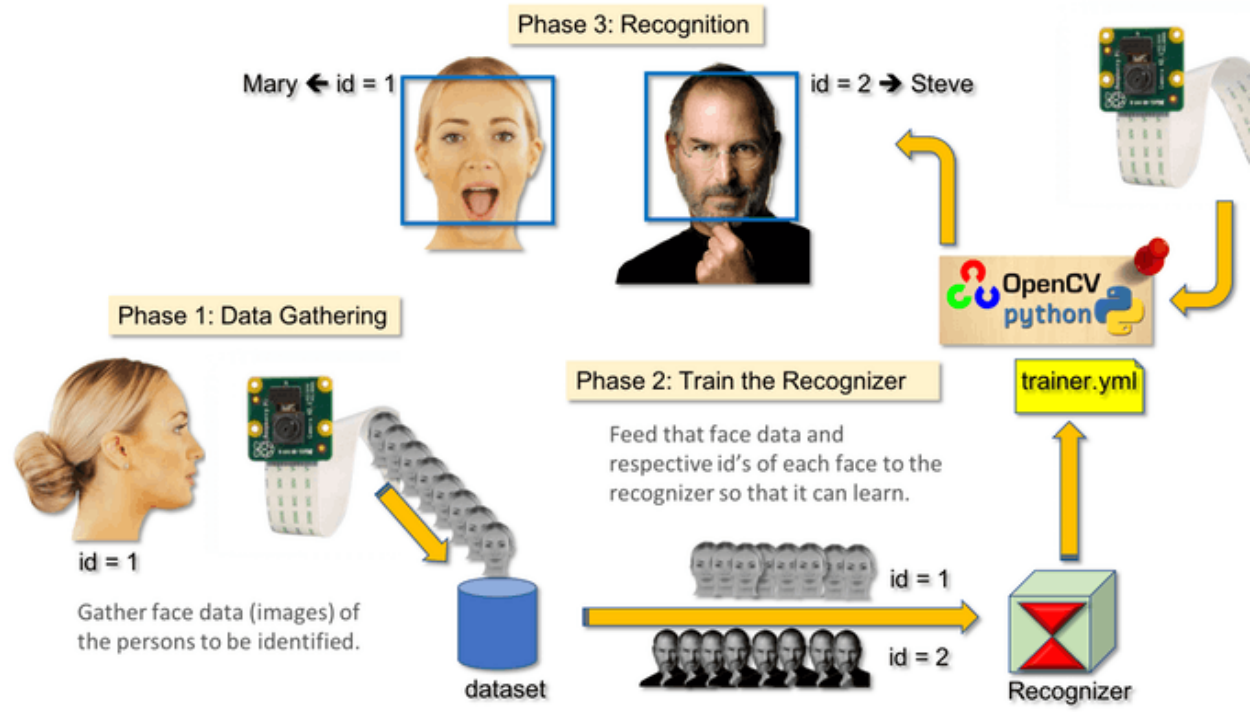
The library can compare different faces, returning the degree of likeness. This allows identifying human faces appearing in still images or video streams by looking up face databases. Recognizing and identifying still images enables locating similar faces in driver's license databases while helping detect duplicates. The system implements image indexing, creating compact templates for faster searching. This in turn allows building a range of security applications such as video surveillance and real-time access control systems. Many more features and higher performance are achievable in video-based surveillance systems using the new set of motion-based recognition algorithms.

FaceSDK is designed to perform equally well under varying lighting conditions. It works fine under daylight, fluorescent and incandescent lighting. When testing on a FRGC database, the library successfully identifies individuals in 93.9% of cases if acceptable false positive is 0.1%.

To create a complete project on Face Recognition, we must work on 3 very distinct phases:

- Face Detection and Data Gathering
- Train the Recognizer
- Face Recognition

The below block diagram resumes those phases:



Phase 1: Data Gathering functions

1. Create dictionary. (To save on it the facial classifier)
2. Create a subdirectory. (Where we store our facial samples and name it "dataset")
3. Input command. (To capture user id)
4. Save the captured frames.

