ISSN(O): 2456–0278

Local and Texture Features Based Palmprint Identification System Using KNN Classifier

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Abstract: Palmprint is one of the very important biometric characteristics. In this, the identification process is divided into feature extraction, image acquisition, preprocessing, and matching with the available database. This paper includes the design of a biometric system for identification of human palm. The Proposed algorithm uses the local feature called SIFT and texture feature GLCM for extracting the features. The use of SIFT for feature extraction make the system robust. The palm images, which is used to extract feature is generally captured using a low-cost scanner. The algorithm is tested on IITD database which consist data of 235 users.

Keywords: Biometric, Feature extraction, Gray Level Cooccurrence Matrix (GLCM), Scale Invariant Feature Transform (SIFT).

I. Introduction

As a potential way of identifying a person in the security application, biometric has received an increased research interest and considered one of the most important and reliable methods in the field of information security. Increasing requirement for security has give rise to rapid development of effective personal identification system based on biometric and have found its application widely in commercial and law enforcement application. Nowadays, it is being more and more important to automatically identify an individual according to his physiological features such as iris, fingerprint or behavioral feature such as voice, signature etc. Fig. 1 shows various types of biometric technology. Biometrics gives an identity of a person by physiological or behavioral characteristics. Like any other biometric technique, palmprint is believed to have critical properties of universality, uniqueness, permeance, and collectability for personal identification [3]. Most palmprint based biometric identification system is designed based on feature extraction and matching. Their identification performances may, therefore, be diminished by the poor-quality feature extracted from the different palmprint images. It is often difficult to get a satisfactory identification performances with techniques that use only single- modal. Nowadays, multi-modal biometric techniques have attracted increasing research interest which might improve the identification performances [1]. This paper describes a biometric identification system based on feature extraction of palmprint.

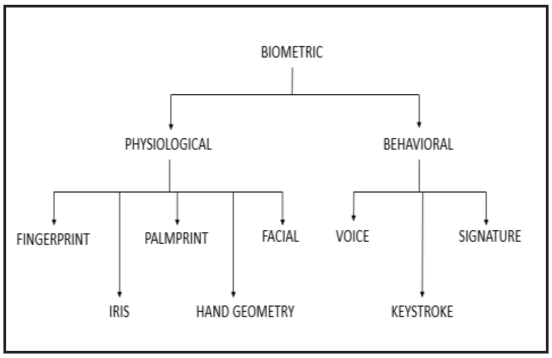

Fig. 1: Biometric Technology

II. Scale Invariant Feature Transform (SIFT)

SIFT is an algorithm to detect and describe local features in an image. It is an image descriptor for image-based matching and recognition. The SIFT descriptor is invariant to translations, rotation and scaling.

SIFT Key point of the desired object is first extracted from a set of the reference image and stored in the database. An object is recognized as a new image by individually comparing each feature from the new image to this database and finding candidate matching features based on distance metric vector.

SIFT extracts a highly distinctive invariant feature from images. The extracted features are invariant to image scaling, rotation and translation. Main stages of computation to generate the image feature are following:

- Scale-space extrema detection
- Key point localization
- Key Point Descriptor

A. Scale-Space Extrema Detection

This algorithm receives a local feature obtained by Gaussian Linear Transformation applied on the original image to form a list of images on a different scale. Then, the extrema points are searched by comparing each point to the other in the same and neighbor space. So, the extreme points are detected into the scale space factor σ, which determines the smoothness of the transformed image.

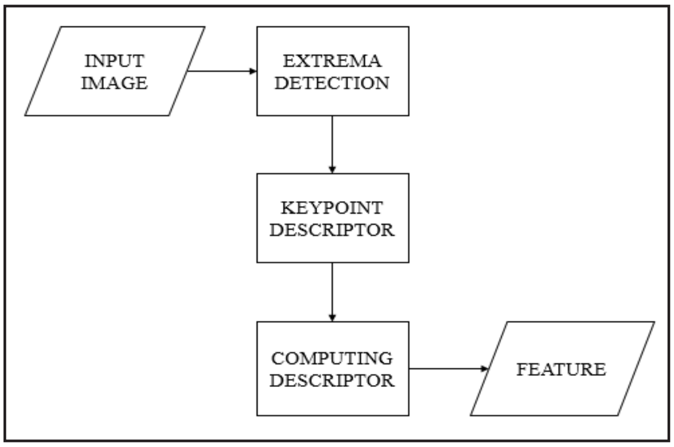

Fig. 2: Block Diagram of SIFT

The operator of the Gaussian scale transform used by Lowe [2] was the difference of Gaussian (DoG) which is defined as the difference of two neighbor scales, separated by the multiplicative constant factor k [2]. Lowe [2] demonstrated that the point detected by this operator is invariant to scale changes. So, the Gaussian Scale-Space L(x,y,σ) of an image is given by:

$$L(x,y,\sigma) = G(x,y,\sigma)*I(x,y) \quad (1)$$

And Gaussian Difference scale space is defined as:

$$D(x,y,\sigma) = (G(x,y,k\sigma) - G(x,y,\sigma)) * I(x,y)$$
$$= L(x,y,k\sigma) - L(x,y,\sigma) \quad (2)$$

