Face Recognition

A MINI PROJECT REPORT

18CSC305J - ARTIFICIAL INTELLIGENCE

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### in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE & ENGINEERING

of

FACULTY OF ENGINEERING AND TECHNOLOGY



#### S.R.M. Nagar, Kattankulathur, Chengalpattu District

MAY 2023



ABSTRACT

The human face is central to our identity. It plays an essential role in day-to-day interactions, communication and other routine chores. To build fully automated systems that analyses the information contained in face images, resilient and impeccable face detection algorithms are required and many algorithms are in use. Partial face occlusion is one of the most challenging problems in face recognition. A face recognition system can confront faces in the real-world applications occluded with the use of accessories, such as mask, scarf or shades, hands on the face, the objects a person carries. Unfortunately, the shadow of facial occlusions is very common in real-world applications especially when the individuals are not cooperative with the systems such as in video surveillance. While there has been a huge amount of research on face recognition under pose changes, changes in lighting and image mortification, problems due to occlusions are for the most part overlooked. The theme of this paper is on facial occlusions, and specifically on how to improve the identification of faces occluded by sunglasses and scarves, beards etc. Facial occlusions may occur for several intentional or deliberate reasons. For example, football hooligans and ATM criminals tend to wear scarf and/or sunglasses to prevent their faces from being recognized. Some other people do wear veils for religious convictions or cultural habits. Other sources of occlusions include medical masks, hats, beards, moustaches, hairs covering the face, make up, etc. Undoubtedly, occlusions can significantly affect the performance of even most sophisticated face recognition systems, if occlusion analysis is not specifically taken into account. Robustness to partial occlusions is thus crucial in nowadays face recognition systems.

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ABBREVIATIONS

|  |  |
| --- | --- |
| Numpy | Numerical Python |
| PIL | Python imaging library |
| LDA | Linear Discriminant Analysis |
| LBPH | The Local Binary Pattern Histogram |
| XML | Extensible Markup Language |

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CHAPTER 1

INTRODUCTION

A facial recognition system is a technology capable of matching a [human face](https://en.wikipedia.org/wiki/Human_face) from a [digital image](https://en.wikipedia.org/wiki/Digital_image) or a [video frame](https://en.wikipedia.org/wiki/Film_frame) against a [database](https://en.wikipedia.org/wiki/Database) of faces. Such a system is typically employed to [authenticate](https://en.wikipedia.org/wiki/Authenticate) users through [ID verification services](https://en.wikipedia.org/wiki/ID_verification_service), and works by pinpointing and measuring facial features from a given image.

Development began on similar systems in the 1960s, beginning as a form of computer [application](https://en.wikipedia.org/wiki/Application_software). Since their inception, facial recognition systems have seen wider uses in recent times on [smartphones](https://en.wikipedia.org/wiki/Smartphone) and in other forms of technology, such as [robotics](https://en.wikipedia.org/wiki/Robotics). Because computerized facial recognition involves the measurement of a human's physiological characteristics, facial recognition systems are categorized as [biometrics](https://en.wikipedia.org/wiki/Biometrics). Although the accuracy of facial recognition systems as a biometric technology is lower than [iris recognition](https://en.wikipedia.org/wiki/Iris_recognition) and [fingerprint](https://en.wikipedia.org/wiki/Fingerprint) recognition, it is widely adopted due to its contactless process. Facial recognition systems have been deployed in advanced [human–computer interaction](https://en.wikipedia.org/wiki/Human%E2%80%93computer_interaction), [video surveillance](https://en.wikipedia.org/wiki/Video_surveillance) and automatic [indexing](https://en.wikipedia.org/wiki/Search_engine_indexing) of images.

