SUPPORT VECTOR MACHINE BASED FACE RECOGNITION

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ABSTRACT

Face recognition is one of the robust means of authentication that can be deployed in many critical security related applications. Many techniques to aid this has been researched in the past few decades.Support Vector Machine (SVM)is one of the robust means of classifier which can be applied effectively to face recognition. The proposed study makes use of SVM to classify face images from two popular face databases:Japanese Female Facial Expression (JAFFE) Database and Indian Face Database. It was found that the algorithm could accurately classify the two sets of images under an assortment of variations like expressions, illumination, occlusions, pose, etc.

Keywords: Face Database, Face Recognition, SVM.

I. INTRODUCTION

Broadly speaking, face recognition is a non-intrusive form of identifying a given face image and matching it against a set of faces in the database, in order to validate a person [1]. Face recognition tasks can be grouped into three categories, namely open-universe face identification, closed-universe face identification and open-universe face verification [2]. The block diagram of the basic model of a face recognition system can be seen in Fig. 1.

Today there are a number of face recognition algorithms available and it can be attributed to the rigorous research done in this regard. Even then, face recognition has been an active research domain in computer science. This is due to the fact that the inability or limited functionality of these systems in real time applications. The major reason being the variation in faces due to change in poses [3], age, goggles and other accessories, facial hair, illumination, etc [4].

To overcome these challenges, currently stress is laid on using Support Vector Machines. It is effective in terms of classification of like data by drawing a hyperplane differentiating the different datasets by using the support vectors. The study uses SVM to classify the test face image so as to check for its availability in the training database.

The rest of the paper is organized as follows. Section II deals with a brief introduction of SVM with its mathematical background. Section III elaborates the implementation details and the details of the face databases used for the study. The results and discussions are given in Section IV. The paper concludes in Section V.

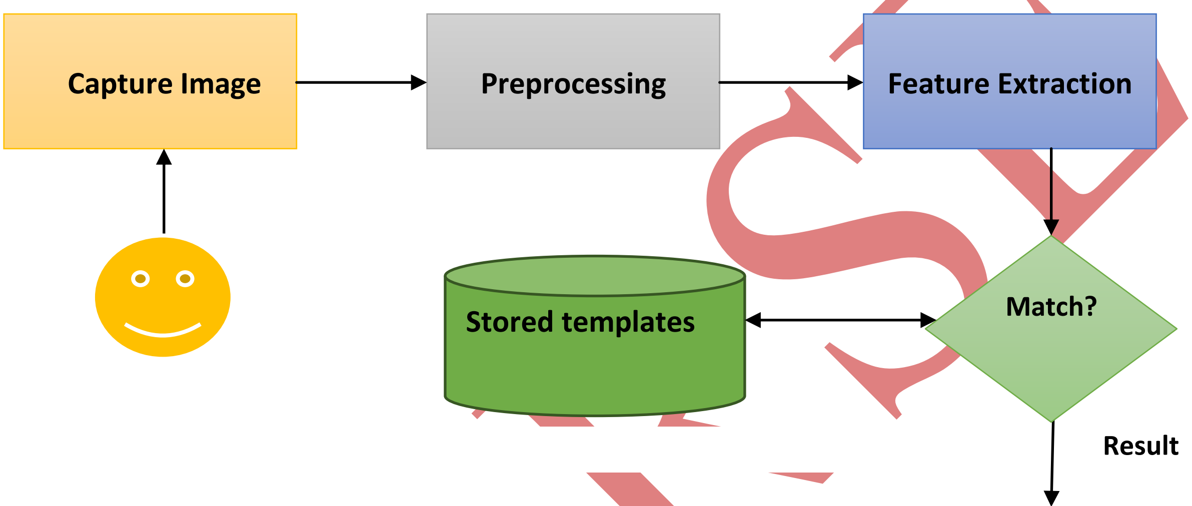

Fig. 1. Abstract model of face recognition system.

II. SUPPORT VECTOR MACHINES

Support Vector Machine (SVM) is associated with machine learning domain. The credit of formulating it goes to Vladimir N. Vapnik. They are basically supervised learning models to scrutinize the data and identify patterns [5,6].This is basically used for regression analysis and classification. More specifically, a SVM builds a boundary or classifier to distinguish or classify a set of data. It is a straight line in case of 2 D feature vector, while in 3D, it is a plane. For other higher dimensions, it is called hyperplanes. A good classifier is supposed to provide a larger separation between the feature vectors of different classes. Intuitively, this is to assure that the classification is general when the feature vectors are subjected to change due to noise.

Many of the traditional algorithms for face recognition are based on an assumption that the classifier once trained, cannot be subjected to amendments during run-time. Hence it requires the entire data specific to a face to be present during training period, which is highly not feasible in real -time applications. However, SVM classifiers overcome this shortcoming by identifying the faces that are not present in the database. These unknown faces can be used to retrain the classifier.

