Palmprint Identification System Based On Local and Texture Features Using KNN Classifier

Harcharan kaur[1], Anish Kumar Vishwakarma[2]

[1]MTech Scholar, Digital Electronics
[2]Assistant Professor
[3] Dept. of Electronics and Telecommunication Engineering, Rungta College of Engineering and Technology Bhilai, India

---

Abstract - *In the biometric family, Palmprint based identification system has become one of the active research topics. Palmprint is the one of the important biometric characteristics with high user acceptance. In this, identification process is classified into image acquisition, preprocessing, feature extraction and matching with the database. This paper describes the design of biometric system for personal identification of human palm. The system uses feature extraction method i.e. local feature called SIFT and texture feature GLCM for extracting features. The palm images, which is required to extract feature is generally acquired using a low-cost scanner. The use of SIFT operator for feature extractions make the system robust to scale or rotation of the hand images acquired. The system is tested on IITD database which is of 235 users. Each image is of bit map (*.bmp) format. 5 or 6 images were captured for each individual person. Resolution of captured image is 800 * 600 pixels. This method can be used for civilian application as it had reduced an error rate compared with global feature.*

Key Words: Biometric, Feature Extraction, Scale Invariant Feature Transform (SIFT), Gray Level Cooccurence Matrix (GLCM)

1.INTRODUCTION

As a potential way of identifying person in security application, biometric has received an increased research interest and considered to be one of the most important and reliable methods in the field of information security. Increasing requirement for security has led to rapid development of intelligent 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 feature such as iris, handshape, fingerprint or behavioral feature such as voice, dynamic, signature etc. Figure 1 shows various types of biometric technology.

Biometrics establishes identity of a person by physiological or behavioral characteristics. Fingerprint is the most widely used biometric feature and iris is the most reliable biometric feature. Like any other biometric identifiers, palmprint are believed to have critical properties of universality, uniqueness, permeance and collectability for personal identification [3]. Using human hand as biometric feature is relatively new approach. Human hand contains many unique feature in the palm region, which is the inner surface of a hand between.

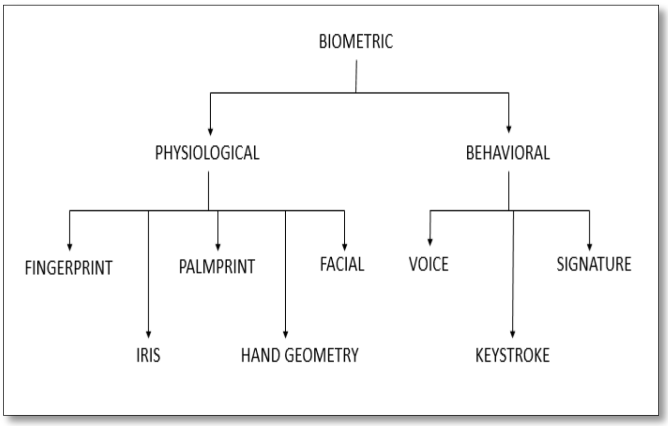


Figure 1: Biometric Technology

Most palmprint based biometric identification system are designed based on algorithm for feature extraction and matching. Their identification performances may therefore be impaired 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]. For that, this paper describes a biometric identification system based on feature extraction of palmprint using classifier.

Feature selection is one of the most important factors that influences the classification accuracy rate. Since some features is selected among extracted features by discarding some redundant feature. The most popular group of feature extraction methods for palmprint recognition is appearances based method such as PCA, LDA etc. Recently, even more attention has been given to local features. These local features are more robust to light variance and can give better recognition accuracy than global feature.

So, an important issue in palmprint identification is to extract the feature that can discriminate an individual from the other. Thus, our proposed biometric identification system is based on feature extracted from palmprint images by Scale Invariant Feature Transform (SIFT) and Gray Level Cooccurrence Matrix (GLCM). SIFT is a feature extraction method as a means of key point extraction and number of matching point carried out using classifier. This system is designed to be robust to translation, rotation and highly accurate, at reasonable price so that it is suitable for civilian application and high end security application. PCA is used for dimensionality reduction. GLCM is used for calculating the texture features from the gray images.

The rest of the paper is organized as follows: Section II describes Scale Invariant Feature Transform (SIFT), Section III describes Gray Level Cooccurrence Matrix (GLCM), Section IV explains review of previous paper, Section V describes the proposed method, Section VI describes result and discussion and Section VII summarizes the Contribution towards the work.