Facial recognition systems are employed throughout the world today by governments and private companies. Their effectiveness varies, and some systems have previously been scrapped because of their ineffectiveness. The use of facial recognition systems has also raised controversy, with claims that the systems violate citizens' privacy, commonly make incorrect identifications, encourage [gender norms](https://en.wikipedia.org/wiki/Gender_role) and [racial profiling](https://en.wikipedia.org/wiki/Racial_profiling), and do not protect important biometric data. The appearance of [synthetic media](https://en.wikipedia.org/wiki/Synthetic_media) such as [deepfakes](https://en.wikipedia.org/wiki/Deepfakes) has also raised concerns about its security. These claims have led to the ban of facial recognition systems in several cities in the [United States](https://en.wikipedia.org/wiki/United_States). Growing societal concerns led social networking company [Meta Platforms](https://en.wikipedia.org/wiki/Meta_Platforms) to shut down its [Facebook facial recognition system](https://en.wikipedia.org/wiki/DeepFace) in 2021, deleting the face scan data of more than one billion users. The change represented one of the largest shifts in facial recognition usage in the technology's history.

CHAPTER 2

LITERATURE SURVEY

### Face Tracking

Face tracking refers to identifying the features which are then used to detect a Face In this case the example method includes the receiving or we can say that it gets the first image and the second images of a face of a user who is being taken into consideration, where one or both of the images which were used to sort of look for a match have been granted a match by the facial recognition system which also proofs the correct working of the system. “The technique includes taking out a second sub- image coming from the second image, where the second sub-image includes a representation of the at least one corresponding facial landmark, detecting a facial gesture by determining whether a sufficient difference exists between the second sub - image and first sub-image to indicate the facial gesture, and determining, based on detecting the facial gesture, whether to deny authentication to the user with respect to accessing functionalities controlled by the computing” [1]

#### Mechanisms of human facial recognition

Basically what we see in this paper is that it presents an extension and a new way of perception of the author's theory for human visual information processing, which The method includes extracting a second sub-image from the second image, where the second sub-image includes a representation of the at least one corresponding facial landmark. “In turn detecting a facial gesture by determining whether a sufficient difference exists between the second sub-image and first sub-image to indicate the facial gesture, and determining, based on detecting the facial gesture, whether to deny authentication to the user with respect to the human recognition system and same was applied”. Several indispensable techniques are implicated: encoding of visible photographs into neural patterns, detection of easy facial features, measurement standardization, discount of the neural patterns in dimensionality [2].

“The logical (computational) role suggested for the primary visual cortex has several components: size standardization, size reduction, and object extraction”. “The result of processing by the primary visual cortex, it is suggested, is a neural encoding of the visual pattern at a size suitable for storage. “(In this context, object extraction is the isolation of regions in the visual field having the same color, texture, or spatial extent.)”It is shown in detail how the topology of the mapping from retina to cortex, the connections between retina, lateral geniculate bodies and primary visual cortex, and the local structure of the cortex itself may combine to encode the visual patterns. Aspects of this theory are illustrated graphically with human faces as the primary stimulus. However, the theory is not limited to facial recognition but pertains to Gestalt recognition of any class of familiar objects or scenes [2].

#### Eye Spacing Measurement for Facial Recognition

Few procedures to computerized facial consciousness have employed geometric size of attribute points of a human face. Eye spacing dimension has been recognized as an essential step in reaching this goal. Measurement of spacing has been made by means of software of the Hough radically change method to discover the occasion of a round form and of an ellipsoidal form which approximate the perimeter of the iris and each the perimeter of the sclera and the form of the place under the eyebrows respectively. Both gradient magnitude and gradient direction were used to handle the noise contaminating the feature space. “Results of this application indicate that measurement of the spacing by detection of the iris is the most accurate of these three methods with measurement by detection of the position of the eyebrows the least accurate. However, measurement by detection of the eyebrows' position is the least constrained method. Application of these strategies has led to size of a attribute function of the human face with adequate accuracy to advantage later inclusion in a full bundle for computerized facial consciousness”. [3].

