University Classroom Attendance System Using Face Recognition Technique

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Abstract **- There are rules and principles to obey for everywhere. And also there are various rules to obey for every staff, students and teachers in every University. Among many rules, each student must be full the defined the attendance record percentage. The attendance record is an important role for the evaluation of each student for classroom participation. For instance, if the attendance of the lecture must be full 75 percentage for each subject, it defines that the student can perform in exam well and can know well for that subject. So, only the students having at least 75 percentage attendance can sit the exam. There are many ways to take the attendance record. Nowadays, the attendance management system is by using QR code, fingerprint recognition, face recognition, etc. And also, in many applications, face recognition become popular to use and it is used for tracing the criminals, for payment, for access right and for taking the attendance because it is reliable, convenience, inexpensive, and easy to use. This proposed system is the classroom automatic attendance system for the University by using face recognition technique Deep Learning technique is used for this system. CNN (Convolutional neural network) is one of deep neural networks. There are many famous CNN models (LeNet, AlexNet, GoogleNet, VGGNet, ResNet, FaceNet, etc). In the proposed system, FaceNet is used for feature extraction and Support vector machine is used for face classification of students. The result of proposed system is compared to the results of RestNet model. The proposed system can be used to reduce time consuming and paper works and can also replace the manual system with the automated attendance system.**

Keywords **- deep learning, face recognition, FaceNet, convolutional neural network, support vector machine, ResNet**

I. INTRODUCTION

Nowadays, human face recognition is still gaining popularity and widely used in many different applications such as face tracking in real time, payment by using face recognition, access control, real time CCTV surveillance system, etc. Traditional taking attendance method is recording the attendance of students in sheet by calling their names. It takes a lot of time and sometimes can cause the mistake. Therefore, it is necessary to use automated taking attendance system. It takes some beating the problems like consuming of time, mistaken attendance and faking attendance. This system is the computerized system for taking the attendance of students by using face recognition technology. There are three main parts for face recognition technology. They are detection the faces, extraction the features and classification. Deep Learning is especially used for recognition because it becomes the best technique for recognition in these days.

Face recognition becomes one of the top three methods among biometric recognition system to identify people from some part of individual anatomy. Face recognition grow rapidly among biometric technology. Moreover, face recognition is still trending in researched fields. It also becomes wide range in commercial areas. Face recognition is applied in various applications for tracking the crimes, for payment, for access right and for taking the attendance because it is dependable, simple to set up, and simple to use.

In early 1990s, traditional face recognition systems were not stable and had several errors in real time applications. Nowadays, deep learning appears, and it is especially great for recognition and detection. Deep learning acts like a human brain, learning by itself. In deep neural network architecture, when we create a neural network, the more the hidden layers (neurons), the better the accuracy.

In this proposed system FaceNet is used for feature extractor and SVM as a classifier and compared the result of proposed system with ResNet model. The purpose of the system is to take the attendance easily which students are in classroom in a short time by using the implemented automated attendance management system by face recognition technique and to save time consuming for taking attendance. Main purpose is to develop the reliable and convenience system. The system will take the attendance of the student automatically in which class. The faces are recognized by the training dataset.

II. RELATED WORKS

Face recognition system is popular and interested research area in IT field. In recent year many new researches have been carried out for efficient face recognition. It is also used in automatic attendance management system. Rajat Kumar Chauhan et. al. proposed the smart attendance management system using CNN [12]. In this paper, Finally, SVM classifier was trained with these 128-dimension values for each face. In paper [3], new method for face recognition was presented using Convolutional Neural Network (CNN) with three well-known image recognition methods such as Principal Component Analysis (PCA), Local Binary Patterns Histograms (LBPH) and K–Nearest Neighbor (KNN) was tested. Softmax classifier and the Deep Learning system was used for face recognition in [14]. This paper outlines the different algorithms used in the face recognition system based on Convolutional Neural Networks. P. Jonathon Phillips [15] compared the SVM based face recognition algorithm and principal component analysis (PCA) based algorithm. Navin Prakash and Dr.Yashpal Singh [16] also used the SVM and discussed the advantages and disadvantages of the Support Vector Machines and resolution. FaceNet was used in unified embedding for face recognition and clustering in [9]. The benefits of this approach are much greater representational efficiency and achieve the state-of-the-art face recognition performance using only 128-bytes per face. A tool for automated

