Enhancing the Performance of Face Detection and Recognition

[1] Suman Kumar Jha
Computer Science and Engineering, Dr. A.P.J. Abdul Kalam Technical University (AKTU), Lucknow, Uttar Pradesh, India
Mangalmay Institute of Engineering and Technology Greater Noida, India

[2] Mahima Payala
Computer Science and Engineering, Dr. A.P.J. Abdul Kalam Technical University (AKTU), Lucknow, Uttar Pradesh, India
Mangalmay Institute of Engineering and Technology Greater Noida, India

[3] Shubham Tiwari
Computer Science and Engineering, Dr. A.P.J. Abdul Kalam Technical University (AKTU), Lucknow, Uttar Pradesh, India
Mangalmay Institute of Engineering and Technology Greater Noida, India

***Abstract*:- Human Face is complicated multidimensional visual model which is very crucial for human identity. Facial Recognition is one of the most challenging issues of biometrics. Hence; it is difficult and essential to recognize the face. In this paper, we will notice almost latest methodologies which are used from earlier to recognize the face from the images using digital cameras. Here we will represent past and present covering algorithms for the same field by using convolution neural network (CNN, or ConvNet) in deep learning and Artificial Neural Network (ANN). This paper discusses various Artificial Neural Network (ANN) approaches towards Face Detection and Recognition.**

Keywords- Face Detection and Recognition Algorithms, Convolution neural network (CNN), Deep Learning, Artificial Neural Network (ANN),

I. INTRODUCTION

Facial recognition system is able to person mass identification as it does not require the cooperation of the test subject to work. It is used to detect faces in real time for surveillance and tracking of person or objects [1]. Traditionally, Face Detection and Recognition Algorithms were used to recognize the common features of faces like Principal Component Analysis (PCA). But, as time passed, there are a lot of algorithms introduced in this field. These algorithms give better efficiency, performance, reliable, etc. Since lots of methods are introduced for detection and recognition which considered as a milestone [10]. Recently, with the emergence of deep learning, face recognition achieves impressive results. A convolutional neural network (CNN), one of the most popular deep neural networks in computer vision applications, shows an important advantage of automatic visual feature extraction [1].

Fig.1 Face Detection and Recognition

The field of biometrics technology utilizes detection and recognition method involving human body parts such as fingerprint, palm, retina (eyes) and face. Biometrics ID method of access is not only authenticates but also verifies the identity of a person, which is corresponding to the authorized access. It helps us from many frauds and cheatings etc

The aim of the proposed methodology is to detect the face in an image and identify the person using a standard image database with a better efficiency and accuracy in comparison with the existing methods by using Deep Learning and Artificial Intelligence [8].

II. CHALLENGES OF FACE DETECTION AND RECOGNITION

Detecting and recognizing faces are challenging as faces have a wide variability in poses, gestures, postures, shapes, sizes and texture. The problems or challenges in face detection and recognition are listed as follow [6], [9]:

A. Pose

A face can vary depends on the position of the camera during the image is captured.

B. Presence of structural components

There may be other additional components on the face such as spectacles, moustache or beard.

These components may have different types, shapes, colors and textures.

C. Facial expression

The facial expression resembles directly on the person's face.

D. Occlusion

A face may be partially obstructed by someone else or something when the image is captured among crowds.

E. Image orientation

It involves with the variation in rotation of the camera's optical axis.

F. Imaging condition

The condition of an image depends on the lighting and camera characteristics.

G. Different Facial Features

Different type of facial features such as glasses, beard, hair moustache, scars, moles, tattoos, skin colors and makeup affect the face recognition accuracy.

H. Face Size

This factor is also a major challenge because face size can vary a lot person to person. Not only different people have different sized faces but the face closer to the camera and far away from the camera also pose a challenge.

I. Facial Expression
This factor depends on the nature of the images i.e. face images vary at different camera rotations about its optical axis
There are other challenges (which are not discussed in this paper) in face detection and recognition but these are the most general problems.

III. ADVANTAGES OF FACE RECOGNITION

A. The Improvement of Security Level
Face biometrics help person or organizations to improve their security level .
B. Easy Integration Process
It is small space or time required process.
C. High Accuracy Rates
It gives better accuracy to performances.
D. Full Automation
It does not required man to operate or automate the devices

IV. DISADVANTAGES OF FACE RECOGNITION

A. Processing & Storing
As, it requires large data set to detect the person .hence it require more processing and storage.
B. Image Size & Quality
To detect and recognize the person, device need sharp, good quality image.
C. Surveillance Angle
To capture and detect the person, surveillance device need a perfect angle to detect the person.

