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Multimodal Biometric Recognition Using Sift And K-Means Algorithm

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Abstract: Most biometric systems that are presently used in real time applications typically use a single biometric characteristic to authenticate the user. A biometric system which is based only on a single biometric identifier in making a personal identification is often not able to meet the desired performance requirements. Multimodal biometrics is an emerging field of biometric technology, where more than one biometric trait to improve the combined performance. We design a bimodal biometric system which integrates FKP and Face. Hence this paper has focused on the extraction of features from FKP and Face using Scale Invariant Feature Transform (SIFT), and the key points are derived from FKP and Face and then they are clustered using K-Means Algorithm. The centroid, mean and variance of key extracted image of K-Means are stored in the database which is compared with the query FKP and Face features to prove the recognition and authentication. The comparison is based on the XOR operation. Results are performed on the Poly-U FKP and Face database to check the proposed FKP and Face recognition method. It can be used to overcome some of the limitations of a single biometrics, increases the performance.

Keywords: Biometric, SIFT Algorithm, Feature Extraction, K-Means Algorithm

I. INTRODUCTION

The term "biometrics" is derived from the Greek words, bio (life) and metric (to measure). Biometrics refers to the automatic identification of a person based on his/her physiological or behavioral characteristics. Verification involves confirming or denying a person's claimed identity while in identification, one has to establish a person's identity. The biometric identifiers have their advantages and disadvantages in terms of the precision and user acceptance. So authentication leads major part in the secured way of communication. Currently, passwords and smart cards are used as the authentication tool for verifying the authorized user *[1][11][12]*. However, passwords are easily cracked by dictionary attacks, as well as the smart cards are stoles by anybody, and then we cannot check who the authorized user is. So the multimodal biometrics is an only remedy to enhance higher end security.

Fig 1: Images of Finger knuckle and Face

The combinations of face, finger print, palm print, iris recognition are readily available. But there is no possibility of having the combination of FKP and Face. This paper combines the facial features along with FKP for improving the performance of security as shown in the figure 1. The system first capture the image of the whole hand and then extract the finger or finger knuckle surface areas, the system captures the image around the finger knuckle area of a finger directly. Face recognition is a nonintrusive method, and facial images are probably the most common biometric characteristic used by humans to make a personal recognition. The general recognition process was shown in the figure.2, which consists of two-phase, i.e., enrollment phase and verification phase. The first extracted features of any biometrics are stored in the database is known as enrollment phase and the same features are matched with the database using the query input is known as verification phase. Above all the papers are explained that key points as key features are used to match the FKP and Face image with its database for its recognition. This paper proposes an innovative of extracting the features of FKP and Face using SIFT algorithm after the histogram process.

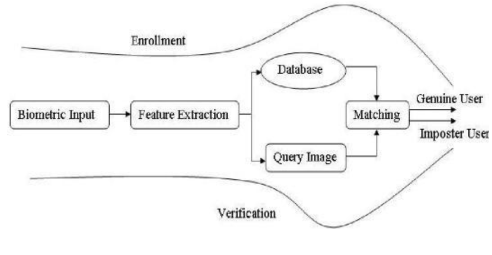

Fig.2: General Biometric Recognition Process

Afterwards the key points extracted from the SIFT are clustered into groups with the K-Means algorithm, which is then converted into bits. The bit values are stored in the database, and these bits are used to match the authenticate user through the XOR operation process. The rest of this paper is arranged as follows. Section 2 describes about structure of the proposed work. Section 3 gives the details of the feature extraction of FKP and Face. Section 4 discusses about the clustering process using K-Means Algorithm. Section 5 explains about the enrollment and verification phase. The experimental results and the analysis are discussed in section 6. Finally, section 7 provides the conclusion.

II. STURUCTURE OF PROPOSED METHOD

The clustering is a method, which will give centroid value of the group which reduces the number of points of a system. So this paper proposes a new technique named as biometric clustering system to merge the above two process to provide authentication for individuals. This paper proposes a novel method to combine the SIFT algorithm with clustering to find the output values of knuckle print in the bit format *[10]*. This paper also consists of two process i.e. enrollment and verification phase.

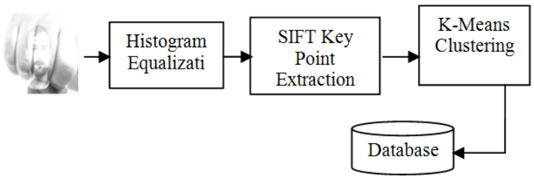

Fig.3: Enrollment Phase

The Enrollment process is shown in the figure 3. In this phase, the key points are extracted from the FKP and Face using *histogram and scale invariant feature transform*. The key points are placed on the graph and clustered together to find the centroid value using K-Means algorithm. Then the centroid value is converted to binary values which is stored in the database. The next phase of this paper is the verification phase which is shown in the figure 4. First step of the verification phase is same as enrollment phase to find the binary values with SIFT and K-means algorithm. The value found out from the query input is compared with values in the database. The comparison is done by XOR operation i.e. all the outputs of the compared values are zero, then the user is authenticated, otherwise the user is not a genuine user as shown in the figure 4.

