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PALMPRINT IDENTIFICATION SYSTEM BASED ON HISTOGRAM OF ORIENTED GRADIENT (HOG)

Ashok T. Gaikwad
Director of Institute of Management Studies and Information Technology, Aurangabad, (M.S), India

ABSTRACT

In this paper, an efficient palmprint identification system based on Histogram of Oriented Gradient (HOG) technique, the pieces of the work focused on many steps and the goal of these steps to make palmprint images very clear and extract The Region Of Interest (ROI). ROI was the most important in palmprint identification system to extract the area which has a lot of information useful for identifying the human by biometric data. In this work, the ROI method was used by Competitive Hand valley Detection (CHVD) while the feature extraction extracted by using HOG and distance measure used as the matching technique by using Euclidean distance (ED), finally the decision was done with help of threshold values (T)to decide the accepted or rejected. All these steps were performed on CASIA dataset to test our algorithm for palmprint identification system. The results show that HOG technique was achieved the good result with minimum EER of 1.966089 % and maximum GAR reach to 98.03391%.

Key words: *ROI ,feature extraction ,HOG, identification , analysis.*

I. INTRODUCTION

The palmprint recognition system has active research works over 15 years, which are employed on different images resolution (High and Low). There are two types of palmprint, first one called high resolution and second called low resolution each types were suitable for different types of application. In the case of high resolution images were used for forensic [1] while low resolution was used for access controls.Today, personal identification is paly active research and more prominent in different types of application in our life like banking, immigration ,access control, id card, passport office and country borders etc. in recently , the biometric application / identification or verification a widely used and studied research topic in the field of security system with different technologies (modalities or traits) such as fingerprint, iris, palmprint ,face, retina etc.[2] Biometric was the automatic system used to recognized the person by their characterization (behavioral and physical)[3]. The working in any biometric system should be with low cost, less error rate, speed and finally high accuracy this objective to design and evaluated biometrics system. From the definition of palm which is the rectangular shape area in your hand and that contain a lot of information which was uniqueness and permanence and it was reliable and confident modality. Regarding palmprint features, it has rich of features some of this feature is similar to fingerprint line minutiae feature [4], that contain ridge ending and ridge bifurcation. Also, it has many features namely Geometry feature, Delta point feature, principal lines feature and finally the wrinkles feature. All these features are extracted with different methods. Also, this feature can be captured by different resolution devices (low or high) resolution this one of advantages of palmprint which is there is side effect by devices used to capture the palm image. Another advantage is it has a small area with a lot of information to extract compare with another, also it has high acceptance. Figure 1 shows CCD palmprint image and different palmprint image namely high and low-resolution palmprint images.

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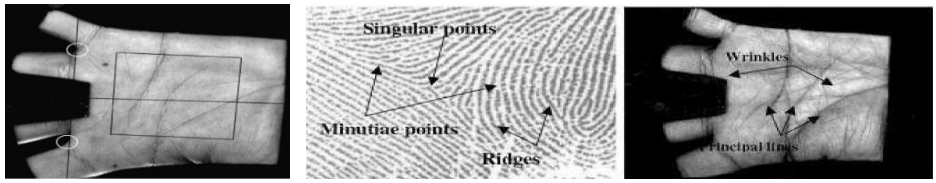

(a) *(b)* *(c)*

Fig.1. palmprint image by different forms (a) CCD-devices (b) high resolution (c) low resolution [5]

