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Face Recognition: A Comparative Analysis using SVM, KNN and K-Means Algorithms

Punam Kumari[1], Mansi Kapoor[2], Naman Jain[3] and Kanika Gupta[4]

[1]AKGEC
[2,3,4]Student ,AKGEC
E-mail: [1]punam_taurus@hotmail.com, [2]mansikapoor333@gmail.com,
[3]namanjain1909@gmail.com, [4]kanikagupta373@gmail.com

Abstract—*In the past few years the domain of face recognition has received substantial attention, but is still very challenging. By the current date a lot of face recognition algorithms have been developed and analyzed but, because of advancement in technology only face recognition technology is not sufficient to provide security. Everyone has to think one step ahead of this, Era of multi model has on its peak in every domain, considering this in this paper we have proposed a method in which 3 level securities has been proposed, one is simple text password, second is face recognition and third is graphical password. In this paper the prime emphasis is to determine the efficiency of Support vector machine, K nearest neighbor algorithm and K-Means algorithm in face recognition on the basis of two parameters, intensity and time elapsed. This paper is an implementation of a project made on face recognition in MATLAB. In this work we have used three different methods to enhance the security of the system. Such enhanced security had no negative impact on the experimental work done.*

Keywords*: Face Recognition, SVM, KNN, K-means, Graphical Password*

1. INTRODUCTION

The human face plays an important role in our social interaction, conveying people's identity. Using the human face as a key to security, biometric face recognition technology has received significant attention in the past several years due to its potential for a wide variety of applications in both law enforcement and non-law enforcement.

As compared with other biometrics systems using fingerprint/palmprint and iris, face recognition has distinct advantages because of its non-contact process. Face images can be captured from a distance without touching the person being identified, and the identification does not require interacting with the person.

Support Vector Machines are based on the concept of decision planes that define decision boundaries. A decision plane is one that separates between a set of objects having different class memberships.

In K nearest neighbour an object is classified by majority votes of its neighbours with the object being assigned to the class most common among its K nearest neighbours where K is a positive integer with a small value.

k-means clustering aims to patition n observations into k clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster. This results in a partitioning of the data space into Voronoi cells.

This Paper is primarily divided in to 5 parts. First section is introduction which gives brief introduction about face recognition, and the algorithms we have used in the papers like Support vector machine, K means Clustering and K nearest neighbour algorithm. Second section is about related work what other authors and scientist have already been done in this area of face recognition .Third section is about description of work what we have done to implement our project and to write this paper on the basis of our project This part represent the multilevel security what we have use in our paper one is face recognition and next step is graphical password.. Fourth Section is about Tools and Techniques like MATLAB and Viola –Jones algorithm etc what we have use for implementation. Fifth section is about measurement procedure which is used to show efficiency of SVM , K means and K nearest neighbour algorithm on the basis of elapsed time and intensity. Last but not the least Sixth section shows the result and observation the SVM is more accurate as compare to K means and KNN algorithm.

2. RELATED WORK

In [1], a simple and scalable detection algorithm is proposed that improves mean average precision (map) by more than 30% relative to the previous best result on VOC 2012---achieving a map of 53.3%. This approach combines two key insights: (1) one can apply high-capacity convolution neural networks (CNNs) to bottom-up region proposals in order to localize and segment objects and (2) when labeled training data is scarce, supervised pre-training for an auxiliary task, followed by domain-specific fine-tuning, yields a significant

performance boost. In [2] the research proposed K-Nearest Neighbor (KNN) algorithm to recognize face by ARM processor, which was common processor in robot system. This research sought best k-value to create proper face recognition with low-power processor. The 15 images were set as testing image and 315 images were used as reference data set. OpenCV was choosen as main core image processing library, due to its high-speed. In [3] for quality of face recognition, a robust and reliable computational model for face recognition has been proposed. In this model, two Transformation methods such as discrete wavelet transform (DWT) and discrete sine transform (DST) along with local based feature representation namely: local binary pattern (LBP) and local phase quantization are used to extract numerical features from face images. Irrelevant, noisy, and redundant features are eradicated using Minimum redundancy maximum relevance (mRMR). Various classification learners such as K-nearest neighbor (KNN), Support vector machine (SVM) and Probabilistic Neural Network (PNN) are utilized. SUMS facial dataset and 10-folds cross validation test are used to evaluate the performance of classification algorithms. In [4] Appearance-based face recognition system includes linear Analysis like PCA, ICA, LDA, and Non-linear analysis is Model-based face recognition like, Elastic Bunch Graph Matching, 2D Morph able Model, 3D Morphable Model etc. In linear Analysis, matching score between the test face image and training images can be achieved by calculating the differences between their projection vectors determined by PCA, ICA or LDA. In nonlinear analysis, a mapping function is required to be applied on data space and then the linear analysis on the mapped data is applied. In this paper, RBFNN, FBNN and KNN classifier algorithms for face recognition using PCA and Rectangular feature have been implemented for the purpose of their comparison. The number of PCA features on different image size has been used along with four rectangular features. The recognition rate of different classifiers has been recorded in different conditions for the comparison. In [6] a full solution to facial image tagging and classification in a cloud environment using Hadoop and KNN has been provided. Experimental results confirm that this system makes significant improvements in performance. Furthermore, the effectiveness of the system is evaluated by comparing recognition rates and processing times.