attendance system was developed by Naeema et. al. [17] by using face recognition and this paper also proposed an efficient method by which we can implement such a system with high accuracy. Paper [18] used Viola-Jones Algorithm face detection which detects human face using cascade classifier and PCA algorithm for feature selection and SVM for classification. The proposed system saves the time and also helps to monitor the students. Deepan. P [19] proposed the hybrid classifier for attendance management system using modified Viola-Jones algorithm with PCA and LBP for more accurate performance. Prof.V. P. Chitragar [20] and group developed the smart attendance which used the Principal Component Analysis (PCA) algorithm based on Eigen face approach. In Paper [21] integrate two deep learning algorithm Faster R-CNN face detection algorithm and SeetaFace face recognition algorithm for automatic attendance system. In this paper FaceNet and SVM was used to develop University Classroom Attendance System.

III. Flow of Face Recognition System

Facial recognition is a very convenience technology that helps in identifying faces of human from an image or a video. The facial recognition system uses the biometrics of faces to map features of faces from the given photo or video as input. The flow of the proposed system is described in the following figure.

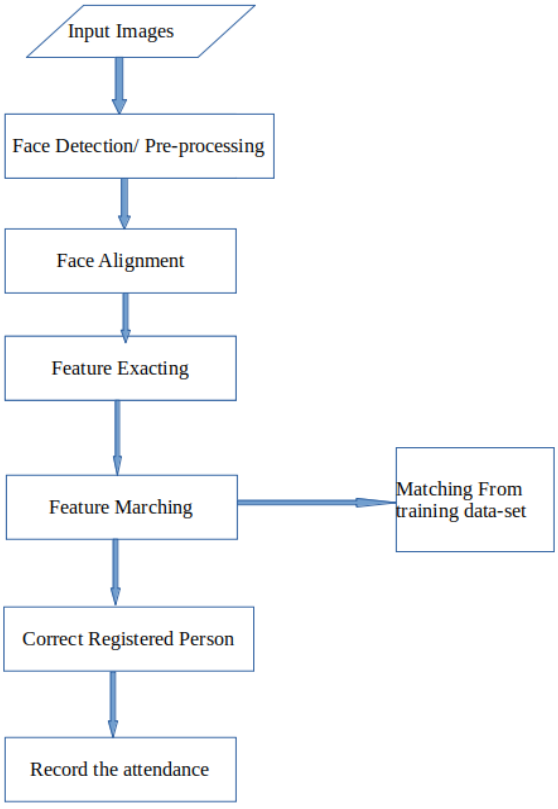

Fig. 1 Flow of the proposed system

A. *Pre-processing*

Pre-processing is important to get training set of faces. Training dataset and testing dataset are pre-processed the faces from image by using pre-process library. However, the pre-process method is not good enough for all images. Some images got errors. It crops even though it is not face. In this case, face location library can get the right one even though it has low resolution. If the size of cropped faces is not same for the input shape of the training model, we do resize. Computer knows the images only as the pixels. So, the input image is changed as a array by numpy. To create dataset of faces, we must to resize for each of face images because the image size for input of FaceNet is (160x160x3) and for ResNet is (224x224x3) to train the model. Output label name of each person will be from the label of the folder name of faces by using FaceNet and SVM. I used the images of my friends and celebrities for training dataset. In this paper, we used at least10 images of different students and there are over 55 students in dataset.

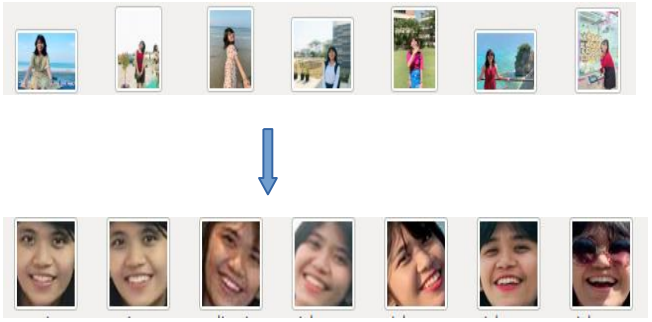

Fig. 2 Pre-processing for training dataset

B. *Feature Extraction*

Facial feature extraction *is the* extracting of main *features of human faces like eyes, nose, mouth, etc.* Feature extraction is a very important part of face recognition because classification depends on the result of extraction. After feature extraction, it inputs to classification. There are many methods (Principal Component Analysis, Fast Pixel Based Matching, Fisher Linear Discriminant Analysis) for extraction. In these days, CNN models become popular.