2.1 A review on the mathematical background of SVM

Binary classification can be viewed as the task of separating classes in feature space:

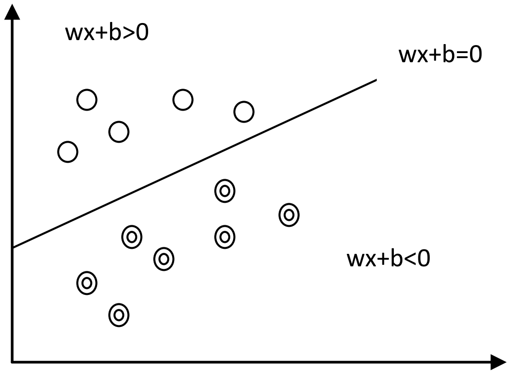

Fig. 2. Linear Classifier

Fig. 2. shows a linear classifier. The classifier is a *separating hyperplane*. Most "important" training points are support vectors; they define the hyperplane. Quadratic optimization algorithms can identify which training points x_i are support vectors with non-zero Lagrangian multipliers α_i.

$f(x) = \text{sign}(w^T x + b)$

In the above equation, the sign determines the class to which the samples belong (in case of two class classifier).

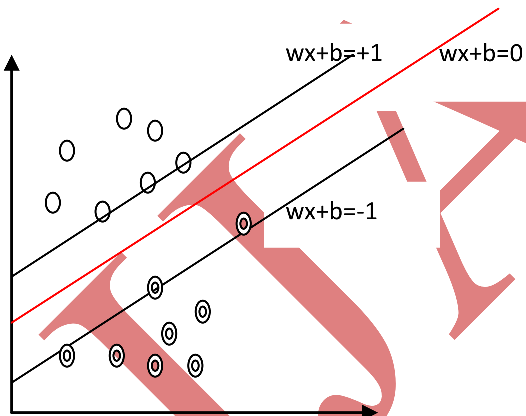

Fig. 3. Linear SVM Classifier

Fig. 3. shows a linear SVM Classifier for two classes of samples. Note that the points lying on the lines wx+b=+1 and wx+b=-1 are called support vectors.

Vectors that are closest to the hyperplane are *support vectors*. The distance between the support vectors is called the Margin M.

Let M be the margin width, then,

$$M = \frac{\mathbf{w}^T \mathbf{x}_i + b}{\|\mathbf{w}\|}$$

Let training set $\{(x_i, y_i)\}_{i=1..n}$, $x_i \in R^d$, $y_i \in \{-1, 1\}$be separated by a hyperplane withmargin M.

Then for each training example (x_i, y_i):

$w^T x_i + b \leq -M/2$, if $y_i = -1$

$w^T x_i + b \geq M/2$, if $y_i = 1$

$y_i(w^T x_i + b) \geq M/2$

For every support vector x_s the above inequality is equality. After rescaling w and b by M/2in the equality, we obtain that distance between each $x_s$and the hyperplane is

$$r = \frac{y_s(\mathbf{w}^T \mathbf{x}_s + b)}{\|\mathbf{w}\|} = \frac{1}{\|\mathbf{w}\|}$$

Then the margin can be expressed through (rescaled) w and b as:

$$M = 2r = \frac{2}{\|\mathbf{w}\|}$$

Then we can formulate the *quadratic optimization problem:*

Find w and b such that it is maximized and for all (x_i, y_i), $i=1..n$:

$y_i(w^T x_i + b) \geq 1$

Find w and b such that

$\Phi(w) = \|w\|^2 = w^T w$ is minimized and for all (x_i, y_i), $i=1..n$:

$y_i (w^T x_i + b) \geq 1$

As a summary, to design a better classifier, the margin width is to be maximized, which can be done by maximizing b and minimizing w.

2.2 Applications of SVM

SVM algorithm is extensively used in applications like Bioinformatics (Protein classification, Cancer classification), text and hypertext categorization, hand written character recognition, brain-wave data analysis [7, 8], and image classification. Face images with occlusions can also be recognized by SVM [9].

III. IMPLEMENTATION

3.1 Details of the face databases used

Two face databases were used exclusively for the implementation of the SVM algorithm. They are JAFFE and Indian Face database.

3.1.1 The Japanese Female Facial Expression (JAFFE) Database

The database comprises of 219 images taken from ten female subjects [10]. The database was developed by Michael Lyons, Miyuki Kamachi, and JiroGyoba. The six basic expressions- surprise, sadness, disgust, anger, happiness, and fear were considered. Even neutral face was used. For the sake of less intricacy, only Japanese female models were taken as subjects. To expose all the regions dealing with expression, the hair was tied at the back. To create illumination on the face, tungsten lights were used. Fig. 4. shows the face images of taken from JAFFE database.