Phase 2: Train the recognizer functions

1. Create subdirectory. (To store the trained data)
2. Use the PIL library on the Rpi. (If not run “pip install pillow”)
3. Take all the photos on directory. (By using “getImagesAndLabels (path)”)

Phase 3: Recognition

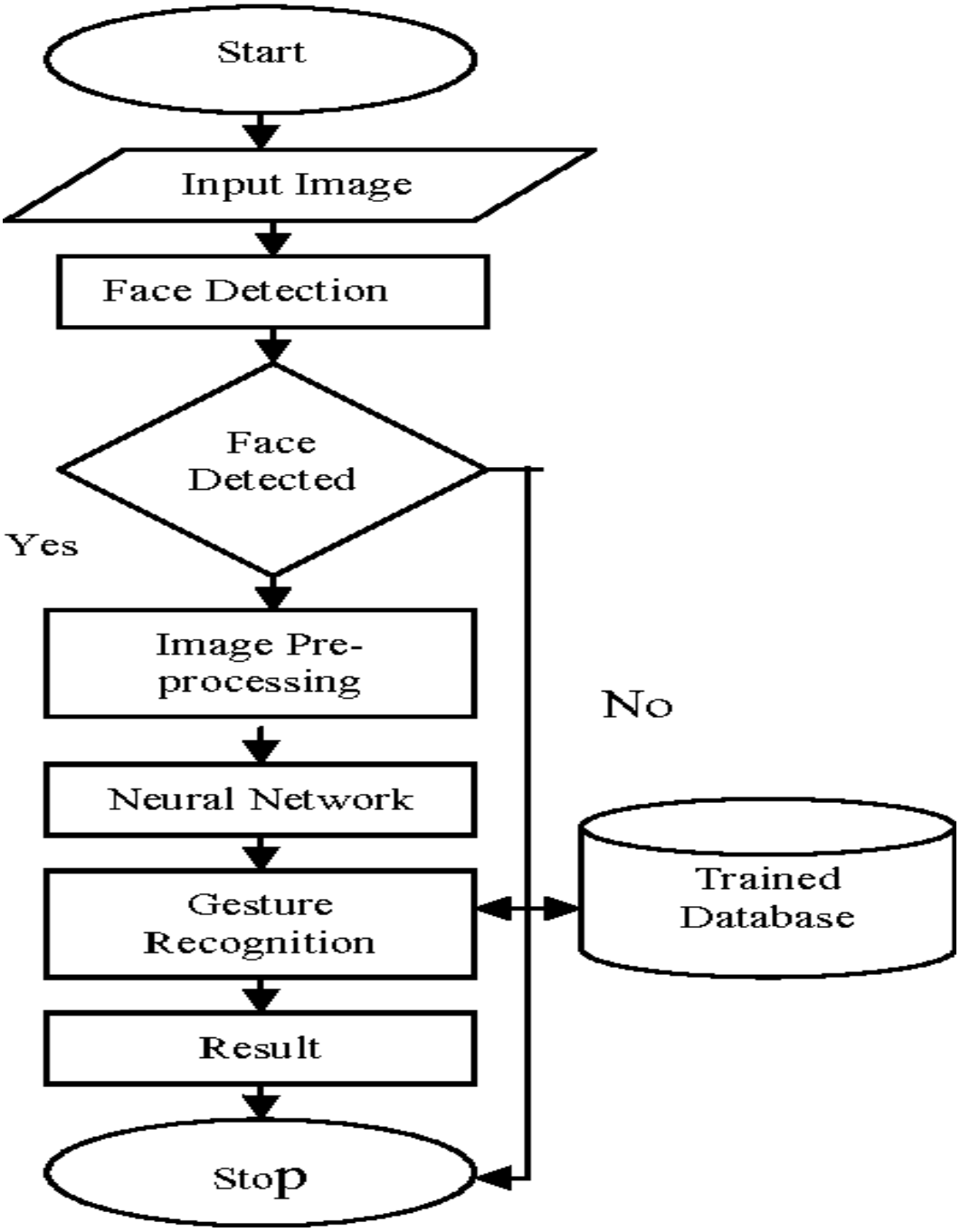
1. Display the data set. (Names or numbers)
2. Detect the face.
3. Use a function to predict whether it is the photo or not.