Palmprint trait has a rich of information which useful for identification and verification propose. The feature from high resolution like Minutiae feature, ridges features and singular point[6,7].Whereas, the feature extract from low resolution was principal line, texture feature, palm-crease, wrinkles and statistical features. All these feature present on surface of palmprint images. The methods of palmprint can be classify to different classes depend on verification and identification. In the case of Line-based methods which was focused on edge detectors to extract palm lines from palmprint images such as mention in[8-11] and the matching of these lines can be made are either directly or non-direct by using different matching format. While in case of Subspace-based methods the PCA method, LDA method and ICA methods as mention in many research work in literature as[12,13]. In addition, the wavelets, Gabor, DCT and kernels as mention in many research work like [14,15]. Statistical methods were either local or global. In the case of Local the images should be transform to another domain and divided the transform images into several small regions[16,17] such as means ,slandered division and variances of each region were calculated and store it as features. Some researcher used Gabor, wavelets and Fourier transforms [19,20]. Another researcher used local binary pattern (LBP) histograms as features [21]. Whereas, some of them used global statistical methods like Moments, centers of gravity and density as mention in [22]. Different types of techniques were perform for different types of application such as subspace techniques like LDA, PCA etc.[23,24]. local feature as mention in [25,26],statistical as mention in [27,28], appearance [29,30], texture [31,32] and hybrid feature[33,34].There was different work related to palmprint on texture feature with (LBP)[35, 49,50] and 2DLPP) for achieved the higher accuracy was shows in [36,37].

The remaining section discussing the proposed of study includes the preprocessing, feature extraction, matching and decision by sectionII. In the section III experimental results and discussion was given. Exhibits the conclusion and future work given in Section V.

II. PROPOSED OF THE STUDY

In this section the proposed of the palmprint identification system based on Histogram of Orientated Gradient (HOG) was discussed. the main points in this section was extract the ROI from palmprint images which conducted by two ways called as Competitive Hand Valley Detection (CHVD) which passed to feature extraction techniques by using texture feature called HOG and then the feature reduction technique is utilized to reduce the dimensionality by PCA. Then store the features as data template which used for matching proposes. The system was divided into different subsections. In section 2.1covering the pre-processing in details. Whereas, section 2.2 discusses HOG feature extraction methods while section 2.3 present the matching process. Finally the section 2.4 conducted by decision making. Figure 2 shows the block diagram of Methodology system studies of plamprint recognition system.

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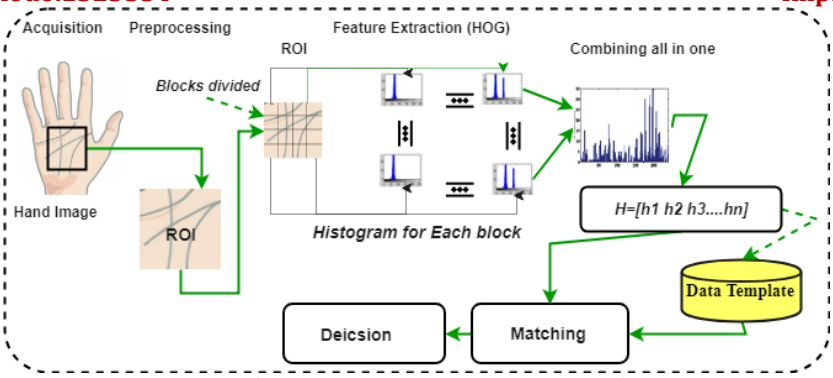

Fig.2. Palmprint identification system by using Histogram of Oriented Gradient

Pre-processing stage

The pre-processing steps are a collection of steps and the output of these steps were the clear images without noise and extract the Region of Interest (ROI) which is very important steps for building palmprint biometric system (identification or verification). In palmprint ROI is the data of two- dimensional and defines as rectangular area on the hand surface. This is small area including more information like minutiae, principal line, and the key point that includes an end point or a branch point[38] needed in process of identification or Verification. The Region of Interest (ROI), which defines as a rectangle area on the palm. In this section we follow the steps of pre-processing which derived from our works [39] for Binarization, and determine the ROI. CHVD was derived from [40,19] to extract ROI.