2. SCALE INVARIANT FEATURE TRANSFORM (SIFT)

SIFT is an algrithm in computer vision to detect and describe local features in image. It is an image descriptor for image based matching and recognition. This descriptor as well as related image descriptor are used for a large number of purposes in computer vision related to point matching between different views of a 3-D scene and view based object recognition. The SIFT descriptor is invariant to translations, rotation and scaling transformation in the image domain and robust to moderate persecptive transformation and illumination variations.

SIFT Key point of object are first extracted from a set of reference image and stored in database. An object is recognized in 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 has been designed for extracting highly distinctive invariant feature from images. The extracted features are invariant to image scaling, rotation and translation and partially invariant to illumination changes, addition of noise and affine distortion. Major stages of computation to generate the image feature are following:

- Scale space extrema detection
- Key point localization
- Key point descriptor

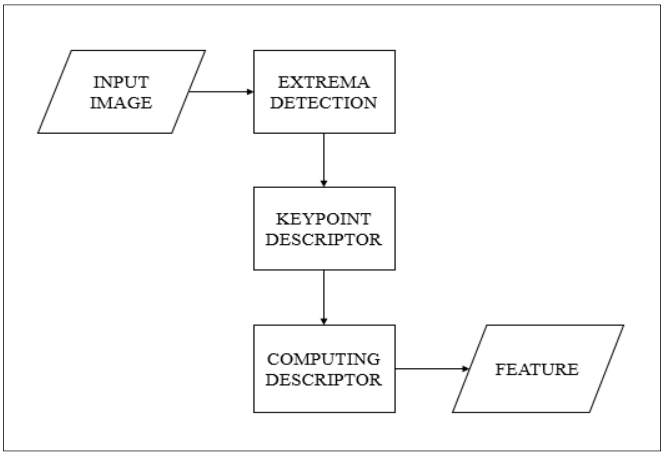


Figure 2: Block Diagram of SIFT

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 in 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 scale. 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 are invariant to scale changes. So, the Gaussian Scale Space L(x,y,σ) of an image is given by

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

And Gaussian Difference scale space is defined as

$$\begin{aligned} D(x,y,\sigma) &= (G(x,y.k\sigma) - G(x,y,\sigma)) * I(x,y) \\ &= L(x,y,k\sigma) - L(x,y,\sigma) \qquad (2) \end{aligned}$$

Once the DoG are found, each point is compared to its eight neighbor 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 in that scale.

Accurate Key Point localization

Once extreme 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.

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

$$m(x,y) = \sqrt{}(L(x+1,y) - L(x-1,y))2 + (L(x,y+1) - L(x,y-1))2$$

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

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.

3. GRAY LEVEL COOCCURENCE MATRIX (GLCM)

It is a well-established statistical device for extracting second order texture information from images. 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 of that surface. GLCM 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.

Texture feature calculation use 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 based on two parameters, which are the relative distance between the pixel pair d measured in pixel number and their orientation θ. Normally, θ is quantized in four direction (0˚, 45˚, 90˚, 135˚), even though various other combinations could be possible. GLCM has fourteen features but between them most useful feature is: angular second moment (asm), contrast, inverse difference moment, sum entropy and information measures of correlation.

Figure 3 represents the formulation of the GLCM of the gray level (8 level) image at distance d=1 and direction of 0˚. In the output of GLCM, element (1,1) contains the value 1 because there are only one instances in input image in which two horizontally adjacent pixels have the value 1 & 1. Similarly, element (1,2) contains the value 2 because there are 2 instances in input image which two horizontally adjacent pixels value have the 1 & 2.