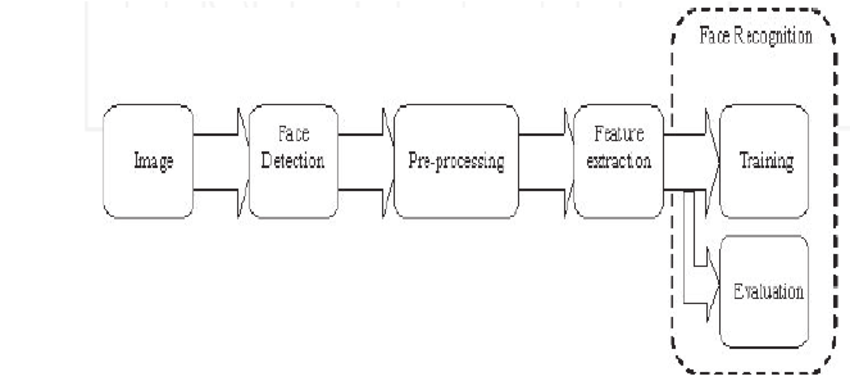
#### A direct LDA algorithm for high-dimensional data \* with application to face recognition

“Linear discriminant analysis (LDA) has been successfully used as a dimensionality reduction technique to many classification problems, such as speech recognition, face recognition, and multimedia information retrieval”. The objective is to "nd a projection A that maximizes the ratio of between-class scatter against within-class scatter S (Fisher's criterion) [4]

CHAPTER 3

SYSTEM ARCHITECTURE AND DESIGN

3.1 Architectural Diagram



1. Input: The system takes an image or a video frame as input, containing one or more faces to be recognized.
2. Face Detection: The first step is to detect and locate faces within the input image or frame. This can be done using techniques like Haar cascades, Histogram of Oriented Gradients (HOG), or convolutional neural networks (CNNs).
3. Face Alignment: Once the faces are detected, they need to be aligned to a standardized pose. Face alignment techniques correct for variations in head position, scale, and orientation. This step ensures that faces are represented consistently for further processing.
4. Feature Extraction: Next, the system extracts facial features from the aligned faces. Deep learning-based techniques such as Convolutional Neural Networks (CNNs) or Siamese networks are commonly used to learn discriminative representations from faces. These models extract high-dimensional feature vectors that capture unique characteristics of each face.
5. Feature Encoding: The extracted feature vectors are often passed through a feature encoding step. This can involve techniques like Principal Component Analysis (PCA) or Linear Discriminant Analysis (LDA) to reduce dimensionality and improve computational efficiency.
6. Face Database: A face recognition system usually maintains a database of known faces. This database contains a collection of pre-registered or enrolled faces, along with their corresponding feature representations.

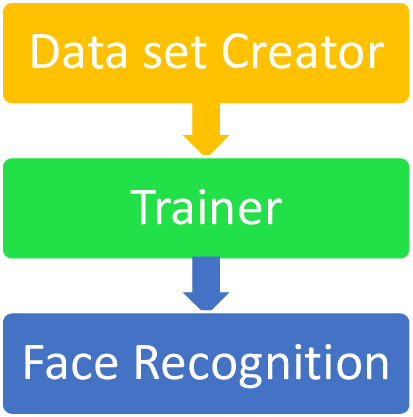
Similarity Calculation: When a new face is encountered, its feature vector is compared with the feature vectors stored in the face database. Similarity measures like cosine similarity or Euclidean distance are commonly used to calculate the similarity between feature vectors.

Face Recognition Decision: Based on the similarity scores, a decision is made whether the face belongs to one of the registered individuals in the database or if it is an unknown face. A threshold is often applied to determine the acceptance or rejection of a face.

Output: Finally, the system provides the recognition result, which could include the identity of the recognized individual or a label indicating an unknown face.

It's important to note that face recognition systems can be more complex and may include additional steps such as face tracking, continuous video processing, and post-processing techniques for improved accuracy. The above diagram provides a high-level understanding of the major components involved in a face recognition system.

