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Research Article

PALMPRINT RECOGNITION USING HOL

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ABSTRACT

Till date, no appropriate results have been obtained in the field of palmprint recognition due to variations like clarity, rotation and insufficient translationl. In this paper, we propose a new methodology named as Histogram of Lines, which is a variant of Histogram of Oriented Gradient (HoG) for a clear detection of the palm presented. HoL can recognise even with any change in clarity. Histogram of Lines has the capability of recognizing even with small changes present as it can alter the histogram results on a smaller scale. For edge detection, HoL can achieve high recognition results.

INTRODUCTION

In the recent times, Biometric mechanism has been a keen area of interest for many researchers and scientists and the developments for the same are being conducted. Biometrics is of two types, physiological and behavioral characteristics of a person. Behavioral includes typing; gait and voice *et al.* Physiological traits include DNA, fingerprint, palmprint recognition, Iris and retina recognition and odour/scent. Some areas, such as fingerprint recognition, have achieved immense success, which are found in many systems such as smart phone and security systems. Iris and retinas recognition are in the development phase but since they are internal organs, they are feared to be damaged to the system. Voice Recognition is also developed as most of us know. Palmprint is a promising approach for a biometric system, due to the stability, pattern of the lines and less distortion. It is faster mode for recognition due to the above mentioned advantages it has over other recognition patterns. Researchers are keen on developing a system to recognize the same.

There are some problems with the development of the palmprint recognition, such as minutiae by its local features and edges. Also, the angle at which we would be putting our palm on the sensor is also an issue as it should detect the rotation by which the wrinkles, ridges and principle lines are varying with the one already present in the database provided. There is also the location problem; sometimes some part of the palm wouldn't be present in the detector although the entire palm is present in the database but it wouldn't recognize it due to the missing lines from the detected image. These often become a barrier in the recognition.

Palmprint recognition requires large amount of accuracy in detection of the important lines, such as the principle lines, wrinkles and ridges. It's a complex task because of quality, size, shape, rotation and occlusion. These can be the barriers for the recognition. So a system should be designed in order to overcome these problems. Palmprint recognition can be either Open-set or Closed-set. Closed-set identification is the one in which all the search queries have a corresponding registered entry in the corresponding biometric database. For Instance, let's consider a Security system in a society. All the residents would have their palmprint registered. Any outsider won't be able to access into the building unless his palm is registered in the device. The closed-set identification system yields a list of matching candidates whose identity are most similar to the search (query) input. As such, the important accuracy metric

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for closed-set identification system is the hit rate. Practically, it is not possible to implement the closed-set due to the large amount of enrollment it would need in order to work. Most of the present Biometric identification is Open Set Identification. System which does not require enrolling all the available individuals in the respective database. The basic accuracy metrics of the latter identification approach are false positive identification rate and false negative identification (miss) rate.

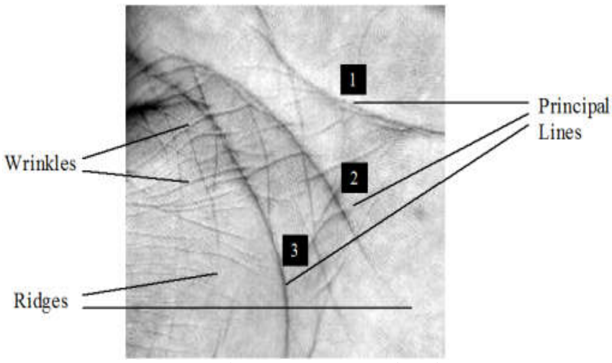

Fig 1 Line patterns on a palmprint

Literature Survey

In the recent years, many different feature detection methods were put forward, each with a different method to extract and bring out the results. Kong *et al*.[1] uses the 2-D Gabor filter to obtain the textural information and two palmprint images are compared in terms of their hamming distance. In this method the phase information in palmprint images is stored in the feature vector. Field *et al*. [2] proposed Log-Gabor filters to overcome the bandwidth limitation in traditional Gabor filters. These Log-Gabor filters always have null dc component and desirable high-pass characteristics, i.e. fine details to be captured in high frequency areas. In paper [2] the implementation of Log Gabor function for palm recognition is done, further its efficiency is compared with other existing technique ICA. After testing, result gives the better performance for Log Gabor technique. Gabor filters can provide robust features against varying brightness and contrast of images. However, the procedure for feature coding and matching by pixels requires too much time and memory. Moreover to extract more local features from the original images, a series of Gabor filters with various scales and orientations (i.e. Gabor filter bank) are needed. Eventually this will enlarge the feature dimension by time and make feature matching beyond implementation. So Zhiqiang *et al*. [3] proposes a novel Gabor feature-based two-directional two-dimensional linear discriminate analysis GB(2D)2LDA for palmprint recognition. In GB (2D)2LDA, Gabor feature vector is derived from a Gabor filter bank, then (2D)2LDA uses the augmented Gabor feature vector as an input. Meanwhile, GB(2D)2LDA can reduce the augmented Gabor feature vector in horizontal and vertical directions sequentially, and hence fewer coefficients are required for image representation and recognition. Hence the GB(2D)2LDA is effective in both recognition accuracy and speed. As Gabor filter based texture information extraction method is both time and memory intensive to convolve palm images with a bank of filters to extract features. Histogram of oriented gradients (HOG) descriptor was initially proposed by Lowe in his scale invariant feature transform (SIFT) [4]. Dalal and Trigges [5] proposed using HOG features to solve the pedestrian detection problem. Meanwhile, HOG descriptor has been successfully applied to other object detection and recognition tasks [6]. However, for palmprint recognition, gradient exploited in HOG is not a good tool to detect the line responses and orientation of pixels because different palm lines have different widths and there are complicated intersections between lines.