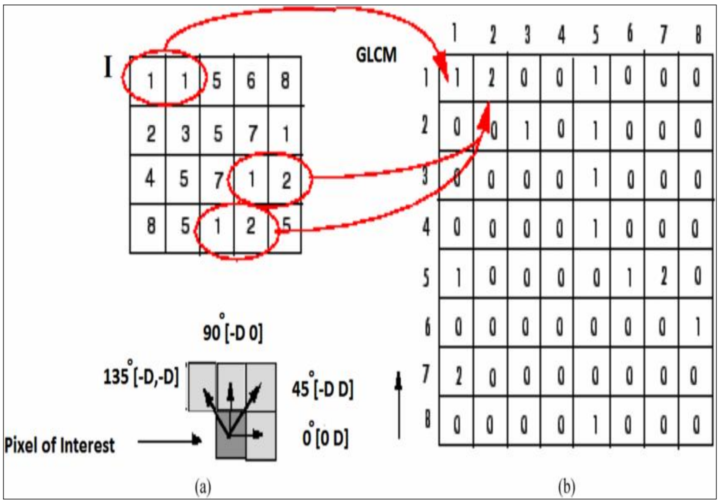


Figure 3: (a) Input image & (b) Gray Level Cooccurrence Matrix (GLCM)

4. LITERATURE SURVEY

Some of the papers are studied for palm print recognition:

A.K.Jain et al [3] provide an overview of biometrics and discuss some of the salient research issues that need to be addressed for making biometric an effective tool for providing information security. Establishing identity is becoming critical in our vastly interconnected society. The primary contribution of this overview includes examining applications where biometric scan solves issues pertaining to information security and enumerating the fundamental challenges encountered by biometric system in real world application.

Bilgehan asslan et al [4] presented a novel method for security perspective of biometric recognition and machine learning techniques. In this study, the techniques, methods, technologies used in biometric system are researched, machine learning techniques used biometric application are investigated for the security perspective. The level of security provided by the use of biometric systems developed using machine learning techniques.

H.Ibrahim et al [5] proposed an article which presents a design of a low cost biometric system that uses combined biometric features to improve the overall system performance by decreasing the False Acceptance Rate (FAR) and False Rejection Rate (FRR). Demand for reliable biometric systems has highly increased during that past decade. The system creates a unique template for each subject based on both his/her facial expressions and ear pattern. DCT are employed as a feature extraction method for the system then the template is fed into a back propagated feed forward neural network to classify and identify the target.

Deepti Tamarkar et al [6] proposed a palmprint verification using competitive index with PCA. Among the various palmprint recognition techniques, competitive coding techniques is very effective and gives efficient results. In the competitive coding method, Gabor filter of six different orientation convolve with the palmprint image to extract the orientation information from the image. Competitive index is coded into 3 bits, but in this study, competitive index is not coded into bits. An approximation band of wavelet transform of the image is used to compress the image, which makes the system illumination and translation invariant. Competitive index scheme is applied in the approximate band. PCA is used to reduce the size of the feature vector. Two different palmprints are matched using Euclidean distance Metrics.

Raouia Mokni et al [8] aims to present a biometric system based on a new approach that focuses on the dominant features of palmprint for recognition. It also introduces new techniques to locate the ROI of the hand by using the database. They used various methods which employ the image processing techniques to binarize the original image, the boundary extraction, the smoothing determination to remove the noise and to eliminate the hole curve and detection of the centroid to extract the key point applying the Euclidean distance. These methods are used to finally extract the ROIs of the Left and Right Hand.

Habibeh Naderi et al [9] presents a trimodal biometric recognition system based on Iris, palmprint and Finger print. Wavelet transform and Gabor filter are used to extract features in different scales and orientation from Iris and Palmprint. Minutiae extraction and alignment is used for fingerprint matching. Six different fusion algorithm including score based, rank based and decision based methods are used to combine the results of 3 modules. They had also proposed a new rank based fusion algorithm Maximum Inverse Rank (MIR) which is robust with respect to variations in scores

Sen Liu et al [10] designed an online non-contact palmprint recognition simulation system. Palmprint has rich texture information and palmprint recognition is very promising biometric identification technology. To study online palmprint identification technology under non-contact mode, a novel and simple method for online palmprint identification technology is presented. Firstly, based on the coordinate position of finger root in palm outline and by locating the contour feature points, mean gray values are extracted as the palmprint features. Finally, the feature matrix distance is used for the palmprint matching.

Nirmala Saini et al [11] presented a palmprint recognition system based on Gabor Wigner transform as feature extraction technique. In the present paper, a palmprint recognition system has been used to extract the features from the palmprint images. The novelty of the system lies in the fact that GWT has been used for the first time for feature extraction in a biometric system. A particle swarm optimization technique has been used to select the significant features and to reduce the dimension of the obtained feature vector while keeping the same level of performance. The ROC curve and the EER have been used to evaluate the performance of the technique.