3.2 Description of the modules and the components



A. Data Set Creator/ Face Detector The first stage of proposed method is face detection. One of the best face detector in terms of speed and reliability is Haar-cascade classifier.The training is required for generating new Haar-cascades.In this proposed method, Open Source Computer Vision Library(OpenCV) has been used to generate a robust set of Haar-cascade. Haar cascade was proposed by Paul Voila and Michael Jone. Haar features are important to perceive the occurrence of face in an image using Haar cascade classifier. Fig.2. Flowchart of face detection The random objects identified using face cascades and stable face is detected using eye cascades. The flowchart of the detection system given in the Fig.2.The face detection is carried out by subtracting the sum of pixels of the low intensity area and sum of the pixels of high intensity area. The rectangle features are considered to carry out to detect the features rapidly. In OpenCV, the classifier class is used through cv2 to create a face and eye classifier objects. The respective XML files and CascadeClassifier () are loaded. The cv2 is used to create camera image. And inorder to capture the images the VideoCapture() commands are used. To match the various sizes and to find the location the Cascade, Classifier. Detect MultiScale () object. Using the location data, the face is cropped for further verification. Eye cascade is used to verify there are two eyes in the cropped face. If satisfied a marker is placed around the face to illustrate a face is detected in the location. B. Trainer The trainer set is a way to determine the relationships between different /same data sets in diverse contexts. C. Face Recognition In this paper, the three algorithms are implemented independently and analyzed the performance with respect to the accuracy. These are Eigen face, Fisher face and Linear Binary Pattern Histograms (LBPH) respectively. OpenCV libraries is used to implement the above methods. The face recognition can be carried out by three phases as follows:

1. Gather theImage IDs

2. Extricate the unique features of image and classifying them and store it in XML files

3. Matches the unique features of a given image to the features which stored in XML files and predict identity. The following section provides the detailed information about above mentioned face recognition algorithms.

CHAPTER 4

METHODOLOGY

4.1 The project uses various libraries of the Python such as

4.1.1 DeepFace

Deepface is a lightweight face recognition and facial attribute analysis (age, gender, emotion and race) framework for python. It is a hybrid face recognition framework wrapping state-of-the-art models: VGG-Face, Google FaceNet, OpenFace, Facebook DeepFace, DeepID, ArcFace and Dlib. The library is mainly based on**Keras** and **TensorFlow**.

4.1.2 Matplotlib (For Visualisation)

Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python. Matplotlib makes easy things easy and hard things possible.

* Create [publication quality plots](https://ieeexplore.ieee.org/document/4160265/citations?tabFilter=papers).
* Make [interactive figures](https://mybinder.org/v2/gh/matplotlib/mpl-brochure-binder/main?labpath=MatplotlibExample.ipynb) that can zoom, pan, update.
* Customize [visual style](https://matplotlib.org/stable/gallery/style_sheets/style_sheets_reference.html) and [layout](https://matplotlib.org/stable/tutorials/provisional/mosaic.html).
* Export to [many file formats](https://matplotlib.org/stable/api/figure_api.html#matplotlib.figure.Figure.savefig).
* Embed in [JupyterLab and Graphical User Interfaces](https://matplotlib.org/stable/gallery/" \l "embedding-matplotlib-in-graphical-user-interfaces).
* Use a rich array of [third-party packages](https://matplotlib.org/mpl-third-party/) built on Matplotlib.

4.1.3 Pandas

Pandas is an open-source library that is made mainly for working with relational or labeled data both easily and intuitively. It provides various data structures and operations for manipulating numerical data and time series. This library is built on top of the NumPy library. Pandas is fast and it has high performance & productivity for users.

4.1.4 Face Recognition

The “Face recognition” library in python is a library which helps in recognizing and manipulating the faces by using the programming language python or from the command line with the simplest face recognition library after importing the module and accessing the required functions.The “Face recognition” library was built using dlib’s “state-of-the-art face recognition” and was further enhanced and built with deep learning. The model has an accuracy of 99.38%.It is used to find faces in pictures.