2.1. the basic steps for face recognition:

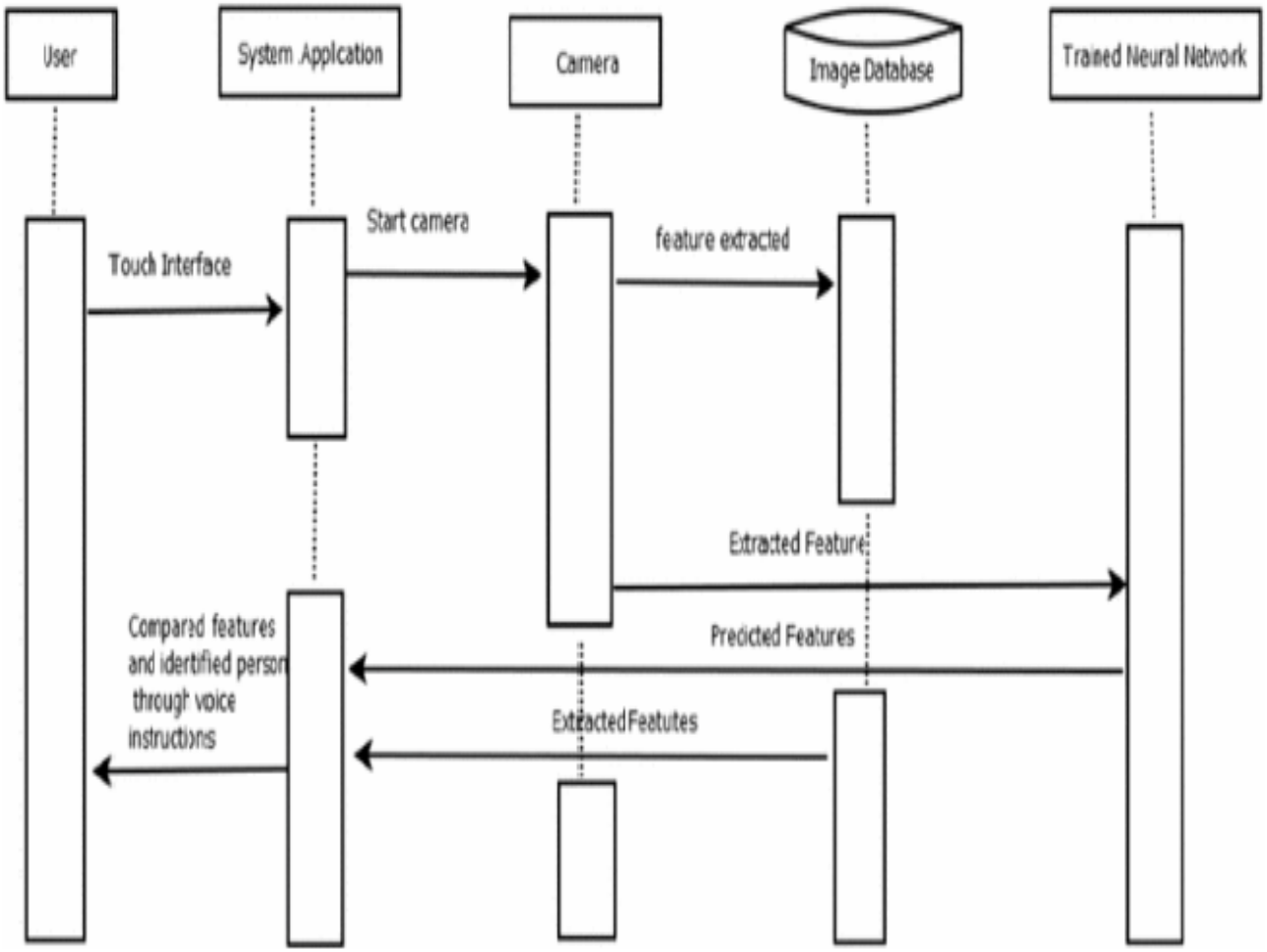
1. Take Face image from local drive as input.
2. Convert it to gray scale image.
3. Apply median filter for noise removal.
4. Enhance the image i.e. contrast adjustment
5. Detect the face using AdaBoost algorithm.
6. Features of the image are calculated using GLDM and pseudo Zernike moment.
7. Train the input images.
8. Update the feature vectors.
9. Once again input the face image from the local drive for testing.
10. All the preprocessing, face detection, feature vectors are computed.
11. Use ANN Classifier for recognize the face.
12. Finally output the recognized face image