Raffaele Cappelli et al [12] represented a fast and accurate palmprint recognition system based on minutiae. Palmprint recognition is a challenging problem, mainly due to low quality of the pattern, large nonlinear distortion between different impressions of the same palm and large image size, which makes feature extraction and matching computationally demanding. This paper introduces a high resolution palmprint recognition system based on minutiae. A sequence of robust feature extraction steps allows to reliably detect minutiae, moreover, the matching algorithm is very efficient and robust to skin distortion.

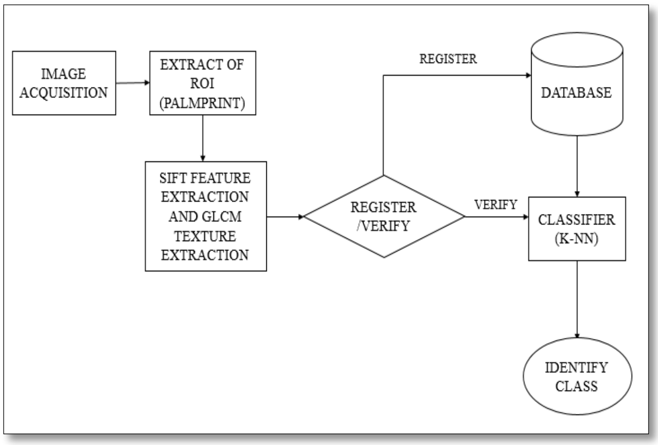
B V Sravan Kumar et al [13] present a robust approach for palm (ROI) extraction in palmprint recognition system. Palmprint based biometric system is potentially a good choice for biometric applications due to its richness in number of features. Palmprint contains geometric features, line features, point features, texture features and statistical features. One of the important stages in the system is preprocessing which contains some operations such as filtering, Region of Interest (ROI) extraction, normalization etc. in this paper, we propose a simple methodology for localizing the palm and extracting the ROI.

Abidin Caliskan et al [14] presented a novel method of palmprint recognition based on Gray Level Cooccurrence Matrix. A biometric provides automation identification of individuals based on unique feature or characteristics of the individuals. In this study, Gray Level Cooccurrence matrix based on palmprint recognition system which provide successful results for identifying image. Firstly, image coordinate system has been defined to facilate image alignment for feature extraction. Then, region of interest is cropped from the palmprint images. The properties of the interested region have been determined using the developed system and it is being given to the classifier (K Nearest Neighbor) for recognition.

R.Rizal Isnanto et al [15] presented a human recognition system which based on the characteristics of palmprint. In the system, feature extraction uses detection of the principal lines features and then the image is divided into blocks and form a feature vector of palmprint. The system developed was tested using 90 palmprint images of 30 individual persons with 3 samples of palmprint were acquired with one person. Two of three palmprint samples were used as test images, while rest is used as references images. From the test result using Euclidean Distance as its similarity measure, it can be concluded that the recognition system based on principal lines feature is well performed with the successful recognition of the palm.

5. PROPOSED METHODOLOGY

The block diagram of the proposed robust biometric system for personal identification using SIFT local features and GLCM texture features is shown above. The process starts with acquiring the input image of palm using images acquired from the database. In the region of interest module images is preprocessed using some standard image, normalized and region of interest is extracted.



In the following module, features are extracted using local and texture feature. Then, these features are matched with the feature enrolled in the database and palm print is identified using nearest neighbor classifier.

IMAGE ACQUISTION

Palmprint Images are obtained from the IITD database. The database is acquired using a digital CMOS camera. The captured images are stored in bit mat format using a contactless imaging device. All these subject in the database are in the group 12-57 years. Resolution of these images are 800*600 pixels and all these images are available in bit mat format.

Figure 5: Palmprint Image

IMAGE PREPROCESSING

Preprocessing images frequently encompasses removing low frequency background noise, normalizing the intensity. It is approach of enhancing data images former to computational processing. It involves converting the color images to gray level images, image rotation and resolution reduction.

