A Review on Various Face Recognition Techniques and Applications of Face Recognition

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Abstract— This study is done for comparing some of the different face recognition techniques and discusses three applications in which face recognition is used. The comparison is mainly done on the basis of robustness of the system to various lighting conditions, occlusions, tilt, rotation and accuracy of the system. Biometrics is one of the best solutions used to enhance security. Face recognition is non-intrusive and the simplest way for person identification compared to all other biometric techniques. Face recognition have a great demand nowadays.

Keywords: Face Recognition Techniques

I. INTRODUCTION

There are many biometric techniques for person identification. Finger print recognition, iris recognition, palm recognition, ECG recognition, face recognition are some of the biometric techniques available now. Comparing all these user identification biometric techniques, face recognition is the simplest one and it is also non-intrusive. The face recognition is a challenging task on which researches are still going on.

Person identification from a crowd, security purposes, attendance marking, age identification, gender prediction, disease diagnosing, law enforcement protection, emotion identification from expression are some of the applications of face recognition. The face recognition system will be best when the system is robust to all the changes in lighting condition, occlusion, tilt and rotation. Face recognition is used in smartphones, laptops etc. The human being have an ability to identify the person from face, they met, after long years. In face recognition, the same idea is taken and the machine is made to perform like human being. There are many techniques through which face recognition can be achieved. PCA (Principle Component Analysis), PCA + BP (Back Propagation), PCA + KNN (K Nearest Neighbour), RCNN (Region Convolutional Neural Network), Histogram equalization, Eigen-face, (ANN) Artificial Neural Network, (CNN) Convolutional Neural Network, Haar cascade, LeNet-5, YOLO (You Only Look Once), SVM (Support Vector Machines), SVM + LBP (Local Binary Patterns), Threshold AdaBoost are some techniques used for face recognition. The section II in this work explain different techniques used for face identification, section III explains the application of face recognition, section IV gives a comparison of all the techniques and conclusion is explained in section V.

II. DIFFERENT TYPES

There are many techniques for recognition which exist now. Some of the existing methods are explained here.

In 2010, Face recognition using Principle Component Analysis (PCA), Eigen-face and Neural network [1] proposed by Mayank Agarwal, Himanshu Agarwal, Nikunj Jain, Mr. Manish Kumar information theory approach of coding and decoding the face image. There were mainly two stages: one is feature extraction done using principle component analysis (PCA) and the next, recognition using feed forward back propagation neural network. The database contained 400 images of 40 classes. The dataset used is Olivetti and Oracle Research Laboratory (ORL) face database. It gave an accuracy of 97.018%. The steps used in this work includes preprocessing and face library formation, get the face descriptor using Eigen-face, training neural network and the last step is simulation of Artificial Neural Network (ANN) for recognition.

In 2017, Face recognition based on convolutional neural network [2] proposed by Musab Coskun, Aysegul Ucar, Ozal Yildirim and Yakup Demir used a modified Convolutional Neural Network (CNN) architecture. Batch normalization is added after the output of first and last convolution layer. This CNN architecture was used to extract the features. Softmax classifiers were used for classifying faces in fully connected layers of CNN. Georgia Tech database is used. The steps coming under this model includes resizing the image, built CNN structure and softmax for classification after extraction. The CNN architecture contains 8 layers, first 3 set of convolution – maxpool layers and then two convolution layers.

In 2018, A face recognition system based on convolution neural network [3] proposed by Shijie Qiao and Jie Ma used a simple system for face recognition. The architecture consists of 4 convolution layers, 3 pooling layers, 1 fully connected layer and 1 softmax layer. 3 activation functions such as tan h, Re LU, and a new activation function combining both were used in this method. When the number of kernels increases the misrecognition decreases. The system gave high performance due to the new activation function. Theano framework was the frame work used and the language used was python. The ORL dataset is extended and 10 % of the dataset is taken as the test dataset. The image size was converted from 92 x 112 to 50 x 60. Different models were tested by changing the kernel size.