Once the DoG is found, each point is compared to its eight neighbors in the same scale as well as in the next or previous scale. If it has the minimum or maximum value, it is treated as an extreme point and it is considered as best key point represented on that scale.

B. Key Point Localization

Once extrema point locations are detected, they have to be refined to achieve more accurate results. In fact, the unstable extreme point may be either sensitive to noise or on the edge of the local texture. So, they have to be filtered, so that it can be treated as key points. The unstable points that are sensitive to noise may easily not be detected since they are dominated by noise and have usually small values. On the other hand, points that are on the edge of the local texture are sensitive to image changes, and various extreme values can be detected from the same location. In this step, only key points which are sensitive to noise and invariant to affine transformation are given.

C. Key Point Descriptor

To create the key point descriptor, an orientation is assigned to each key point in order to reach invariance to image rotation. A neighbourhood is then taken around the location of key point according to the gradient magnitude and the scale, and the direction is then computed in that region. The gradient magnitude m(x,y) and the orientation θ(x,y) are given by:

$$m(x,y) = \sqrt{\begin{aligned}&(L(x+1,y) - L(x-1,y))^2\\ &+(L(x,y+1) - L(x,y-1))^2\end{aligned}} \quad (3)$$

$$\theta(x,y) = \alpha tan\left(\frac{L(x,y+1) - L(x,y-1)}{L(x+1,y) - L(x-1,y)}\right) \quad (4)$$

To obtain orientation of a key point, an orientation histogram represents the essential orientation of this key point. After that, a neighborhood around the key point is taken and divided into 16 sub block, eight orientation histograms is created and a total of 4*4*8 = 128 values is formed to represents the feature vector for each key points.

III. Gray Level Cooccurence Matrix (GLCM)

A GLCM is a matrix where the number of rows and column is equal to the number of distant gray levels or pixel values in the image. It is a matrix that describes the frequency of one gray level appearing in a specified spatial linear relationship with another gray level within the area of investigation.

Calculation texture feature uses the contents of the GLCM to give a measure of the variation in intensity at the pixel of interest. Typically, the cooccurrence matrix is computed by two parameters, which are the relative distance between the pixel pair ‘d’ measured in pixel number. Orientation θ is quantized in four direction (0˚, 45˚, 90˚, 135˚), all though various other combinations could be possible. GLCM has fourteen features the most useful features are: Angular Second Moment (ASM), contrast, inverse difference moment, information measures of correlation and entropy.

IV. Proposed Methodology

The proposed biometric system for personal identification using SIFT local features and GLCM texture features is shown in Fig. 3. The algorithm acquires the input image of palm from the database, Image is preprocessed and region of interest is extracted. Features are extracted using local and texture feature. Then, these features are matched with the feature registered in the database and palm print is identified using nearest neighbor classifier.

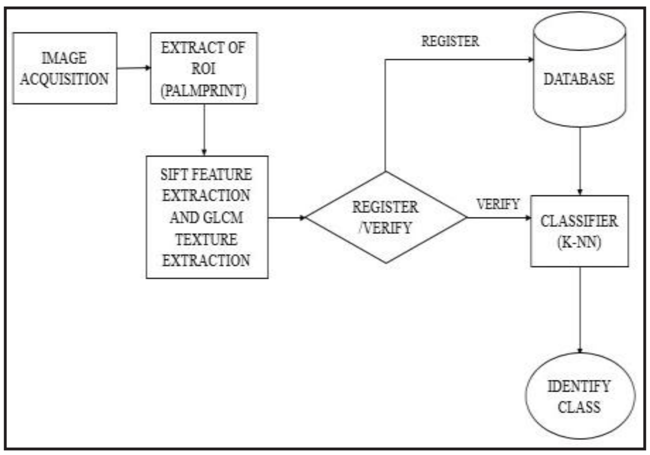

Fig. 3: Proposed Method

A. Image Acquisition

The database used is obtain from IITD and is acquired using a digital CMOS camera. The captured images are stored in bit map format. All the subject in the database are in the group 12-57 years. A sample of palmprint image is shown in Fig. 4.