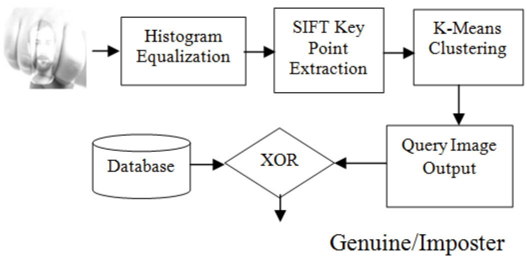

Fig.4: Verification Phase

III. FEATURE EXTRACTION

The process of feature extraction contains two steps i.e. Histogram equalization and SIFT key point extraction. Each valid key point is been characterized by two parameters: x-coordinate and y-coordinate. The first process of feature extraction is histogram equalization, which is used to enhance the input image of FKP and Face as shown in the figure 5(a), in order to acquire the spatial characters correctly as shown in the figure 5(b). Histogram equalization is used to enhance the visualization effect by increasing the pixel size. Histogram processing is the act of altering an image by modifying its histogram. Common uses of histogram processing include normalization by which one makes the histogram of an image as flat as possible. This is also known as contrast enhancement. It is a technique that generates a gray map which changes the histogram of an image and redistributing all pixels values to be as close as possible to a user–specified desired histogram. It allows for areas of lower local contrast to gain a higher contrast. It automatically determines a transformation function seeking to produce an output image with a uniform Histogram.

Fig 5(a): Input image

Fig.5(b):Histogram Equalization Image

The second step of feature extraction is SIFT key point extraction. The next step of feature extraction to extract the key points from FKP and Face using the scale invariant feature transform (SIFT) *[10]* as shown in the figure 6. The SIFT algorithm is mainly used for image matching purpose. Scale invariant feature transform is used for detection and extracting local features of an image.

Fig.6: Key Point of FKP and Face

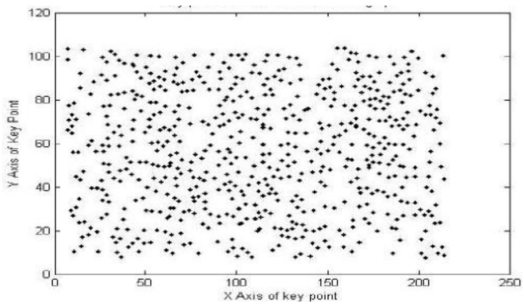

Fig.7: Key Point graph for FKP and Face

IV. K-MEANS CLUSTERING TECHNIQUE

Clustering is used to classify items into similar groups in the process of data mining. It is the unsupervised classification of patterns into groups so that the objects in the same cluster are more similar. There are many clustering algorithms based on cluster model such as connectivity based hierarchical algorithm, centroid based k-means algorithm, distribution based expectation-maximization algorithm and density based algorithm *[9]*. These techniques are used to perform with a given data and are being applied in an ample variety of interdisciplinary applications. In image segmentation, clustering is used to provide the updated centroid value according to the distance between the objects. K-Means, however, is considerable, and the execution is time-consuming and memory-consuming especially when both the size of input images and the number of expected classifications are large. To improve the efficiency of this algorithm, many variants have been developed. It is commonly believed that there are two ways to reduce the time consumption. The first is concerned with optimizing the algorithm itself. The second method focuses on changing the proceeding of execution, that is migrate the sequential process to parallel environment. K-Means is a well known partitioning method. Objects are classified as belonging to one of k groups, k chosen a priori. Cluster membership is determined by calculating the centroid for each group and assigning each object to the group with the closes centroid. This approach minimizes the overall within-cluster dispersion by iterative reallocation of cluster members.