In 2018, Multi-faces recognition process using Haar cascade and Eigen-face methods [4] proposed by Teddy Mantoro*,Media A.Ayu, and Suhendi used Haar cascade and Eigen-face methods. Multiple faces were detected in a single detection using webcam. Face detection was done using Open-CV with Haar cascade classifier. The steps coming under this work includes converting images from RGB to gray, normalization of lighting, Haar cascade detection, facial extraction with Eigen-face calculation for face recognition and face recognition was done by principle component analysis (PCA), Eigen-vector and Eigen-value calculation, the system was able to identify the user if the yaw angle was between -15 degree to 15 degree and the distance 200 cm

from the webcam. 55 persons were detected at a single detection.

In 2018, Face recognition based on histogram equalization and convolutional network [5] proposed by Gaili Yue and Lei Lu used histogram equalization method for preprocessing of face images. Google deep learning framework Tensor Flow 1.3.0 was used to build the CNN structure. The structure is LeNet-5 model. The dataset used was ORL dataset. The LeNet-5 models have 7 layers which include 2 set of convolution – pool layers followed by 3 fully connected layers. Softmax is used for classification. The step includes image processing, training convolution neural network and classification recognition.

In 2018, A deep learning approach for face detection using YOLO [6] proposed by Dweepna Garg, Parth Goel, Sharnil Pandya, Amit Ganatra and Ketan Kotecha used YOLO for face detection. The face detection can be used for face recognition, face verification etc. YOLO-v2 is fast, accurate and uses less power. It can be done on videos. In this work the execution time of two GPUs were compared. FDDB (Face Detection Dataset and Benchmark) is used as database. The architecture includes 7 convolution layers followed by a (2 x 2) max pool layer followed by 3 fully connected layer followed by an output layer and a fully connected layer. Application of this paper was done in the following paper below.

In 2018, Face detection and recognition based on general purpose DNN object detector [7] proposed by Veta Ghenescu, Roxana Elena Mihaescu, Serban-Vasile Carata, Marian Traian Ghenescu, Eduard Barnoviciu and Mihai Chindea used YOLO (You Only Look Once) v2, a real time object detector, for face detection and recognition. Here the user can be identified from face images with – 90 degree to 90 degree yaw angle, - 10 degree to 10 degree vertical angle, and distance 1m to 3m from the camera. Proprietary database was used and checked for 10 subjects. Model used 17 variations of Darknet – 19 and the best model was identified. The system was fast and accurate. This can be extended on real time applications.

III. Applications

In 2019, E-attendance system using face recognition [8] proposed by Aditya Ladage, Pooja Pache, Sahil Maniar and Seetal Pereira YOLO Darknet was used for face detection. In this work the attendance monitoring using smart phone was done. It was able to identify each person from a single group photo. Face recognition was done using Siamese network. This work will save time and effort. Also provide high accuracy. The system was hosted on a Django based web application with MySQL database. Found RCNN was accurate but slow when compared with this work.

In 2017, A new approach for automatic face emotion recognition and classification based on deep network [9] was proposed by Vibha.V.Salunke, Dr. C. G. Patilfor emotion identification. It was done from facial expression of unknown persons. The dataset used was FER 2013 and tested on RaFD dataset. The architecture consists of three convolutional layers each followed by max-pool layers and ReLU. This can be also done on videos. This work gave an accuracy of 68% which was better than previous systems and 71% when the testing was on RaFD dataset. 7 emotions were classified here so there were 7 softmax classifiers. This work gave accuracy of 90% for happy images and 28% for sad images.

In 2015, A neural – network based gender detection algorithm on full face photograph [10] proposed by Elham Arianasab, Mohsen maadani, and Abolfazl Gandomi investigated on frontal images of 18 year old persons. The dataset consists of the face images of 250 males and females and standard Iranian images. The methodology used was neural network based classification algorithm. This was done using MATLAB. The feature information was got by calculating the length and width between eyes, eyebrows, lips etc. and the principle called Leanardo Davincci Principle. This work gave accuracy greater than that of Support Vector Machines (SVM), SVM + Local Binary Pattern (LBP) and Threshold AdaBoost.

IV. Comparison

When analysis is done on the methods of face recognition discussed in chapter 3, it is found that the First model [1] gave an accuracy of 97.018% when compared with K- means, Fuzzy Ant with Fuzzy C-means, but is sensitive to head orientations. Large head orientations increase the misrecognition rate.

