Detailed Survey of Machine Learning Algorithms for Face Recognition

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ABSTRACT

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. Face recognition is a method of identifying or verifying the identity of an individual using their face. Face recognition systems can be used to identify people in photos, video, or in real-time. Facial recognition is a technology that can recognize a person only by looking at them. It uses machine learning techniques to identify, collect, store and evaluate face characteristics so that they can be matched to photos of people in a database. Real-time face recognition is already being used in many countries and even at sport events in the United States.

Keywords—Face, machine learning, Recognition

# INTRODUCTION

Face recognition systems use computer algorithms to pick out specific, distinctive details about a person’s face. Face recognition systems vary in their ability to identify people under challenging conditions such as poor lighting, low quality image resolution, and suboptimal angle of view (such as in a photograph taken from above looking down on an unknown person).It employs machine learning algorithms which find, capture, store and analyse facial features in order to match them with images of individuals in a pre-existing database. The four overarching problems that a machine needs to solve in order to recognize a face are trace detection, face alignment, feature extraction, face recognition and face verification. As of late, the need for biometric security framework is elevated for giving safety and security against frauds, theft, and so on. Face recognition has gained a significant position among all biometric-based systems. It can be used for authentication and surveillance to prove the identity of a person and detect individuals, respectively. In this paper, a point-by-point outline of some imperative existing strategies which are accustomed to managing the issues of face recognition has been introduced along with their face recognition accuracy and the factors responsible to degrade the performance of the study. In the first section of this paper, different factors that degrade the facial recognition accuracy have been investigated like aging, pose variation, partial occlusion, illumination, facial expressions, and so on. While in the second section, different techniques have been discussed that worked to mitigate the effect of discussed factors. The facial recognition process normally has four interrelated phases or steps that help in accurate facial recognition, they are as follows:

• Face detection

• Normalization

• Feature extraction

• Face recognition

The objective of face recognition is, from the incoming image, to find a series of data of the same face in a set of training images in a database. The great difficulty is ensuring that this process is carried out in real-time, something that is not available to all biometric facial recognition software providers.

**II. LITERATURE SURVEY**

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| **AUTHOR** | **TITLE** | **METHADOLOGIES** | **CONCLUSION** |
| Jiachen Chen and W. Kenneth Jenkins | Facial Recognition with PCA and Machine Learning Methods | The facial recognition system is divided into two stages:  1.PCA processing  2. Machine learning classification. | This model uses KNN, SVM and LDA. KNN has the fastest running speed and SVM has the lowest running speed. LDA is a little slower than KNN but much faster than SVM. Thus, although SVM always has higher recognition accuracy the running speed is much slower than other two classifications. |
| Jamal Riffi Adnane ohamed Mahraz Hamid Tairi | Multiple face detection based on machine learning | holistic and feature extraction methods | A comparative study is being done between 4 methods.  (a)Haar-AdaBoost  (b)LBP-AdaBoost  (c)GF-SVM  (d)GFNN  The first two are based on boosting algorithm which is used both for selection and for learning a strong classifier with a cascade classification. The rest two use Gabor filter to extract the characteristics. In terms of detection rates, the Haar-AdaBoost method is the best out of the four. |
| Pranav KB Manikandan | Design and Evaluation of a Real-Time Face Recognition System using Convolutional Neural Networks | Convolution neural networking | Real time face recognition system using convolutional neural network.  AT&T datasets is being used.  Maximum recognition accuracies of 98.75% using CNN method and the standard datasets. |
| Geetha, M, Latha R.S,  NivethaS.K., Hariprasath Gowtham, S.  Deepak C.S. | Design of face detection and recognition system to monitor students during online examinations using Machine Learning algorithms | **1.**Eigenface method  **2.**Principal Component Analysis  **3.**Convolutional Neural Network (CNN)  **4.**Support vector machine | The proposed SVM-based face recognition system achieves a matching accuracy of about 61% with 50 real-time images in the dataset. Accuracy can further be improved by increasing the number of images in the dataset. |
| Bhanushree kJ  MeenavathiM.B | Feature Based Face Recognition using Machine Learning Techniques | Convolution neural networking | 1. In this paper discussed about different variations such as deviation in pose, illumination and different face contours. 2.To improve the accuracy and Scalability Proposed method uses machine learning based Haar Cascade technique for face detection and convolution neural network is used for feature extraction |
| Pooja G Nair and Sneha R. | A Review: Facial Recognition Using Machine Learning | 1.Support Vector Machine  2.,Neural Networks, 3.Convoluted Neural Networks(CNN), 4.Ensemble of classifiers  5. Extreme Learning Machine(E.L.M) | The techniques work by first matching the facial characteristics picked from the image to the faces stored in the database. It is called a Biometric Identification based application that uniquely identifies each individual by analysing their voice, facial expression, face, or fingerprint. Machine learning has taken charge of artificial intelligence where deep learning algorithms and concepts such as SVM,, Neural Networks,, CNN, Ensemble of classifiers, ELM |
| Raktim Ranjan Nath, Kaberi Kakoty, Dibya Jyoti Bora | Face Detection and Recognition Using Machine Learning Algorithm | CLAHE, HOG, HaarCascade, SVM. | In recognition process we are using CLAHE for pre-processing then using HOG for features extraction. HOG features are extracted for the test image and also for the training images. And finally for classification we are using SVM. Pre-processing technique is used to remove the noise, contrast enhancement, and illumination equalization. |
| Arun Alvappillai and Peter Neal Barrina. | Face Recognition using Machine Learning | 1.SVM  2.Viola-Jones algorithm | First face detection is done using a method called Viola-Jones algorithm.Once the face is detected feature extraction on the face is performed using histogram of oriented gradients (HOG). Lastly, training and classification of the facial databases is done using a multi-class SVM.We use two sets of databasesthe AT & T face database and the YALE B face database. |
| Seema Singh Ramya R  Sushma V Roshini SR  Pavithra R | Facial ecognition using Machine Learning Algorithms on Raspberry Pi | 1)Haar Model  2)HOG model- | 1.Haar-Cascade is one of the machine learning algorithms used widely to detect faces in an image. The overall detection process forms a degenerate decision.  2.HOG method offers advantages like being able to detect multiple faces in group images, being non sensitive to uniform change in luminosity and being a light weight model |
| Kirill Smelyakov  Anastasiya Chupryna  Oleksandr Bohomolov  Nikita Hunko | The Neural Network Models Effectiveness for Face  Detection and Face Recognition | Nueral networks | Based on the analysis of the model performance, an algorithm was proposed that describes the choice of the model. Since each of the considered models has its own advantages and disadvantages, depending on the conditions of use and the type of problem being solved |