Most famous CNN models are LeNet, AlexNet, GoogleNet, VGGNet, ResNet, FaceNet, Mobile-FaceNet. A Convolutional neural network is composed of two basic parts. They are feature extraction and classification. Basically, feature extraction of most CNN model has several convolution layers followed by max-pooling and an activation function. Before fully connected layers, these layers do extraction. The better the performance of feature extractor, the less the classifier is depended on. In this proposed system, FaceNet is used for feature extraction.

C. *Classification*

In recent days, Convolutional neural networks become the most successful approach for face recognition problem. There are various algorithms for classification. Principal component analysis, k-nearest and support vector machine are the most popular in research area. The result from the extraction is the input of classification. When working with normalized face embedding inputs. In this proposed system, after extracting the feature with FaceNet, Support Vector Machine(SVM) was used to classify the dataset.

IV. Algorithms

In this proposed system, FaceNet and SVM is used. FaceNet pre-trained model is used for feature embedding. And then these embedding are used for classification.

Ssupport vector machine is used for classification. The result of proposed system is compared with ResNet model.

A. FaceNet with SVM

In the proposed system, FaceNet will extracted the given image as high-quality features of faces and embedded as 128 dimensions for extracted features of faces, and also called face embedding. FaceNet mapped with the face images and resulted the similarity of faces which faces is how many probabilities of whose. The FaceNet model is one of the deep convolutional neural network model. FaceNet used a triplet loss function that restores the vectors to become the same identity for smaller distance, whereas vectors are expected become less the similarity for different identities. In FaceNet model, triplet loss function is chosen to use. Triplet loss can learn from a match between the anchor photo and the positive example, and a match between the anchor and the negative example. SVM is the very quite fast machine learning algorithm for classification of multiclass and it can be used for large data sets.

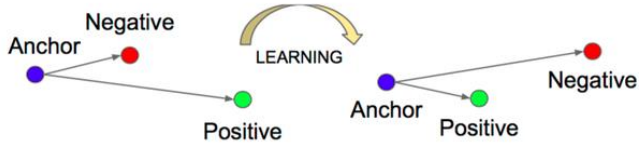

Fig. 3 Triplet Loss

The classification by SVM calculates the distance of embedding data array from the extracted feature by FaceNet. SVM algorithm is implemented by using scikit-learn. SVM is quite well and easy to perform for classification task. SVM gave the probability of classes which face belongs which classes. When making predictions, the output classes can be considered according to the probability of similarity. SVM classify according to the distances of hyperplane. Hyper-planes are data point to make the decision for classification of classes. One hyperplane divides only two classes. Data points falling on same side of the hyper-plane can be attributed to same class and either side belongs different classes. Also, the dimension of the hyper-plane depends upon the number of features. SVM can be given a training dataset of n points of the form.

$$(\vec{x}_1, y_1), \ldots, (\vec{x}_n, y_n),$$

Where the y_i are either 1 or −1, each indicating the class to which the point x_i belongs. "maximum-margin hyper plane" that divides the group of points x_i for which $y_i = 1$ from the group of points for which y_i=-1, which is defined so that the distance between the hyper plane and the nearest point x_i from either group is maximized. Any hyper plane can be written,

$$\vec{w} \cdot \vec{x} - b = 0,$$

where w is the normal vector, x is the set of points.

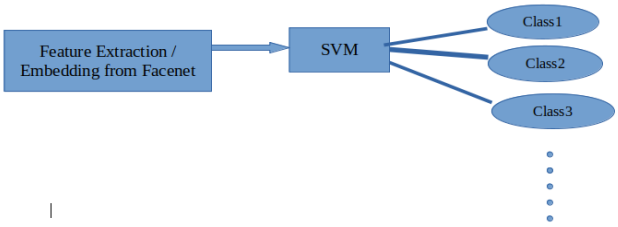

Fig. 4 Flow of FaceNet with SVM

B. ResNet

When giving input image, it changes to numpy array. The array of input image is convoluted with convolution layer. There are three elements for convolution operation. They are input shape of image, feature detector array, feature map array. The pixel of input image is array for input shape of model. For input layer, a 5×5 or a 7×7 matrix is often used as a feature detector, but the more conventional one is a 3×3 matrix. The feature detector is also called as a "kernel" or a "filter". The result from the convolution layer is the input to pooling layer. Pooling operation has two types. Max pooling represents the maximum output within a rectangular neighbourhood. Average pooling represents the average output. The last layers in the network are fully connected, meaning that neurons of preceding layers are connected to every neuron in subsequent layers. In fully connected layer, it uses softmax activation function and give the output of classes.