Fig. 4: Palmprint Image

B. Image Preprocessing

Preprocessing involves converting the color images to gray level images, image rotation and resolution reduction. It removes low frequency background noise and normalizing the intensity.

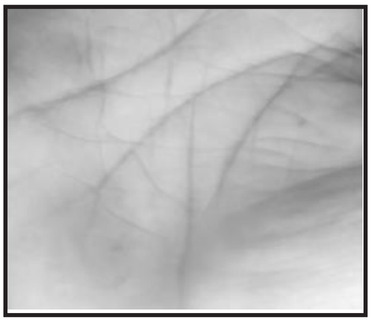

Fig. 5: Preprocessed Image

C. Feature Extraction

SIFT and GLCM are used to extract the feature. Key point of objects are extracted through SIFT from a set of reference images and stored in a database. To recognized an object individually comparing each feature from the new image to this database and finding feature based on nearest neighbor. The detection and description of local image features can help in object recognition. The SIFT features are local and are invariant to image scale, and rotation. PCA is an effective technique for dimensionality reduction.

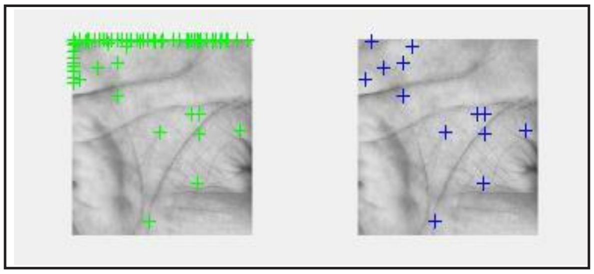

Fig. 6: SIFT Key Point Localization and Key Point Descriptor

GLCM algorithm is used to extract four second order features like energy, entropy, dissimilarity and homogeneity. The local variation in the gray level termed as contrast. Correlation measures the joint probability of occurrence of pixel pair of GLCM. Energy provides the sum of squared pixel value and homogeneity defines the closeness of distribution of element to the GLCM diagonal.

D. Matching

Feature extraction gives the degree of similarity of tested template with master template. Input provided is matched with the template present in the database. One to many matching is done for identification, which matches input as palmprint of individual with all templates of database.

V. Experiment Results

The Proposed method is performed in MATLAB. Firstly, image of palmprint is obtained from IIITD database. After that, image of the palmprint is preprocessed. Preprocessing is done to reduce the distortion and to capture the Region of Interest (ROI) part of the palm images. Then, feature is extracted using algorithm called SIFT for local feature extraction and GLCM for texture extraction.

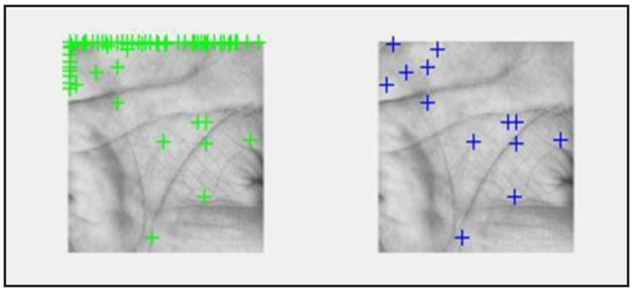

Fig. 7: SIFT Key Point and Accurate Key Point

After extracting features, PCA is applied which reduced the dimensionality. Classification is done using the K Nearest Neighbor Classifier. Table I shows the comparison of error rate with the proposed method.

TABLE I: COMPARISON OF ERROR RATE

S.No.	Method	Error Rate
1	Histogram of Gradient (HOG) with multi classifier [7]	0.257
2	Proposed method (SIFT and GLCM Feature Extraction)	0.205

As in proposed method, two feature extraction method were used which improves the results.

VI. CONCLUSION

This paper proposed an effective biometric system which is robust to rotation, translation and scale of the palm image. A novel method using local feature SIFT and texture extraction GLCM with K Nearest Neighbor (KNN) is used. Scale Invariant Feature Transform (SIFT) is invariant to scale, rotation, translation and affine transformation. Similarly, Gray Level Cooccurrence Matrix (GLCM) is used to find texture feature with some geometrical features like energy, entropy, homogeneity and dissimilarity. The K-Nearest Neighbor classifier is used to classify the palmprint images. Cross-validation (K-Fold) is applied on the dataset which shows that the error rate is reduced compared with the previous method.

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