3. DESCRIPTION OF WORK

This project has been made in MATLAB. It consists of three modules: Front, Classification and clustering as shown in Fig. 1.

Fig. 1: When image is captured and matched with the database

Record In this module we have record the face of the user using web cam and winvideo() function. A couple of images of the user are already present in the database. These images are taken from various angles to ensure accuracy during classification. To ensure that the intended user is accessing the system, an ID is initially given to every user. This ID is input by the user before accessing face recognition. The webcam opens up and captures the image of the user standing in front of it. This step is followed by the next module i.e., Classification.

Classification is the first step to train the data. This is done with the help of SVM and KNN. The image taken by the webcam is now classified whether it belongs to the user or not. If it does not belong to the original user then a dialog box appears that access has been denied. The features of the user are extracted using extractHOGFeatures(). Hog training features are created from the gallery. The features are elevated portions on the face like blobs. These features are then mapped with the images stored in database. It eventually depicts if the user is genuine or not. The next module is clustering.

Clustering K-means algorithm is used for clustering. Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). Here a cluster of similar images is made. The image is mapped with one of the images from this cluster. That one image chosen should be the image which is the nearest i.e., which matches with the image the closest.

The final security step is graphical password as depicted in Fig. 2.

Fig. 2: Graphical password security

Each user is given a unique user ID. If the ID does not match the user then an alarm starts ringing. An image appears in 6*6 grid format. The images change their position in the grid each time the user accesses it. Only four out of 36 images chosen in a particular sequence are the password. This eliminates the security threat of shoulder surfing.

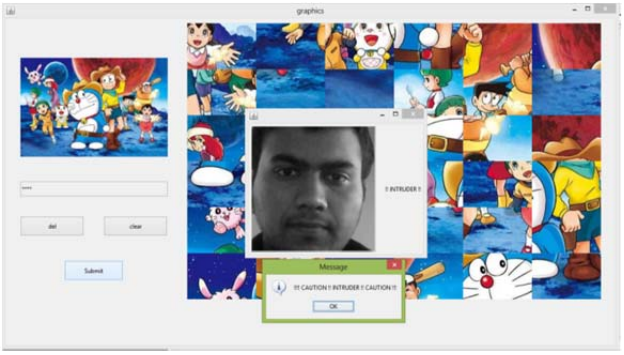

Fig. 3: An intruder is detected

If the input images are wrong or the sequence is mismatched then an email is sent to the original user along with the image of the intruder captured as shown in Fig. 3. The three algorithms used SVM, K-means and KNN have now been compared based on the accuracy during various intensities of light and the time elapsed in matching the image.

4. TOOLS AND FUNCTIONS USED

The tool used in implementing this project is MATLAB .It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Various functions are used in implementing this project. extractHOG Features() is used to extract features from the image. These features include elevated portions on the face like blobs. imwrite(I,'dest') stores the image at the current folder mentioned by 'dest' with the extension mentioned by the user. Invision. Cascade Object Detector, the cascade object detector uses the Viola-Jones algorithm to detect people's parts of the faces like the lips, eyes etc. Train Image Category Classifier (imgSets,bag) returns an image category classifier. The classifier contains the number of categories and the category labels for the input imgSets, an image Set object. Imread()reads the image from the file specified by filename, inferring the format of the file from its contents. For calculating the time elapsed the function tictock() is used. The name of the algorithm to be used is typed between tic and tock . Hence time elapsed is computed.