V. APPLICATIONS OF FACE RECOGNITION

A. Payments
It wants to made payments to be easy. Online shopping is an example. In 2016, MasterCard launched a new selfie pay app called MasterCard Identity Check. Facial recognition is already used in store and at ATMs, facial recognition are useful.

B. Access and security
As well as verifying a payment, facial biometrics can be integrated with physical devices and objects. Instead of using pass codes, mobile phones and other consumer electronics will be accessed via owners' facial features. Apple, Samsung and Xiaomi Corp. have all installed FaceTech in their phones. In future, it will work at commercial places.

C. Criminal identification
It will help police to identify the criminal at many places to catch the prisoner.Face spoofing and anti-spoofing, where a photograph or video of an authorized person's face could be used to gain access to facilities or services.

D. Advertising
The ability to collect and collate masses of personal data has given marketers and advertisers the chance to get closer than ever to their target markets. FaceTech could do much the same, by allowing companies to recognise certain demographics.

5. Healthcare
Instead of recognising an individual via FaceTech, medical professionals could identify illnesses by looking at a patient's features.

VI. FACE DETECTION AND RECOGNITION ALGORITHMS

A. Principal Component Analysis (PCA)
Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components [11]
It is also known as Karhunen-Loeve method, is most famous method that used to dimension reduction [13].
PCA was invented in 1901 by Karl Pearson, it was later independently developed and named by Harold Hotelling in the 1930s.
Recognition of human faces using PCA was first done by Turk and Pentland [8] [3] and reconstruction of human faces was done by Kirby [8] [3]
A mathematical procedure performs a dimensionality reduction by extracting the principal component of multi-dimensional data. It reduces the feature space by using Eigen Values to data space which help to recognize the images.
But poor discriminating power within the class and large computation are the well known common problems in PCA method.
Its disadvantage is overcome by Linear Discriminate Analysis (LDA). LDA is the most dominant algorithms for feature selection in appearance based methods [11] [3]. But many LDA based face recognition system first used PCA to reduce dimensions and then LDA issued to maximize the discriminating power of feature selection. [11]
B. Linear Discriminant Analysis (LDA)
Linear Discriminant Analysis (LDA) is a dimensionality reduction technique that reduces the number of dimensions (i.e. variables) in a dataset while retaining as much information as possible. LDA is also known as Fisher's Linear Discriminant (FLD) [6].
It uses the information from both features to create a new axis and projects the data on to the new axis in such a way as to minimize the variance and maximizes the distance between the means of the two classes. [14]
It is a generalization of Fisher's linear discriminant, a method used in statistics, pattern recognition, and machine learning to find a linear combination of features that characterizes or separates two or more classes of objects or events. The resulting combination may be used as a linear classifier, or, more commonly, for dimensionality reduction before later classification [15].
It is not an interdependence technique: a distinction between independent variables and dependent variables (also called criterion variables) must be made. Discriminant analysis is used when groups are known a priori (unlike in cluster analysis) [3].

C. Independent Component Analysis (ICA)

Independent component analysis (ICA) is a strategy for finding basic elements or components from multivariate (multidimensional) measurable information. There is have to execute face recognition framework utilizing ICA for facial pictures having face introductions and distinctive illumination conditions, which will give better outcomes as contrasted and existing frameworks. What recognizes ICA from different strategies is that, it searches for component that is both measurably independent and non-gaussian [3], [14].

D. Locality Preserving Projections [LPP]

It is the best alternative of PCA for preserve locality structure and designing. Pattern recognition algorithms usually search for the nearest pattern or neighbours. Therefore, the locality maintaining the quality of LLP can quicken the recognition. main purpose of Local Binary Pattern was designed for texture classification. The successful of LBP in robustness under illumination variations, discriminative power and computational simplicity have make it more useful in computer vision study in term of detection. [14].

E. Gabor Wavelet

In this algorithm, it signifies that Neuro-physiological data evidence from the visual cortex of mammalian brains suggests that simple cells in the visual cortex can view as a family of self-similar 2D Gabor wavelets. The Gabor functions proposed by Daugman are local spatial band pass filters that achieve the theoretical limit for conjoint resolution of information in the 2D spatial and 2D Fourier domains [14].

F. Kernel PCA

Scholkopf et al. introduced the use of Kernel functions for performing nonlinear PCA. Its basic methodology is to apply a nonlinear mapping to the input and then solve a linear PCA in the resulting feature subspace [14].