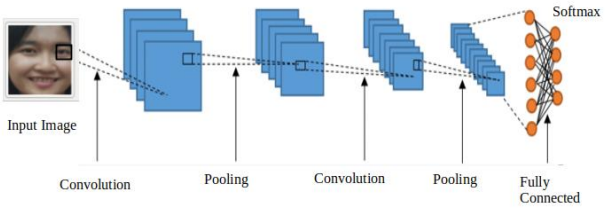

Fig. 5 Flow of ResNet

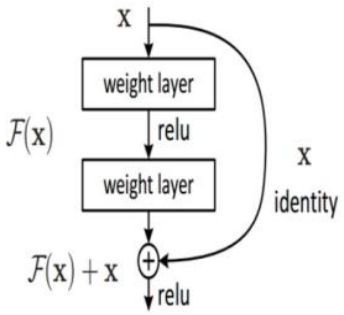

Fig. 6 Residual network

F(x) which defined as H(x)-x with residual connection. At the output of the second weight layer add x to F(x) through Rectified Linear Unit (ReLU). This enables to carry important information in the previous layer to the next layers.

TABLE 1 RESNET ARCHITECTURE

Layer Name	Output size	Layer	Iteration
conv1	112x112	7x7,64, strides2	-
conv2_x	56x56	3x3,max pool, stride 2	-
	56x56	1x1,64 3x3,64 1x1,256	3
conv3_x	28x28	1x1,128 3x3,128 1x1,512	4
conv4_x	14x14	1x1,256 3x3,256 1x1,1024	6
conv5_x	7x7	1x1,512 3x3,512 1x1,2048	3
	1x1	Avg pool, 1000d fc, softmax	

V. EXPERIMENTAL RESULT

We use the face recognition algorithm to detect faces. Therefore, it has to install Tensorflow libraries, Keras, Scipy, Scikit-learn, Matplotlib and Opencv. We use ResNet pre-trained model from keras, for both feature extraction and classification

The training time depends on the size of dataset. When training the model, FaceNet and SVM takes lesser time than ResNet model.

Example of training dataset and face detection results are described in the following figures.

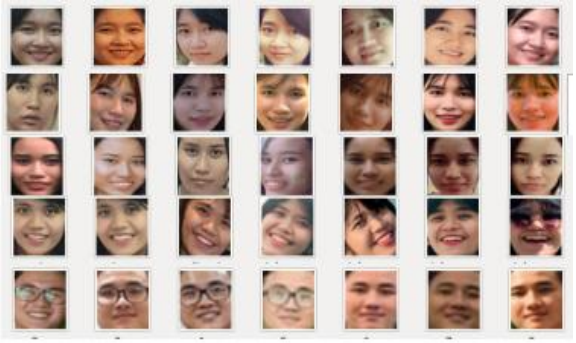

Fig. 7 Example of training dataset

Fig. 3 Face detection of the testing data

The proposed system was tested using different training datasets and testing datasets. The testing results are described in the following tables. In each test case FaceNet with SVM is better than RestNet model.

To get the great accuracy, we need to test with many changes the parameters, for example, optimizer, learning rate, loss function, activate function.

TABLE 2 Result of FaceNet with SVM

Number of people	Number of train image	Number of test image	Correct number	Accuracy
19	181	50	50	100%
35	377	100	100	100%
55	611	150	146	97.33%

TABLE 3 Result of ResNet

Number of people	Number of train image	Number of test image	Correct number	Accuracy
19	181	50	49	98%
35	377	100	97	97%
55	611	150		

VI. CONCLUSION

The smart attendance system is proven as an efficient system for taking the attendance of classroom. This system is non-intrusive, and it reduces the chances of fake attendance. Many approaches for smart attendance system have been proposed but face recognition-based approach is found to be the best method for smart attendance system. According to the experiment, it is more suitable by using FaceNet with SVM. To take attendance a reliable system must be made.

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