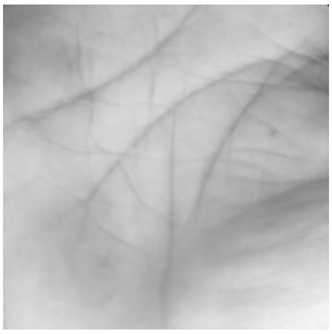


Figure 6 : Preprocessed Image

FEATURE EXTRACTION

In this module, feature of palmprint images are extracted. SIFT and GLCM algorithm are used to extract the feature. SIFT key point of objects are extracted from a set of reference images and stored in a database. An object is recognized in a new image by 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 based on the appearances of the object at particular interest points, and are invariant to image scale, and rotation. PCA is a standard technique for dimensionality reduction, which is well suited to represent the key point patches and enables us to project high dimensionality samples into a low-dimensionality feature space. PCA-SIFT uses PCA instead of histogram to normalize gradient patch.

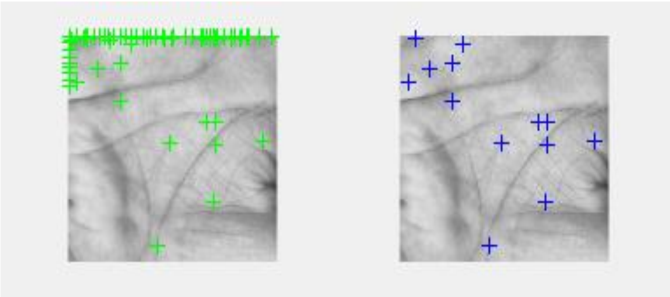


Figure 7: SIFT key point localization and key point descriptor

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.

$$Entropy = -\sum_{i=0}^{G-1}\sum_{j=0}^{G-1} P(i,j) * \log\left(P(i,j)\right)$$

$$Contrast = \sum_{n=0}^{G-1} n2 \left\{\sum_{i=0}^{G-1}\sum_{j=0}^{G-1} P(i,j)\right\}$$

$$Correlation = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1} \frac{\{i * j\} * P(i.j) - \{\mu x * \mu y\}}{\sigma x * \sigma y}$$

$$Energy = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1} (P(i,j))2$$

MATCHING

Matching is next to the feature extraction phase. Feature extraction determines the degree of similarity of recognition template with master template. Input provided by individual is matched with the template present in the database. Here, we are performing identification, so one to many matching is done, which matches input as palmprint of individual with all templates of database. K Nearest Neighbor is a non-parametric method used for classification.

6. EXPERIMENT RESULTS

The experiment reported in this paper uses palmprint images obtained from the IITD database. The database is acquired using a digital CMOS camera. The captured images are stored in bit mat format using a contactless imaging device. Hand images were acquired from 230 users aged from 14 to 56 years and contributed voluntarily at least 5 or 6 images samples per one hand. Firstly, image of palmprint is captured using a digital camera. After capturing, data or image of the palmprint, preprocessing is formed on the image. Preprocessing is done to reduce the distortion and to crop the Region of Interest (ROI) part of the palm image. After getting ROI part, feature is extracted using algorithm called SIFT for local feature extraction and GLCM for texture extraction.

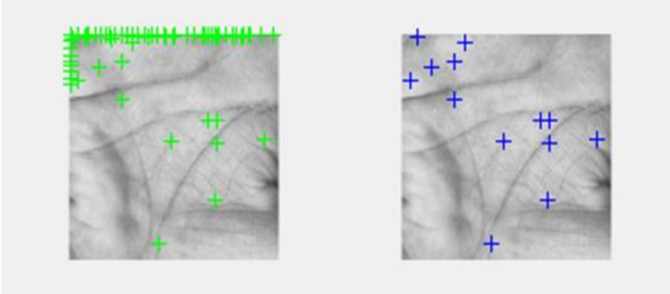


Figure 8: SIFT key point and accurate key point

After extracting features, PCA is applied which reduced the dimensionality. Classification is done using the K Nearest Neighbor Classifier. The ROC Curve is plotted between True positive rate and False positive rate. Figure 9 shows the ROC curve. ROC curve is used to measure the performance of a biometric system.