5. MEASUREMENT PROCEDURE

Initially the parameter of Intensity is taken into account. We analyze K-means first. Five different images are taken with varying intensities. In the first image, intensity is kept minimum. In the second image, intensity is the maximum. In the third image, intensity is reduced down to some extent. In the fourth image, intensity is further reduced and in the final image, intensity is made the lowest. In all the five images, face of the user has been matched accurately.

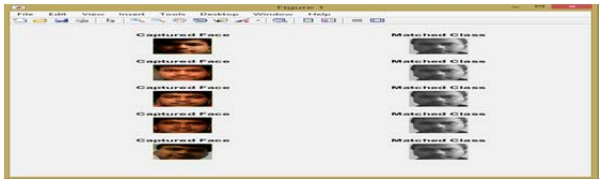

Fig. 4: matching of face based on various intensities using k-means algorithm

We first analyze K-means algorithm which is used for clustering. Different images with different level of intensities are as shown above. Classes are being matched efficiently in all the five scenarios. The time elapsed in matching of the class is as depicted in Fig. 5.Time taken to match the image with the lowest intensity is the least i.e, 0.679976 seconds.

This indicates that pixel to pixel mapping takes minimum amount of time in it. The image with the highest intensity takes the maximum time i.e., 0.777228 seconds. With a little lower intensity, we have the time dropping further to 0.711999 seconds. When further reduced the time achieved is 0.730474 and 0.774851 seconds consequently. This clearly indicates that it takes more time to map an image with brighter intensity as compared to the darker one. Since pixels are more clear in a brighter image hence we can conclude that mapping takes more time since matching of every single detail does.

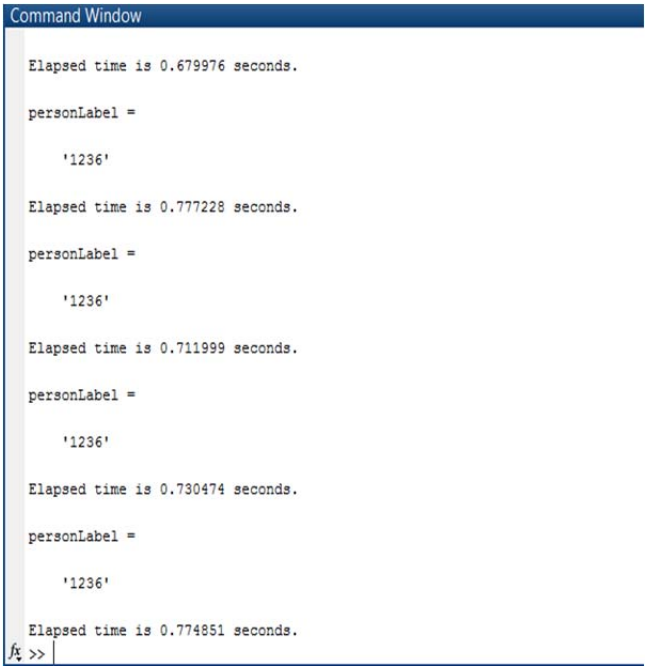

Fig. 5: Time elapsed in matching faces in K-means under varying intensities

The next algorithm we take into consideration is KNN algorithm. It is used for clustering similar types of images in one set. The image that matches the closest to the captured image with respect to the features extracted is used for mapping. Fig. 6 clearly indicates that three out five images under varying intensities matched accurately whereas two did not. These two images are the images with darker intensities.

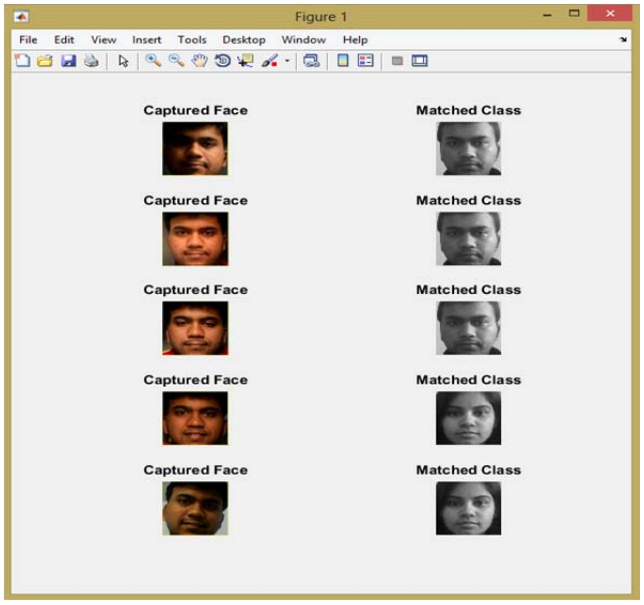

Fig. 6: Images matched under varying intensities using KNN algorithm

Hence in K-means algorithm we can say that Images with more intensity are matched accurately as compared to the ones with less intensity.