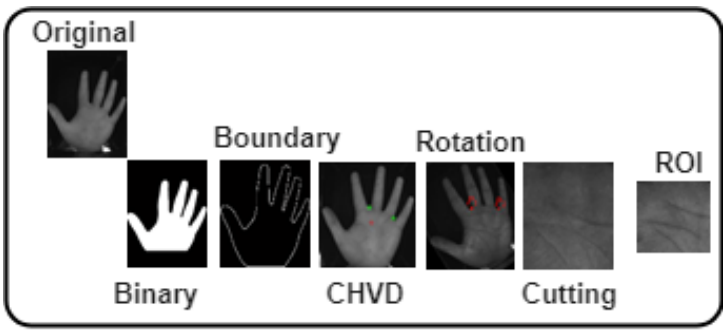

Fig.3.palmprint Pre-processing steps

Feature Extraction Stage using HOG

Palm contains many lines like principal line winkles line or robust lines .All these lines presented in surface of palms which are unique for each person. The state of the art features such as Gabor [41] and wavelet [42] extract the lines and code them without any respect to the kinds of lines. HOG was present in different work like in [43] covering of object detection for texture features. In this section we described the HOG feature extraction techniques which is a popular to object detection and description. The good application of HOG was used in pattern recognition and computer vision based on image pre-processing tools box. The technique was derived the description from different research work [46,47] and the summaries of these was covering by divided the palmprint image into region or blocks we have 49block related to 7x7 size and for each blocks compute the gradient magnitude and orientation by Eq.(1-3) the orientation was in the range of (0 o- 180o) and divided in to 9 bins. Afterward the histogram compute for each cells in the blocks, then the integrated all histogram to generate the feature vectors. The normalization was performing on the feature vector and feature reduction technique was used by using PCA. Finally the size of the feature vector was 1764 feature points which calculated from 49 blocks. Algorithm 1 shows the HOG step by step.

$$G_x = \frac{\partial_1}{\partial_x} \qquad G_y = \frac{\partial_1}{\partial_y} \tag{1}$$

$$\text{Magnitude} = \sqrt{G_x^2 + G_y^2} \tag{2}$$

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$$\text{Orientation} = \frac{180}{\Pi}\left(\tan^{-1}\left(\frac{G_y}{G_x}\right)+\frac{\Pi}{2}\right) \quad (3)$$

***Algorithm 1**: Feature Extraction using HOG*

1: **Input** : Palmprint images, ROI of CHVD
2: **Output**: HOG Features vector
3: **Begin**
4: **For** each sample of palmprint images **do**
5: Divided palmprint images to(*n x n*) overlap blocks(Cells)
6: Construct each block (overlap block)
7: Calculate the gradient magnitude by Eq.(1,2) for each pixel I(x,y)
8: Calculate the orientation(θ) by Eq.(3) for each pixel I(x,y)
9: Divided the orientation θ in the range of (0^o -180^o) to *N* bins and obtained the Histogram for each blocks
10: Combining all Hist for each blocks to generated the feature vector
11: $FV_{CHVD+HOG} = \bigcup_{i=1}^{N} HOG_{hist(i)}(CHVD\_ROI)$
12: Normalized the feature vector by z-score normalization techniques.
13: Store whole Hist after normalization as feature vector for matching purposed.
14: **End**
15: **End**

Matching

Matching conducted in this work was calculated similarity between two palmprint images. The distance mesures was used to find the distance of two feature vector. A point can be said to be a data that has two attributes, namely x and y or two-dimensional vectors. Euclidean distance has a general or generalized form that is used to measure the similarity of two data having n attributes or two n-dimensional vectors. Suppose x is a single dimensional vector / column of dimension n and x represents a multiplication of a W vector dimension wh x n with W = w1, w2, ..., wn with image Ii dimension w x h, then the degree of similarity between Xi and Xj can be calculated using the equation:

$$d(Test_i, Temp_j) = \sqrt{\sum_{i\&j=1}^{N}(Test\_V_i - Template\_V_j)^2} \quad (4)$$

Where, N is determining the number of feature in $Test\_V_i$ and $Template\_V_j$.
Algorithm 2 describes the Matching step by step.