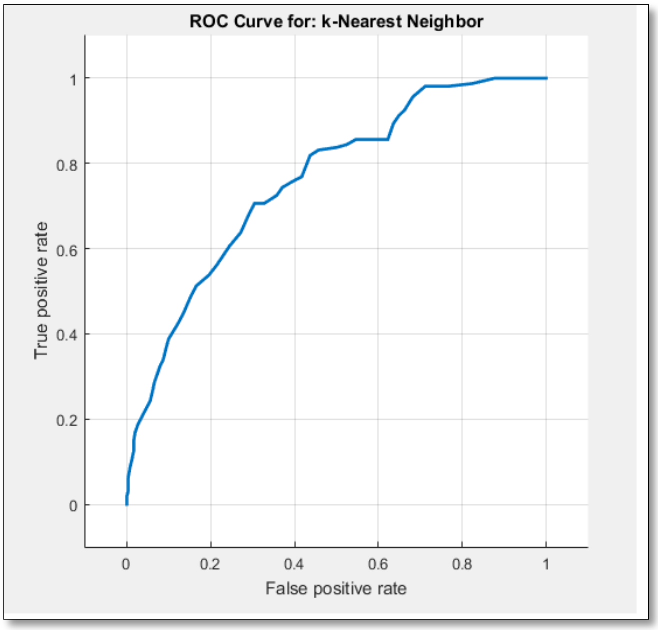


Figure 9: ROC Curve of K Nearest Neighbor Classifier

Cross-validation is a widely-used approach, was used to tune the parameter of the K-NN classifier. Here, we used k-fold cross validation method. In this validation, original sample is randomly partitioned into k equal sized subsamples. Of the k subsamples, a single subsample is retained as the validation data for testing the model and remaining k-1 subsamples are used as training data. In our method. Value of k = 10, thus dataset is divided into 10 subsets, 9 were used as training data and 1 was used as test data. Figure 10 shows the ROC for cross validation.

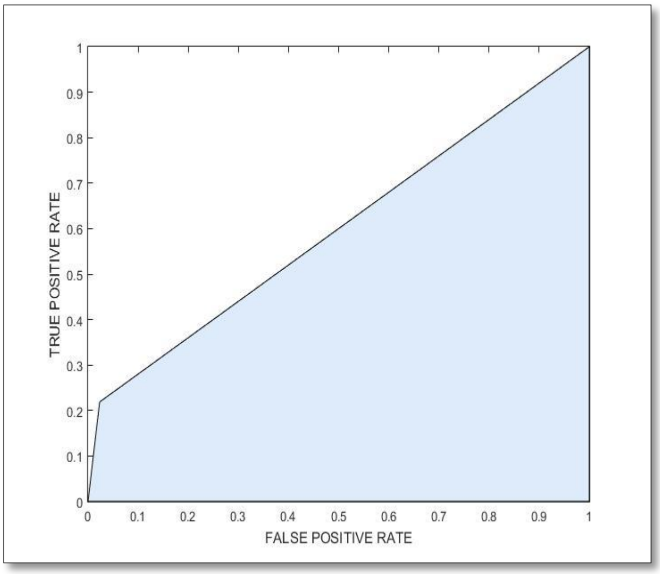


Figure 10: ROC for cross validation

The shaded portion shows the area under performance and error rate is reduced as compared with base paper which illustrated the HOG method used for palmprint recognition. Tables shows the comparison of error rate with our proposed method.

Table 1: Comparison of error rate with our proposed method

S.NO.	METHOD	ERROR RATE
1	Histogram of Gradient (HOG) with multi classifier [7]	0.257
2	Proposed method (SIFT and GLCM Feature Extraction)	0.2175

As in our proposed method, we used two feature extraction method which improves our result than using single feature extraction. Below figure shows the comparison graph of the proposed method with the single method