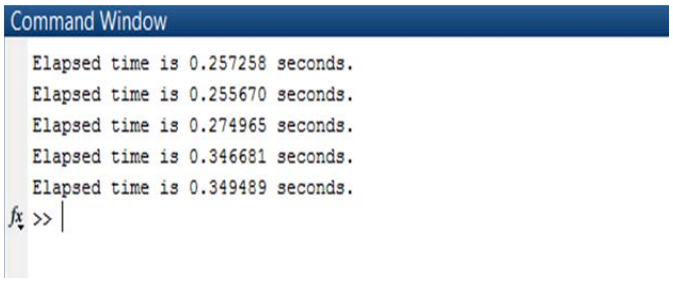

Fig. 7: elapsed time under KNN algorithm

Fig. 7 shows that out of the three images matched accurately the one with the maximum intensity takes the least time in matching. Its elapsed time is 0.255670 seconds. A little more time is taken when intensity is reduced. Time elapsed in the third image after reducing intensity is 0.274965 seconds. From this observation we can infer that as intensity reduces, time taken to match the images increases.

The last algorithm we have worked upon in this paper is SVM i.e., support vector machine used in clustering.

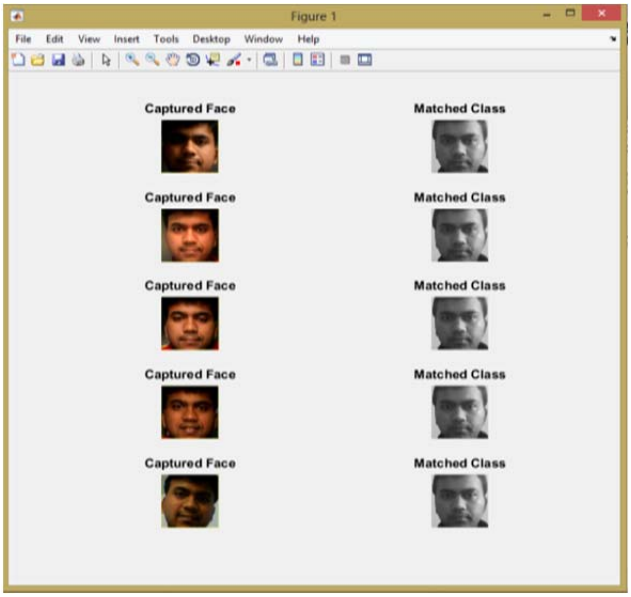

Fig. 8: Mapping of face using SVM under varying intensities

Fig. 8 shows that all the five images under varying intensities have been matched accurately. Mapping of images is accurately shown. Fig. 8 clearly shows that the brightest image takes less time to be matched as compared to darker images. The brightest image takes 0.271845 seconds to be mapped. The darkest image takes 0.343711 seconds to be matched. Hence we can clearly say that as intensity reduces, time elapsed increases.

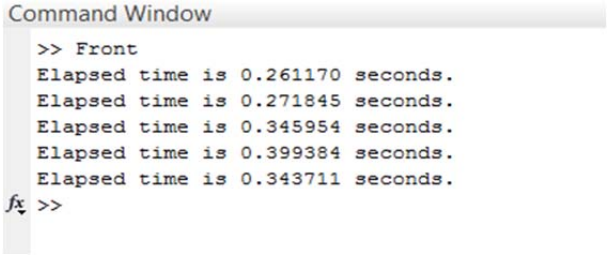

Fig. 8: elapsed time in support vector machine

6. RESULTS & OBSERVATION

From the above experimental work, we have analyzed that in K-means clustering there is no relationship between intensity and time elapsed for matching of images. Nevertheless, all images under varying intensities have been matched accurately. In KNN algorithm, not all images have been matched accurately. The accuracy of images being matched is 60%. There is an inverse relationship between intensity and time elapsed. As intensity decreases, time elapsed increases. Finally in SVM, the accuracy of matching of all the images is 100%. Here not corresponding to all images can we establish a relationship between intensity and elapsed time but time elapsed increases when intensity is reduced but the images are still in a bright frame(not completely dark).

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