Second model [2] gave higher accuracy rates due to the use of batch normalization for the outputs of the first and final convolution layers. The result showed satisfying recognition rate, but database used only frontal and small degree tilt face images.

In third model [3], the system was efficient and due to new activation function it performs better than other two activation functions but, the number of kernels in each convolution layer was not so bigger and caused some rate of misrecognition in tilt faces, faces with accessories, cropped faces and faces with expression change.

Fourth model [4] showed an accuracy of 91.67% and was able to detect and recognize faces both in day and night (with good light). It can also recognize faces which are 200 cm distant from the webcam. But here, webcam was used and cannot use small mobile devices and detection was possible only for faces between -15 degree and 15 degree tilt.

Histogram equalization used in model [5] improved the quality of images. It has an advantage of simple operation and strong transplantation. Good accuracy when compared with Principle component analysis (PCA) + BP (Back propagation) and PCA + KNN (K Nearest Neighbour).

The seventh model [7] used YOLO (You Only Look Once), a real time object recognition network, have high accuracy compared to Haar cascade and R-CNN (Region Based Convolution Neural Network) based face detection. YOLO have three versions. YOLO v2 is the version used in this model. It was robust to changes in illumination, head orientations including a horizontal tilt of -90 degree to +90 degree and vertical tilt of -10 degree to +10 degree, occlusion, and 1m to 3m camera to subject distance. YOLO is faster and better compared to other object recognition techniques and can be used in real – time applications. It is also able to detect multiple objects from the same image.

Table 1 shows the comparison of 6 models based on techniques used, database or images used, horizontal tilt and accuracy.

Model	Technique Used	Database / Images Used	Horizontal Tilt	Accuracy
[1]	PCA + Feed Forward Back Propagation Neural Network	ORL	Frontal + Tolerance For Some Side Movements	97.018%
[2]	CNN With Batch Normalization	Georgia Tech	Frontal + Some Varying Degrees	94.8% For64x64 x3 Input Image Size
[3]	CNN With New Activation Function	ORL Database + Expansion	Frontal + Small Varying Degrees	96.92% For Network 15-20-35-50
[4]	Haar Cascades & Eigenface Methods	Taken Using Webcam	Frontal + 15 Degree Tilt	91.67%
[5]	Histogram Equalization & CNN	ORL	Frontal + Some Varying Degree	98.25% For 40 Groups
[7]	YOLO Model, Darknet-19 NN Architecture	Proprietary Database	-90 Degree To 90 Degree	89.65% For 280 Generations

Table 1: Comparison of Different Techniques

From these models we get a conclusion that model seven [7] is best when compared with other models. It gave satisfying accuracy rate for all images including horizontal tilt from -90 degree to 90 degree, occlusions and lighting conditions. The specifications which is included in database of model 7 [7] is shown in table 2.

D	Vd (degree)	Hd (degree)						
1m	-10	-90	-45	-15	0	+15	+45	+90
	0	-90	-45	-15	0	+15	+45	+90
	10	-90	-45	-15	0	+15	+45	+90
3m	-10	-90	-45	-15	0	+15	+45	+90
	0	-90	-45	-15	0	+15	+45	+90
	10	-90	-45	-15	0	+15	+45	+90

Table 2: Specification of Database in Model 7 [7]

D is the distance between camera and the subject.
Hd is the horizontal deviation.
Vd is the vertical deviation.

V. CONCLUSION

Different techniques of face recognition are evaluated here. Compared to all the techniques, it is found that YOLO is the latest method used and it will give a satisfying accuracy rate in all kind of databases which have lighting condition changes, occlusion, tilt, rotations etc. YOLO is a real time object detection network so face recognition can be used in real time applications. YOLO have three versions. YOLO v2 is used in the model discussed here. It is fast, accurate and better. YOLO can be used to detect multiple objects from a single scene. Face recognition will be an aid for security purposes, attendance marking systems etc. This work also explained the three applications of face recognition such as emotion recognition from expression, gender identification and E-attendance system. E-attendance system uses YOLO as the method for face detection of multiple persons from single image.

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