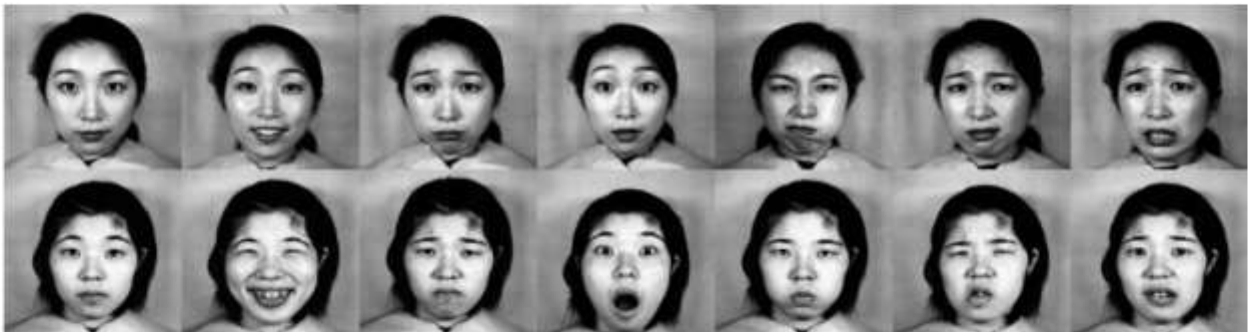

Fig. 4. Sample images from JAFFE database

3.1.2 Indian Face Database

This database was created by Vidit Jain and Amitabha Mukherjee [11]. The data samples were acquired in February 2002, from IIT Kanpur. Totally 61 subjects (242 females, 422 males) were selected, totaling to 664 images. The subjects are in frontal, upright position. The background selected is bright and homogeneous. The variations include: emotions-smile, neutral, sad and laughter; poses-looking left, looking front, looking up and looking right. Gender classification using the PCA method has been done on the samples taken from this database [12]. Fig. 5. Shows samples taken from the Indian Face Database.

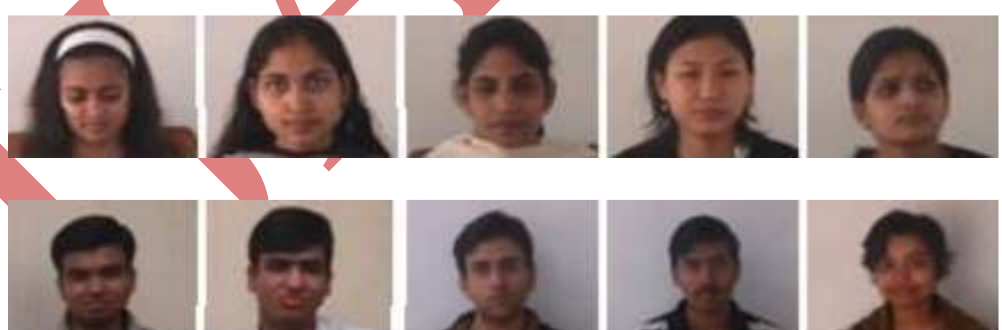

Fig. 5. Sample images from Indian Face database

3.2 Methodology

Fig. 6 shows the block diagram of the proposed system. The images were either acquired from the available databases mentioned above, or real time images. Each image belonging to a particular class was labelled accordingly. The images were then normalized and the SVM was trained. The probe image was tested for its validity (existence in the training database) by the classification mechanism of the SVM. The result returned was the class label to which the probe image belonged. On no match, a suitable error message was displayed.