CHAPTER 5

CODING AND TESTING

pip install deepface

from deepface import DeepFace

import matplotlib.pyplot as plt

import pandas as pd

img1\_path = 'deepface/tests/dataset/img1.jpg'

img2\_path = 'deepface/tests/dataset/img2.jpg'

img3\_path = 'deepface/tests/dataset/img3.jpg'

img4\_path = 'deepface/tests/dataset/img4.jpg'

img1=DeepFace.detectFace(img1\_path)

img2=DeepFace.detectFace(img2\_path)

img3=DeepFace.detectFace(img3\_path)

img4=DeepFace.detectFace(img4\_path)

plt.imshow(img1)

plt.imshow(img2)

plt.imshow(img3)

plt.imshow(img4)

model\_name='ArcFace'

resp= DeepFace.verify(img1\_path=img1\_path,img2\_path=img2\_path,model\_name=model\_name)

print(resp)

resp= DeepFace.verify(img1\_path=img1\_path,img2\_path=img2\_path,model\_name=model\_name)

print(resp)

find\_result=DeepFace.find(img\_path="deepface/tests/dataset/img4.jpg",db\_path="C:/Users/admin/Desktop/deepfacev1/deepface/tests/dataset/")

print(find\_result)

DeepFace.Verify

This function is used to verify the two faces.

DeepFace.find

This function is used find the image path.

CHAPTER 6

SCREENSHOTS AND RESULTS

Text

Description automatically generated

Graphical user interface

Description automatically generated

Graphical user interface, application

Description automatically generated

Graphical user interface, text, application, Teams

Description automatically generated

Graphical user interface, application

Description automatically generated

Graphical user interface, text, application, email

Description automatically generated

CHAPTER 7

CONCLUSION AND FUTURE ENHANCEMENTS

7.1 Conclusion

Facial Detection and Recognition systems are gaining a lot of popularity these days. Most of the flagship smartphones of major mobile phone manufacturing companies use face recognition as the means to provide access to the user.

This project report explains the implementation of face detection and face recognition using OpenCV with Python and also lays out the basic information that is needed to develop a face detection and face recognition software.The goal of increasing the accuracy of this project will always remain constant and new configurations and different algorithms will be tested to obtain better results. In this project, the approach we used was that of Local Binary Pattern Histograms that are a part of the FaceRecognizer Class of OpenCV.

7.2 Future Enhancement

[Facial recognition](https://www.nec.co.nz/expertise/biometrics/facial-recognition/) is a topic that divides opinion. If you were to believe everything you read in the media, you would think that facial recognition technology is universally mistrusted and disliked. This couldn’t be further from the truth.

Like most technology, facial recognition has its detractors. Most of the dislike and mistrust comes from a fear that facial recognition technology is an infringement on our personal privacy. Fueled by misinformation in the media, many have jumped on the bandwagon, fearing that once your face has been recognised and identified by facial recognition technology, that hackers can simply break into a database, steal your identity and you can never get it back again.

This is simply not true. Facial recognition and other [biometric technologies](https://www.nec.co.nz/expertise/biometrics/) are some of the safest ways to authenticate that you are who you say you are. Much safer than a traditional password and much less likely to be stolen. You also can’t lose your biometric indicators – your face, your [fingerprints](https://www.nec.co.nz/expertise/biometrics/fingerprint-palm-recognition/) and your [irises](https://www.nec.co.nz/expertise/biometrics/iris-recognition/) are always with you, making them more practical than passwords for many people.

The truth is, that more and more industries are investing in facial recognition technology as a way of improving security, creating a better user experience and reducing costs. From airlines to automobiles, law enforcement to border control, the practical applications for facial recognition technology, coupled with the enhanced security that biometric authentication offers means that we are all going to become more familiar with facial recognition in 2022 and beyond.

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