2.2. Diagrams

2.2.2 Flow Chart

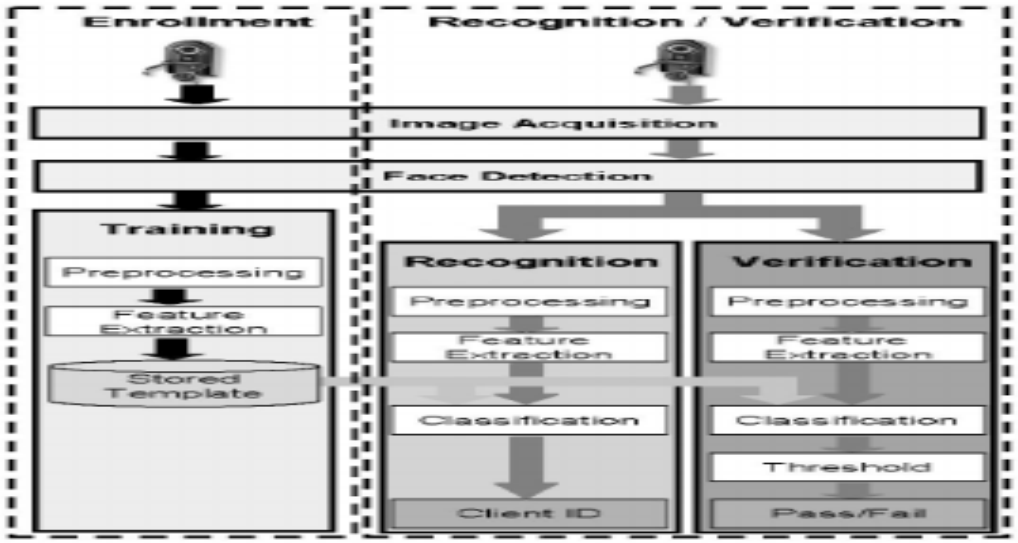


2.2.3 Sequence

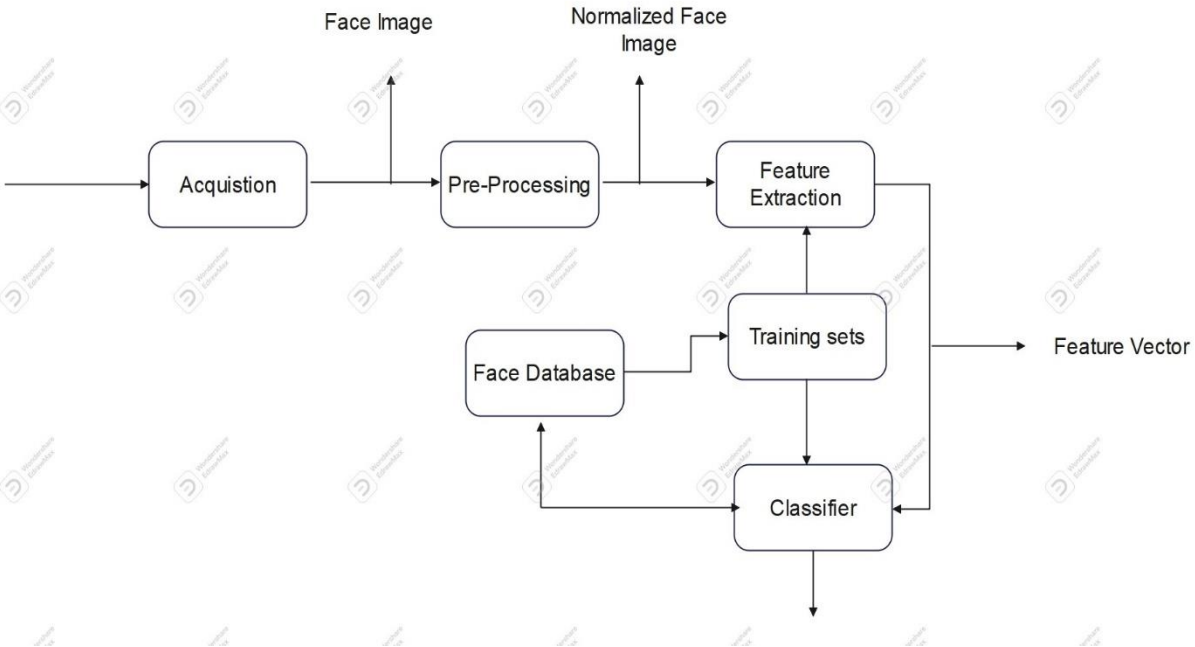


2.2.4 Another block diagrams

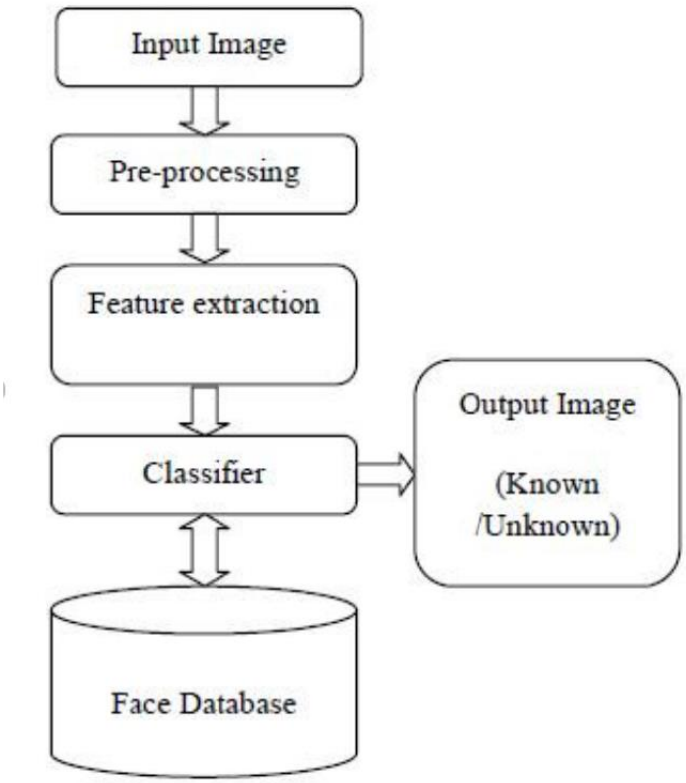
1)



2)



3)



Block Diagram of Face Recognition System

3. Similar applications in the market

3.1. Railer

Railer app is a face recognition attendance app and a mobile attendance system. Through this app, educational and corporate organisations can manage the attendance of their students and employees, and keep a check on their attendance using face recognition.

3.2. TrueKey

A product of McAfee Security, True Key is based on biometric technology, which uses face recognition software or fingerprint to protect and manage your passwords.

3.3. AppLock

AppLock allows apps to unlock using facial recognition features as well as voice recognition. The software ensures that only a user can access their personal information, social media apps, and financial accounts.

3.4. Luxand Face Recognition

This app allows you to tap a detected face and give it a name. Also, it helps recognize and memorize that face ahead. All you need to do is hold your device at your arm's length and rotate it slowly at multiple views changing the location, and the app will recognize it. This app has the caliber to memorize various persons; if it doesn't, you must repeat the process.

3.5. BioID Facial Recognition

The BioID app performs the best face recognition as a multi-factor user authenticator. Brands and developers can easily use this app to append biometric authentication to their mobile platforms with just a few code lines. On the other end, their end users can authorize the transaction or log in securely and seamlessly. So, this app saves your employees, users, and even yourself from photo attacks and prevents video-replay attacks.

4. An initial literature review of Academic publications

4.1 ABSTRACT

Face detection is one of the most relevant applications of image processing and biometric systems. Artificial neural networks (ANN) have been used in the field of image processing and pattern recognition. There is lack of literature surveys which give overview about the studies and researches related to the using of ANN in face detection. Therefore, this research includes a general review of face detection studies and systems which based on different ANN approaches and algorithms. The strengths and limitations of these literature studies and systems were included also.