G. Fuzzy Neural Networks:-

The fuzzy neural networks for face recognition introduce in 2009. In this face recognition system, we are using a multilayer perceptron. The concept behind this approach is to capture decision surfaces in nonlinear manifolds a task that a simple MLP can hardly complete. The feature vectors are obtained using Gabor wavelength transforms[14].

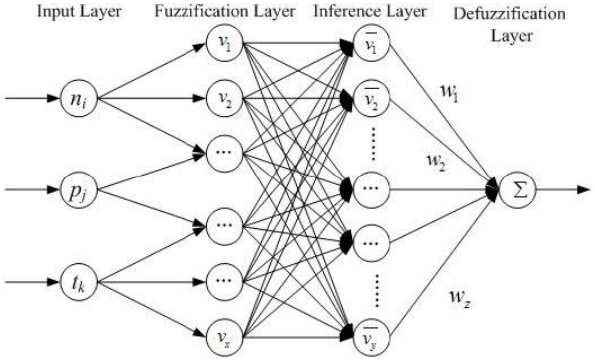

Fig.2 Neural Network [14]

H. Hidden Markov Models:-

Hidden Markov Models are a statistical tool used in face recognition. They have used in conjunction with neural networks. It generated in a neural network that trains pseudo 2D HMM. The input of this 2D HMM process is the output of the ANN, and it provides the algorithm with the proper dimensionality reduction. [14]

I. Local Binary Patterns Histograms

We know that Eigenfaces and Fisherfaces are both affected by light and in real life. We cannot guarantee perfect light conditions. LBPH face recognizer is an improvement to overcome this drawback. The idea is not to find the local features of an image. LBPH algorithm tries to find the local structure of an image, and it does that by comparing each pixel with its neighboring pixels. [14]

VII. PROPOSED METHODOLOGY

A. Artificial neural network (ANN)

Artificial neural network (ANN) is mostly used as a method for recognition process. ANN will be implemented once a face has been detected to identify and recognize who the person is by calculating the weight of the facial information. Basically, ANN imitates human brains biological neuron system. A neuron receives a signal from the previous layer then transmits the signal to all neurons on the next layer. Before transmitting the signal to the next layer, the signal has been multiplied by a separate multi weight value and the weighted input is summed.

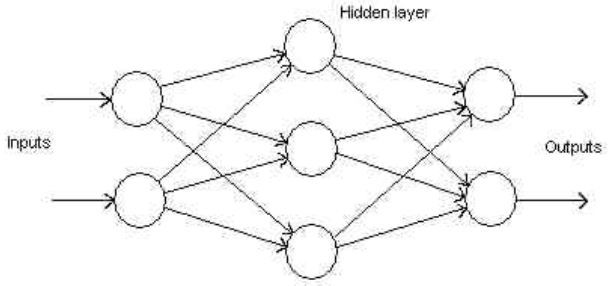

Fig. 3 Generalized neural networks

ANN is divided into several types such as feed forward neural network, back propagation neural network and Radial Basis Function (RBF) network. These three networks are considered as the most commonly used in ANN

.In given table, there is the data of various methods accuracy in different algorithms used.

Methods	Neutral	Illumination	Expression	Pose
PCA	0.80	0.81	0.8445	0.77
LDA	0.91	0.92	0.89	0.83
LBP	0.94	0.97	0.91	0.92
GABOR	0.92	0.88	0.89	0.93
ANN	0.93	0.99	93.9	0.93

ANN requires a lot of deep learning to help in understanding thatswhy weused both to provide more accuracy

B. Convolution Neural Network (CNN, or ConvNet) in Deep Learning

It is a special class of deep learning that works to analyzing visual imagery. It is known to be as Shift Invariant or Space Invariant ANN. It is basically work on shared – weights architecture and translates many characteristics. These are specially used in image and video recognitions. It is work as an multilayer perceptron that has fully connected networks.

Output feature map of the convolutional layer as C,

C = f (H(x, y)), ----------1

Where f(.) denotes the ReLU function f(H(x, y)) = max(0, H(x, y)) and

H(x, y) = å m, n2s W(m, n)I0 i (x + m, y + n) + b,---2

The accuracy of this method could reach 98.1%.[1].

C. Pros and Cons

Radial basis function artificial neural network is naturally integrated with non-negative matrix factorisation.

ANNs is native linearization feature and computation speed up. Ideal solution, especially for recognizing face images with partial distortion and occlusion [16].