**III. MACHINE LEARNING ALGORITHMS**

Face recognition algorithms classified as geometry based or template-based algorithms. The template-based methods can be constructed using statistical tools like SVM [Support Vector Machines], PCA [Principal Component Analysis], LDA [Linear Discriminant Analysis], Kernel methods or Trace Transforms.

The geometric based methods analyse local facial features and their geometric relationship. It is also known as a feature-based method

Facial detection via the viola jones algorithm is a common method used due to its high detection rate and fast processing speed. The algorithm can be summed up in four steps

* Feature selection
* Feature evaluation
* Feature learning to create a classifier
* cascading classifiers

Local Binary Pattern Histogram (LBPH**)** is a popular ML algorithm for face recognition delivering high accuracy in computer vision applications.

Machine learning algorithms used so far are:

* Eigenface method
* Principal component Analysis
* Convolutional Neural networking
* Support vector machine
* Local binary pattern histogram
* viola jones algorithm

**IV. TOOLS**

Python is a programming language that supports wide range of applications. One such application is building and training a machine learning (ML) model. Most of the AI, ML and deep learning models are built using python. Python has libraries that can support and train ML models. Python libraries can process data, analyse data, and can also help us to visualize them. Below are few libraries that can help us to train ML models.

Tensor flow: Tensor flow is one of the most popular open-source libraries used to train and build machine learning and deep learning models. It was developed by Google Brain team. It offers powerful libraries, tools, resources. It helps us to build and train AI/ML models. It provides with various abstracts that lets us use the resources according to our requirement.

**NumPy :** NumPy is well-known general-purpose array processing package. It can process large multi-dimensional arrays and matrices. It is also useful for handling linear algebra, Fourier transforms etc. Other libraries like TensorFlow etc. use NumPy in the backend. It can easily integrate most databases.

**SciPy:** this library offers modules for linear algebra, image optimization integration, interpolation, FFT, signal and image processing, differential equation solutions. SciPy uses NumPy internally for data and array manipulations. It can handle classification, regression, clustering pre-processing, dimensionality reduction etc.

**Theano:** Theano is a python machine learning algorithm that can optimize compiler for evaluating and manipulating mathematical expressions and matrix calculations. It can automatically avoid bugs and errors when dealing with logarithmic and exponential functions.

**Keras**: It is an open source used for neural networks and ML. Keras works with networks to build layers, activation functions and optimizers.it runs alongside with TensorFlow and Theano .

**Pandas**:Pandas are one of the most popular python libraries that is mostly used to analyze data. It is fast, flexible, and expressive. It can work on both labelled and unlabeled data. It can process matrix data with homogeneous or heterogeneous type of data in rows and columns.

**Matplotlib:**Matplotlib is a data visualization library that is used for 2D plotting to produce quality image plots and in different formats.

**PyTorch**: It has wide range of tools that can support computer vision, machine learning and NLP. It has smooth integration with python data science stack .It can perform computation on tensors.

ECG hardware has evolved from a unit that is big in size, wired to smaller wireless and wearable, which allows real time continuous monitoring of patients. Leads are the electric diodes that detects the change in electric flow. Here an electrode comprises of electric pad that connects the skin and allows the recording of electric current. Heart rate monitor boards assists in continuous measurement and displaying patients heart rate. Several processing boards are utilized to process the ECG signals. Most commonly used processing boards are Raspberry’s pi and Arduino. The wireless communication capability of an ECG sensor is significant and enables the ECG sensors to transmit ECG signal recordings to nearby devices. The most commonly used communication standards used in ECG sensors are ZigBee, Bluetooth, and Medical Implant Communication service. Diagnoses, interpretation process, AI, ML, cloud computing and smart phone-based applications are used for practical real time applications.

**IV. APPLICATIONS**

1. Security companies are using facial recognition to secure their premises.
2. Immigration checkpoints use facial recognition to enforce smarterborder control.
3. Ride-sharing companies such as uber or ola can use facial recognition to ensure the right passengers are picked up by the right drivers.
4. IoT benefits from facial recognition by allowing enhanced security measures and automatic access control at home.
5. Retailers can use facial recognition to customize offline offerings and to theoretically map online purchasing habits with their online ones.
6. Facial recognition technology is used in hospitals. The software serves to keep track of everything that is going on within a hospital, ensuring patients are safe and the premise is secure.
7. It is used to track individuals’ movements out in the world like automated license plate readers track vehicles by plate numbers.
8. Used in the area of biometrics, Information security, access control, law enforcement, smart cards and surveillance system.

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