4.2 FACE DETECTION AND RECOGNITION

A general face recognition system includes many steps: face detection; feature extraction; and face recognition, Face detection and recognition includes many complementary parts, each part is a complement to the other. Depending on regular system each part can work individually, Face detection is a computer technology that is based on learning algorithms to allocate human faces in digital images, Face detection takes images/video sequences as input and locates face areas within these images. This is done by separating face areas from non-face background regions,Facial feature extraction locates important feature (eyes, mouth, nose and eye-brows) positions within a detected face, Feature extraction simplifies face region normalization

where detected face aligned to coordinate framework to reduce the large variances introduced by different face scales and poses. The accurate locations of feature points sampling the shape of facial features provide input parameters for the face identification. Other face analysis task: facial expression analysis; face animation and face synthesis can be simplified by accurate localization of facial features.

4.3. RECOMMENDATIONS FOR FACE DETECTION SYSTEM

Face detection is first step in face recognition systems to localize and extract the face

region from the image background. The literature studies related to face detection systems which were based on ANN were described earlier in this research can be summarized as follows:

• The face detection techniques presented above were based on 2D image detection.

• Most of these studies of face detection systems were adopted ANN in combination with other approaches and algorithms to obtain better results for detection and improve the performance of face detection system. But this may increase the system complexity, required memory and time for face detection.

• ANN can be adopted in combination with other algorithms to obtain better results for face detection. At the same time, we must focus on how to simplify the combined algorithms steps to reduce the memory required and processing time.

4.4. CONCLUSION

This paper includes a summary review of literature studies related to face detection systems based on ANNs. Different architecture, approach, programming language, processor and memory requirements, database for training/testing images and performance measure of face detection system were used in each study. Each study has its own strengths and limitations.

In future work, a face detection system will be suggested based on using Pattern Net and Back propagation neural network (BPNN) with many hidden layers. Different network architectures and parameters' values of BPNN and PatternNet will be adopted to determine PatternNet architecture that will result in best performance values of face detection system.

4.5. REFERENCES

[1] " A Systematic Literature Review on the Accuracy of Face Recognition Algorithms" M.A. Lazarini1, R. Rossi2,* and K. Hirama2.

[2] "REVIEW OF FACE DETECTION SYSTEMS BASEDARTIFICIAL NEURAL NETWORKS ALGORITHMS" Omaima N. A. AL-Allaf Assistant Professor.
[3] "Face Recognition Using Neural Network: A Review" Manisha M. Kasar1, Debnath Bhattacharyya1 and Tai-hoon Kim2.*

5.Dataset employed

5.1 Description

- It's a dataset inculiding a lot of images of famous people.
- We take from it some folders to train and test our ANN model
- (we will upload it with our project)

6. Details of the algorithm(s)/approach(es) that will be used

We will be using "ANN" in our project**,** These are some details about it:

6.1. What is a neural network?

A neural network is a method in artificial intelligence that teaches computers to process data in a way that is inspired by the human brain. It is a type of machine learning process, called deep learning, that uses interconnected nodes or neurons in a layered structure that resembles the human brain. It creates an adaptive system that computers use to learn from their mistakes and improve continuously. Thus, artificial neural networks attempt to solve complicated problems, like summarizing documents or recognizing faces, with greater accuracy.

6.2. Why are neural networks important?

Neural networks can help computers make intelligent decisions with limited human assistance. This is because they can learn and model the relationships between input and output data that are nonlinear and complex.

6.3. What are neural networks used for?

Neural networks have several use cases across many industries, such as the following:

- Medical diagnosis by medical image classification
- Targeted marketing by social network filtering and behavioral data analysis
- Financial predictions by processing historical data of financial instruments
- Electrical load and energy demand forecasting
- Process and quality control
- Chemical compound identification

6.4. How do neural networks work?

The human brain is the inspiration behind neural network architecture. Human brain cells, called neurons, form a complex, highly interconnected network and send electrical signals to each other to help humans process information. Similarly, an artificial neural network is made of artificial neurons that work together to solve a problem. Artificial neurons are software modules, called nodes, and artificial neural networks are software programs or algorithms that, at their core, use computing systems to solve mathematical calculations.