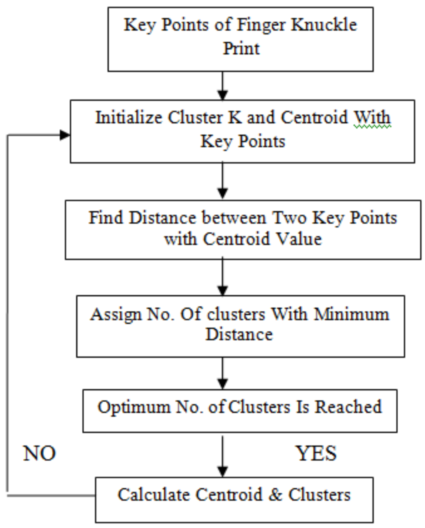

Fig.8:Process Flow of K-means

Simply speaking it is an algorithm to classify or to group the objects based on attributes/features into K number of group. K is positive integer number. The grouping is done by minimizing the sum of squares of distances between data and the corresponding cluster centroid. Thus, the purpose of K-mean clustering is to classify the data. If the number of data is less than the number of cluster then we assign each data as the centroid of the cluster. Each centroid will have a cluster number. If the number of data is bigger than the number of cluster, for each data, we calculate the distance to all centroid and get the minimum distance. This data is said belong to the cluster that has minimum distance from this data. Since we are not sure about the location of the centroid, we need to adjust the centroid location based on the current updated data. Then we assign all the data to this new centroid. This process is repeated until no data is moving to another cluster anymore.

V. ENROLLMENT AND VERIFICATION PHASE

The paper consists of two phases named as enrollment phase and verification phase. Here the input images used for this paper are downloaded from Hong Kong Polytechnic University *[13]*. The steps of enrollment phase are as follows,

a) The first step is to enhance input image of FKP and Face by histogram equalization method.
b) The next step is to extract the key points from the enhanced FKP and Face using SIFT algorithm.
c) After extracting the key points are mapped on the map, and their points are clustered using K-Means algorithm *[9]*.
d) The centroid values calculated from k-means clustering are converted into128 bit binary values, which are stored in the database.

The next phase is verification phase. The steps of this phase are as follows,

a) The first step is to enhance the query image of FKP and Face by histogram equalization method.
b) The next step is to extract the key points from the enhanced query FKP and Face using SIFT algorithm.
c) After extracting the key points are mapped on the map, and their points are clustered using K-Means algorithm[9].
d) The centroid values calculated from k-means clustering are converted into 128 bits of binary values, which are compared with the stored 128 bits of binary values of FKP and Face with XOR operation.
e) Here, if the both values are same, the result is zero, else values are different, and the result is one. Finally, the result is zero means the user is genuine otherwise the user is imposter one.

VI. EXPERIMENTATION RESULTS

Images of finger knuckle and face are obtained from the user. The images are combined and enhanced to obtain the spatial characteristics by using histogram equalization technique as shown in the figure 9. The next step of feature extraction to extract the key points from finger knuckle print using the scale invariant feature transform (SIFT). The SIFT algorithm is mainly used for image matching purpose. Scale invariant feature transform is used for detection and extracting local features of an image. The extracted key points from the SIFT algorithm is grouped by using the K-means clustering technique *[9]*. K-Means clustering is used to find the set of genuine key points, which is converted into binary bits and stored in the database in enrollment phase. The process of FKP and Face K-Means clustering is shown in the figure 10 *[9]*.

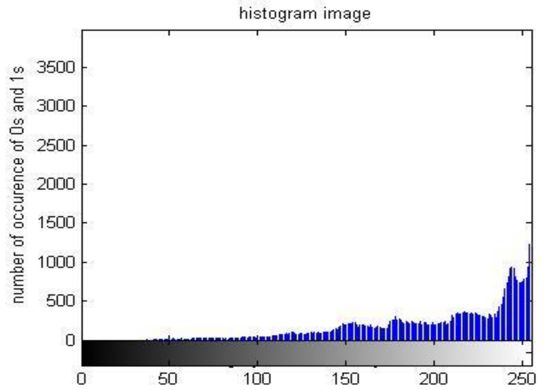

Fig.9: Histogram Equalization graph for FKP and Face

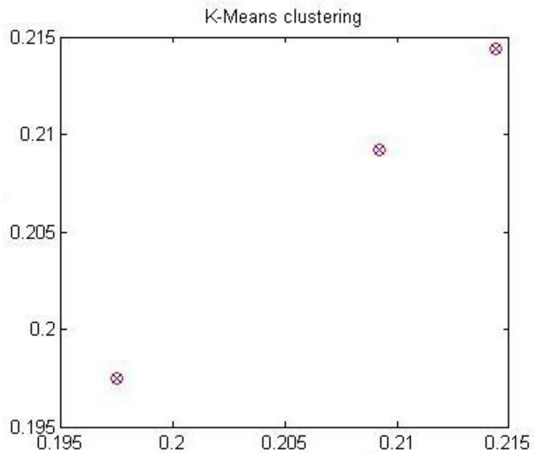

Fig.10: K means clustering graph FKP and Face

The last step of this multimodal biometric recognition system is the matching process used to authenticate the genuine user. This process is done by obtaining the statistical characteristics of combined images of FKP and Face.

VII. CONCLUSION

Thus the multimodal biometric recognition system implemented in this paper provides a higher end security with good efficiency in all the fields.

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