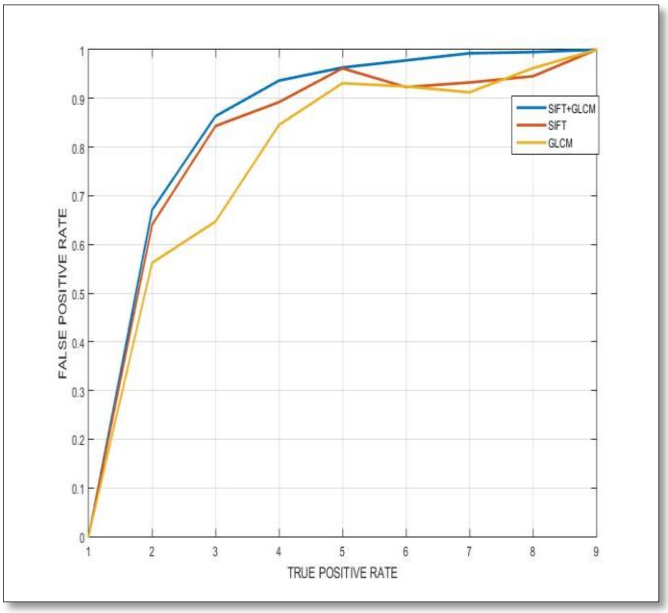


Figure 11: Comparison graph of the proposed method

7. CONCLUSION

In this paper, we proposed a biometric system which is robust to rotation, translation and scale of the palm image is presented. We approached a novel method using local feature called SIFT and texture extraction called GLCM with K Nearest Neighbor (KNN). Scale Invariant Feature Transform (SIFT) is invariant to scale, rotation, translation and affine transformation, is used to give an accurate key point descriptor. 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. The ROC curve is plotted. Cross-validation (K-Fold) is applied on the dataset which shows that the error rate is reduced compared with the previous method.

REFERENCES

[1] J.N.Andrew, D.G.Lewis,"Multiscale Histogram of Oriented Gradient Descriptor for Robust Character Recognition", IEEE International Conference on Document Analysis and Recognition, PP: 1085-1089
[2] D.G.Lowe,"Distinctive Image Features from Scale-invariant keypoints",International Journal of Computer Vision, Vol.2, PP: 91-110, 2004
[3] AK.Jain, A.Ross, S.Pankanti,"Biometrics: a tool for information security", IEEE transaction on information, forsencis and security, 2006, PP: 125-143
[4] Bilgehan Arslan, Ezgi Yorulmaz, Seref Sagiroglu," Security perspective of biometric recognition and machine learning techniques" 2016 15th IEEE

International Conference on Machine Learning and Applications (IMCLA)

[5] H.Ibrahim, N.Hamdy, M.El-Habrouik,"Personal Identification Using Combined Biometrics Techniques", IEEE 16th International Conference on Sytem, signal and Image processing, 2009

[6] Deepti Tamarakar, Pritee Khanna,"Palmprint Verification using Competitive index with PCA" 2011 IEEE International Conference on Signal Processing, communication, computing and networking Techniques (ICSCCN)

[7] Mohd Saigaa, Abdullah, Merooumaia, Salim Chitroub," A robust palmprint identification system Using Histogram of Oriented Gradient and multi classifier" IEEE Conference, 2014

[8] Raouia Mokni, Ramzi Zouari and Monji Kherallah," Pre-processing and extraction of the ROIs steps for palmprint recognition system", 2015 15th IEEE International Conference on Intelligent System Design and Application (ISDA)

[9] Habibeh Naderi, Behrouz Hazi Soleimani, Stan Matwin," Fusing Iris, Palmprint and Fingerprint in a multi-biometric recognition system", 2016 13th IEEE Conference on Computer and Robot Vision (CRV): 327-334

[10] Senliu, Yuchen Bai, Youghua tang,"Design of Online non-contact palmprint recognition simulation system" IEEE International Conference on Image & Signal Processing, biomedical Engineering & Informatics (686-390)

[11] Nirmala Saini, Aloka Sinha,"Palmprint Recognition system based on Gabor transform as feature extraction technique", 2011 IEEE Conference on Hand based biometrics (ICHB): 1-5

[12] Raffaele Cappelli, Matteo Ferrara, Dario Maio," A Fast and Accurate palmprint recognition System based on minutiae", IEEE Transactions on system, man & cybernetics, (Vol.42, Issue:3, June 2012)

[13] Subhashrahul Shekar, B V Sravan Kumar, S.Ramesh," Robust approach for palm (ROI) extraction in palmprint recognition", 2012 IEEE International Conference on Engineering Education: 1-6

[14] Abidin Caliskan, Burhan Ergan," Palmprint Recognition system based on GLCM", 2014 22nd IEEE Signal processing and communication applications Conference: 826-829

[15] R.Rizal Isnanto, Ajub Ajulian Zahra, Eko Didik Widianto," Palmprint recognition system based on principle lines feature using Euclidean Distance", 2015 IEEE 2nd International Conference on Information, Computer and Electrical Engineering: 153-158

[16] "IIT Delhi Touchless Palmprint Database version 1.0", http://www4.comp.polyu.edu.hk/csajaykr/IITD/Database-palm.htm.