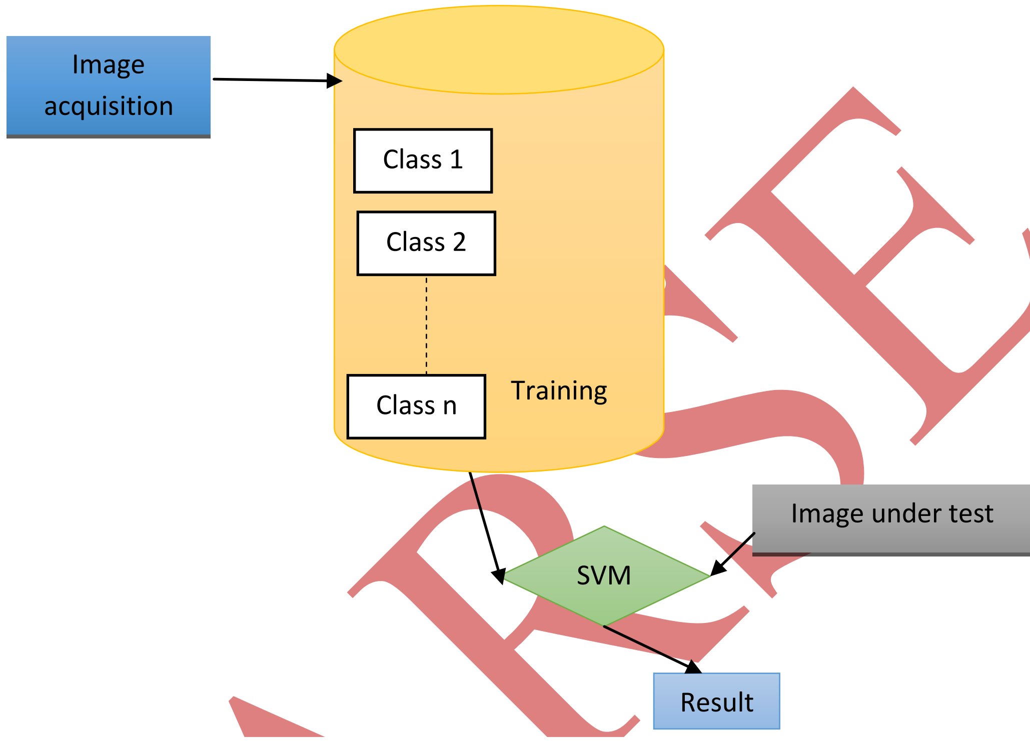

Fig. 6. Block diagram of the proposed implementation

IV. RESULTS AND DISCUSSIONS

The images from JAFFE and Indian Face database were pre stored in the training database with the label of +1 for the former and -1 for the latter. The images were normalized and the SVM was trained with these images. In every iteration, the probe image was tested for its class against the images in the training database. Each time the classification was found to be correct, even if the face images under test varied with respect to illumination, poses, occlusions, etc. The higher the degree of variation, the lower the accuracy of prediction.

V. CONCLUSION

The study dealt with support vector machines to uniquely classify face images into their respective classes. It was found that even with less number of images in the training database, the algorithm was effective in terms of classifying newer images of the same kind with greater accuracy. The technique can be effectively be used in security related issues and thus can aid face recognition to bloom as a robust biometric authentication technique.

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REFERENCES

[l] Xiaozheng Zhang, YongshengGao, "Face recognition across pose: A review", Pattern Recognition 42 (2009) 2876 – 2896, Elsevier.doi: 10.1016/j.patcog.2009.04.017

[2] Enrique G. Ortiz, Brian C. Becker, "Face recognition for web-scale datasets", Comput. Vis. Image Understand. (2013), http://dx.doi.org/10.1016/j.cviu.2013.09.004, Elsevier.

[3] Rabia Jafri, Hamid R. Arabnia, "A Survey of Face Recognition Techniques", Journal of Information Processing Systems, Vol.5, No.2, June 2009. DOI : 10.3745/JIPS.2009.5.2.041

[4] Sheela Shankar, Dr. V. R Udupi, "A Review on the Challenges Encountered in Biometric Based Authentication Techniques", Volume 2, Issue 6, June 2014, International Journal of Advance Research in Computer Science and Management Studies (IJARCSMS). ISSN: 2321-7782 (Online).

[5] W. –S Kang and J.Y. Choi, Kernel machine for fast and incremental learning of face. Proc. of the International Joint Conference SICE-ICASE. pp. 1015-1019. 2006

[6] V. Vapnik, Statistical Learning Theory, Wiley, New York, 1998.

[7] Lin, Yuan-Pin, Chi-Hong Wang, Tien-Lin Wu, Shyh-Kang Jeng, and Jyh-Horng Chen. "Support vector machine for EEG signal classification during listening to emotional music." In *Multimedia Signal Processing, 2008 IEEE 10th Workshop on*, pp. 127-130. IEEE, 2008.
Doi: 10.1109/MMSP.2008.4665061

[8] Panda, R., P. S. Khobragade, P. D. Jambhule, S. N. Jengthe, P. R. Pal, and T. K. Gandhi. "Classification of EEG signal using wavelet transform and support vector machine for epileptic seizure diction." In *Systems in Medicine and Biology (ICSMB), 2010 International Conference on*, pp. 405-408. IEEE, 2010.Doi:10.1109/ICSMB.2010.5735413

[9] Kazuhiro Hotta, "Robust face recognition under partial occlusion based on support vectormachine with local Gaussian summation kernel", Image and Vision Computing 26 (2008) 1490–1498. Elsevier. doi:10.1016/j.imavis.2008.04.008

[10] Available at:http://kasrl.org/jaffe.html

[11]Kekre, H. B., Tanuja K. Sarode, and Jagruti K. Save. "Gender Classification of Human Faces Using Class Based PCA." International Journal of Scientific and Research Publications, Volume 4, Issue 2, February 2014.

[12] Available at:http://www.jdl.ac.cn/peal/

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