***Algorithm 2**: Matching*

1: **Input :** Palmprint feature vector
2: **Output:** Score matrix, Threshold values.
3: **Begin :**
4: **For** each test feature of each Subject **do**
5: Test_FVi
6: **For** each template feature of each Subject **do**
7: Template_FVj
8: Distance between two vector byEq.(4).
9: Score_matrix= d ($Test_i$, $Temp_j$)
10: **End**
11: T_0= Score_matrix; /* total threshold values of system
12: minta = min(min(T_0)); /* minimum score
13: maxta = max(max(T_0)); /* maximum score

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14: β= 100; /* size of optimal threshold values
15: Δ = (maxta - minta) / β ;

16: const = 1:1: β; /* threshold vector
17: **End**
18: Store score_matrix in database as math file for discussion purposed.
19: **End**

Decision

In the final steps of propose of study is the decision of either "Accepted "or "Rejected "with help of threshold value (T). In the case of "Accept" if the distance (score S) $IF\ S \leq T$ that's means Accepted or $IF\ S < T$ means Rejected.

III. RESULTS AND DISCUSSION

This section covering different concept like dataset used, system configuration, software used, evaluation of the by different parameters finally the results of CHVD with HOG feature extraction technique was covering. The experimental applied on the laptop Dell, Intel core i3, CPU 2.20 GHz with RAM 8.00GB on 64-bit operating system (windows 7) and by MATLAB software 2013a.The work was tested on Chinese Academy of Sciences' Institute of Automation (CASIA)[45,46] which we take 100 subject of 600 to evaluated our work and each subject has 12 samples 6 for left hand and 6 for right hand. The figure 4 shows some samples taken from CASIA dataset and their ROI part.

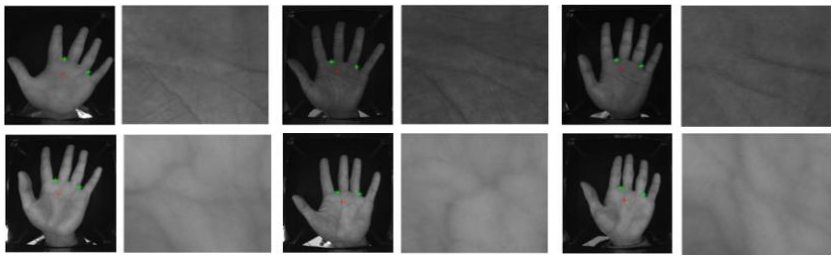

Fig.4. Samples taken from CASIA dataset with ROI

The system evaluated by different parameter such as False Accepted Rate (FAR),False Rejected Rate (FRR), Equal Error Rate(EER) and Genuine Accept Rate (GAR) the details of these parameters was discuses in details in [48] which was derived from that work. The Receiver Operating Characteristic (ROC) curve shows the presentation results of the system in graphical way.

Results of CHVD ROI with HOG

To evaluate the performance of the system with ROI which called Competitive Hand Valley Detection (CHVD) methods with HOG feature extraction technique. The size of ROI dimension size (155x155) and applied on dataset size 100 users each user have 6 samples with the help of threshold values which determine from 0 to 1 with increased by 0.01 up to 100 threshold values generated from score matrix at the time of matching stage. From the table 1 different values of T give different results e.g on T = 0 the EER and GAR of the system were 50% give that means higher EER with minimum GAR for similar cases for all the threshold values. The system can achieve the results with minimum EER of 1.966089% and maximum GAR of 98.03391% at threshold value 0.11 give the best results which determine the performance of the system. Table 1 shows the results of the system by different T values with FAR, FRR, EER and GAR. Figure 5(a) shows the graphical representation of FAR and FRR on the numbers of threshold value to determine EER points of the system. Figure 5(b) represents the performance of the system by EER graph while figure 6 shows the ROC of the system by GAR vs. FAR on different threshold values.