6.5. Simple neural network architecture

A basic neural network has interconnected artificial neurons in three layers:

Input Layer

Information from the outside world enters the artificial neural network from the input layer. Input nodes process the data, analyze or categorize it, and pass it on to the next layer.

Hidden Layer

Hidden layers take their input from the input layer or other hidden layers. Artificial neural networks can have a large number of hidden layers. Each hidden layer analyzes the output from the previous layer, processes it further, and passes it on to the next layer.

Output Layer

The output layer gives the final result of all the data processing by the artificial neural network. It can have single or multiple nodes. For instance, if we have a binary (yes/no) classification problem, the output layer will have one output node, which will give the result as 1 or 0. However, if we have a multi-class classification problem, the output layer might consist of more than one output node.

Deep neural network architecture

Deep neural networks, or deep learning networks, have several hidden layers with millions of artificial neurons linked together. A number, called weight, represents the connections between one node and another. The weight is a positive number if one node excites another, or negative if one node suppresses the other. Nodes with higher weight values have more influence on the other nodes.

Theoretically, deep neural networks can map any input type to any output type. However, they also need much more training as compared to other machine learning methods. They need millions of examples of training data rather than perhaps the hundreds or thousands that a simpler network might need**.**

6.6. What are the types of neural networks?

Artificial neural networks can be categorized by how the data flows from the input node to the output node. Below are some examples:

Feedforward neural networks

Feedforward neural networks process data in one direction, from the input node to the output node. Every node in one layer is connected to every node in the next layer. A feedforward network uses a feedback process to improve predictions over time.

Backpropagation algorithm

Artificial neural networks learn continuously by using corrective feedback loops to improve their predictive analytics. In simple terms, you can think of the data flowing from the input node to the output node through many different paths in the neural network. Only one path is the correct one that maps the input node to the correct output node. To find this path, the neural network uses a feedback loop, which works as follows:

1.Each node makes a guess about the next node in the path.

2.It checks if the guess was correct. Nodes assign higher weight values to paths that lead to more correct guesses and lower weight values to node paths that lead to incorrect guesses.

3.For the next data point, the nodes make a new prediction using the higher weight paths and then repeat Step 1.

Convolutional neural networks

The hidden layers in convolutional neural networks perform specific mathematical functions, like summarizing or filtering, called convolutions. They are very useful for image classification because they can extract relevant features from images that are useful for image recognition and classification. The new form is easier to process without losing features that are critical for making a good prediction. Each hidden layer extracts and processes different image features, like edges, color, and depth.

6.7. How to train neural networks?

Neural network training is the process of teaching a neural network to perform a task. Neural networks learn by initially processing several large sets of labeled or unlabeled data. By using these examples, they can then process unknown inputs more accurately.

Supervised learning

In supervised learning, data scientists give artificial neural networks labeled datasets that provide the right answer in advance. For example, a deep learning network training in facial recognition initially processes hundreds of thousands of images of human faces, with various terms related to ethnic origin, country, or emotion describing each image.

The neural network slowly builds knowledge from these datasets, which provide the right answer in advance. After the network has been trained, it starts making guesses about the ethnic origin or emotion of a new image of a human face that it has never processed before.

6.8 ARTIFICIAL NEURAL NETWORKS FOR FACE DETECTION

In the recent years, different architectures and models of ANN were used for face detection and recognition. ANN can be used in face detection and recognition because these models can simulate the way neurons work in the human brain. This is the main reason for its role in face recognition.

6.9 Computer vision

Computer vision is the ability of computers to extract information and insights from images and videos. With neural networks, computers can distinguish and recognize images similar to humans. Computer vision has several applications, such as the following:

- Visual recognition in self-driving cars so they can recognize road signs and other road users
- Content moderation to automatically remove unsafe or inappropriate content from image and video archives
- Facial recognition to identify faces and recognize attributes like open eyes, glasses, and facial hair
- Image labeling to identify brand logos, clothing, safety gear, and other image details