The main disadvantage of this approach is requirement of greater number of training samples (instead one or limited number). It is inaccurate in the same way like other statistically based methods [16].

VIII. CONCLUSION

In this paper, we have discussed many algorithms that are used to detect and recognize the faces namely, PCA, LDA, ICA, LPP, Gabor Wavelet, HMM, etc. There are some parameters that are taken into account in this research, which are Occlusion, size and types of database, illumination tolerance, and facial expressions variations and pose variations etc. The performance of the proposed method is compared with other existing face recognition methods and it is observed that better accuracy in recognition is achieved with the proposed method. Face Detection and Recognition uses Artificial Neural Network and Deep Learning gives an enhanced in performance and better accuracy than other existing algorithms. Hence, proposed algorithms has better performance and accuracy

IX. REFERENCE

[1] Zhao Pei, Hang Xu , Yanning Zhang , Min Guo and Yee-Hong Yang, “Face Recognition via Deep Learning Using Data Augmentation Based on Orthogonal Experiments, “Article, Electronics2019, August, 25.

[2] Naeem Ratyal , Imtiaz Ahmad Taj ,Muhammad Sajid , AnzarMahmood , Sohail Razzaq, Saadat Hanif Dar, Nouman Ali, Muhammad Usman, Mrza Jabbar Aziz Baig, and Usman Mussadiq, ¨Deeply Learned Pose Invariant Image Analysis with Applicationsin 3D Face Recognition”, Hindawi Mathematical Problems in Engineering Volume 2019, Article ID 3547416, 21 pages,17,June,2019.

[3] Aishwarya Admane, Afrin Sheik, Sneha Paunikar, Shruti Jawade, Shubhangi Wadbude and Prof. M. J. Sawarkar”, International Journal of Scientific Research of Computer Science Engineering and Information Technology, 25, May, 2019.

[4] Sudeshna Bhosale, Ghatage Dhanashri, Mane Namrata, Mugale Pallavi, International Journal of Advanced Research in Computer and Communication Engineering Vol. 7, Issue 11, November 2018.

[5] Chris Xiaoxuan Lu, Xuan Kan, Bowen Du, Changhao Chen, Hongkai Wen, Andrew Markham, Niki Trigoni and John A. Stankovic,” Autonomous Learning for Face Recognition in the Wild via Ambient Wireless Cues”,29, Jan ,2018.

[6] NURULHUDA ISMAIL, MAS IDAYU MD. SABRI,” REVIEW OF EXISTING ALGORITHMS FOR FACE DETECTION AND RECOGNITION”, RECENT ADVANCES in COMPUTATIONAL INTELLIGENCE, MAN-MACHINE SYSTEMS and CYBERNETICS Jan, 2018.

[7] VIJAY SHESHRAO JONDHALE,” “NEW ALGORITHM FOR FACE RECOGNITION SYSTEM FOR ENHANCED FEATURE EXTRACTION”, SYNOPSIS, 08 January, 2018.

[8] Narayan T. Deshpande and Dr. S. Ravishankar,” Face Detection and Recognition using Viola-Jones algorithm and Fusion of PCA and ANN”, Advances in Computational Sciences and Technology ISSN 0973-6107 Volume 10, Number 5 (2017) pp. 1173-1189 © Research India Publications, November, 2017.

[9] Sandeep Kumar, Sukhwinder Singh and Jagdish Kumar, “A Study on Face Recognition Techniques with Age and Gender Classification,
May, 2017.

[10] Faizan Ahmad, Aaima Najam and Zeeshan Ahmed, Image-based Face Detection and Recognition: “State of the Art”, November, 2013.

[11] Sujata G. Bhele and V. H. Mankar,” A Review Paper on Face Recognition Techniques”, ISSN: 2278 – 1323 International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 1, Issue 8, and October 2012.

[12] Cahit GÜREL and Abdulkadir ERDEN,” DESIGN OF A FACE RECOGNITION SYSTEM”, The 15th International Conference on Machine Design and Production June 19 – 22, 2012, Pamukkale, Denizli, Turkey.

[13] https://en.wikipedia.org/wiki/Principal_component_analysis

[14] https://towardsdatascience.com/linear-discriminant-analysis-in-python-76b8b17817c2

[15] https://en.wikipedia.org/wiki/Linear_discriminant_analysis

[16] https://www.intechopen.com/books/face-recognition-semisupervised-classification-subspace-projection-and-evaluation-methods/face-recognition-issues-methods-and-alternative-applications