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Table 1 Performance of the system based on HOG Feature

CHVD + HOG				
T	**FRR (%)**	**FAR (%)**	**EER (%)**	**GAR (%)**
0	0	100	50	50
0.01	0	86.18182	43.09091	56.90909
0.1	0.607143	4.949495	2.778319	97.22168
0.11	1.285714	2.646465	1.966089	98.03391
0.2	32.64286	0.040404	16.34163	83.65837
0.21	40.17857	0.040404	20.10949	79.89051
0.3	98.92857	0	49.46429	50.53571
0.4	100	0	50	50
0.5	100	0	50	50
0.6	100	0	50	50
0.7	100	0	50	50
0.8	100	0	50	50
0.9	100	0	50	50
1	100	0	50	50

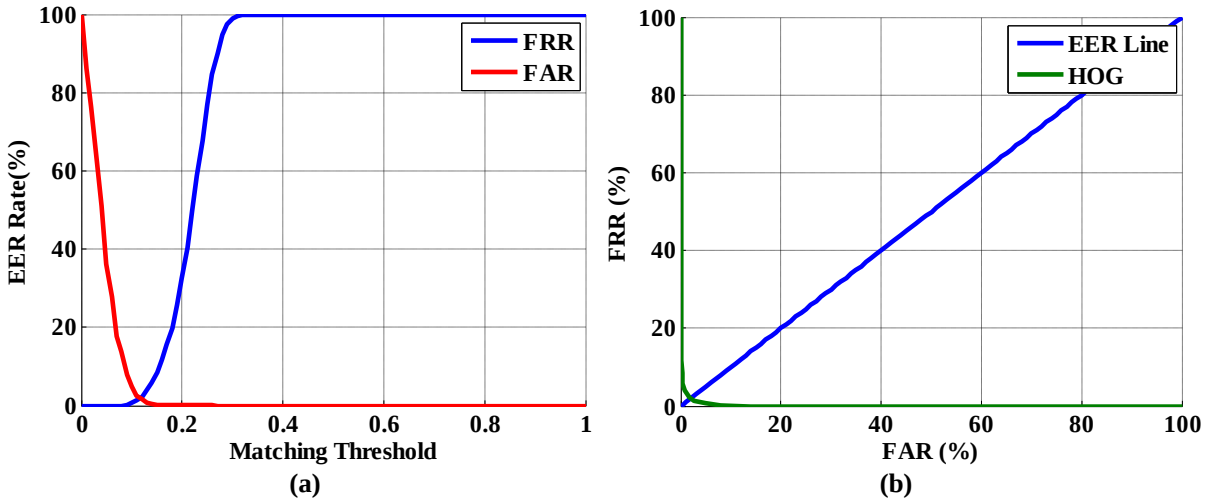

Fig.5. graph representation of HOG results (a) matching score with relation of FAR vs. FRR (b) ROC of EER curve

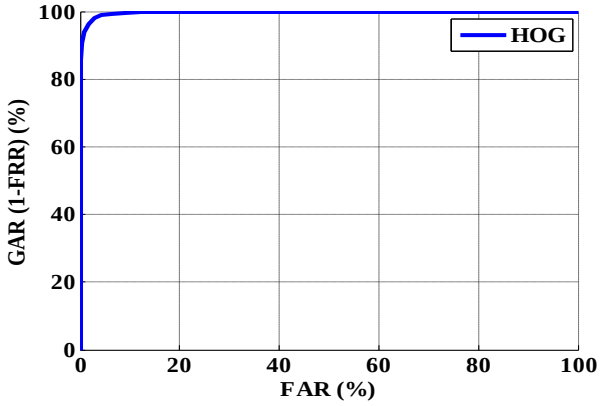

Fig.6. efficiency results of HOG by ROC curve of GAR vs. FAR

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IV. CONCLUSION

In this section, the Regions of interest (ROI) technique called CHVD was used and evaluated on CASIA dataset. It helps in extraction of features in terms of real part and contains rich information required for an authentication system. This work performs CHVD technique with HOG to build feature matrix. The observation of the experimental shows that CHVD method with HOG was improved the performance of the system with accuracy reach to 98.03391 % with minimum EER of 1.966089 %, on Threshold values of 0.11 which shows the best results compare with another threshold values range between (0-1) up to 100 values. This work may be extending to combining HOG with another features techniques and used fusion to improve the performance of the system with neural network.

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