In this paper, we propose the histogram of oriented lines (HOL) descriptor, a variant of HOG, for palmprint recognition, which exploits line-shape filters or tools such as the real part of Gabor filter and modified finite radon transform (MFRAT) [7] to extract line responses and orientation of pixels. Compared with OR, DR, and GWR, HOL has two obvious advantages. First, using oriented lines and histogram normalization, HOL has better invariance to changes of illumination. Second, HOL has the robustness against transformations because slight translations and rotations make small histogram value changes. In addition, line-shape filters and tools used in HOL can well calculate the line response and orientation of pixels. There is no doubt that, owing to these merits, HOL descriptor will help subspace learning methods achieve promising recognition rates.

HOG and HOL

Brief working of HOG

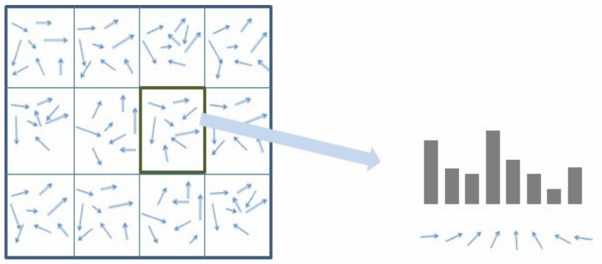

Fig 2 HoG of a block

An example of generating HOG is depicted in Fig. 2.The arrows indicate the direction of the presence of the principle lines on the palm.

Given an image I, the steps of generating HOG are presented as follows

Step 1: Divide the whole image into $n \times n$ non overlapping cells. Each *Cell* contains $c1 \times c2$ pixels.
Step 2: Combine the cells to form a block of $b1 \times b2$ *Cells*. Two adjacent *Blocks* can overlap.
Step 3: For each pixel, $I(x, y)$, the gradient magnitude $m(x, y)$, and orientation $\theta(x, y)$ are calculated by the following formulas

$$dx = I(x + 1, y) - I(x - 1, y) \quad (1)$$
$$dy = I(x, y + 1) - I(x, y - 1) \quad (2)$$
$$m(x, y) = \sqrt{(dx^2 + dy^2)} \quad (3)$$
$$\theta(x, y) = \tan^{-1}\left(\frac{dy}{dx}\right) \quad (4)$$

Step 4: Calculate the histogram within *Cell* (HC)
$HC(k)i = HC(k)I + m(x, y)$
Step 5: The Histogram of the block can be obtained by combining the histogram of each cell present in the block .

$HBj = \{HC1, HC2, \ldots, HCb1 \times b2\}$.
Then, normalize the vector of HBj $(NHB)j$ by $L2$-norm

block normalization

$$\text{NHB}j = \frac{HB_j}{\sqrt{\|HB_j\|^2 - e^2}} \quad (5)$$

where e is a small constant .

If there are *N Blocks* in an image, the final histogram, HOG of the palmprint, can be obtained by integrating all normalized *Block*'s histograms:

$$\text{HOG} = \{\text{NHB1}, \text{NHB2}, \ldots, \text{NHB}j, \ldots, \text{NHB}N\}. \quad (6)$$

Extraction process

To extract line and orientation features, HoL uses different line-shape filters. To extract features and to generate HOL descriptor of palmprint, the real part of Gabor filter will be used.

In computer vision, edge detection and pattern recognition, Gabor filter is used extensively. Recently, some new methods combining Gabor feature and local descriptors, such as local Gabor XOR patterns (LGXP) and local Gabor binary patterns (LGBP) are some new methods combining Gabor Feature and local descriptors, which have been proposed for face recognition and achieved impressive recognition performance.

In general, 2-D circular Gabor filter has the following form:

$$G(x, y, \theta, \mu, \sigma) = \frac{1}{2\pi\sigma^2}\exp\left\{-\frac{x^2+y^2}{2\sigma^2}\right\} \exp\{2\pi i(\mu x\cos\theta + \mu y\sin\theta)\} \quad (7)$$

where $i=\sqrt{-1}$, μ is the frequency of the sinusoidal wave, θ controls the orientation of the function, and σ is the standard deviation of the Gaussian envelops.

Based on this Gabor function, a Gabor filter bank with one scale and k directions can be created.

The direction θ_m is calculated as follows

$$\Theta_m = \frac{\pi(m-1)}{k}, \; m=1,2,\ldots,k. \quad (8)$$

Given a palmprint image, the steps to extract the line features and orientation of pixels using the real part of Gabor filter can be explained as follows

Step 1: Convoluting image I using the real part of designed Gabor filter bank to generate M filtered images.
Step 2: The response $m(x,y)_{Gabor}$ and orientation $\theta(x,y)_{Gabor}$ of each pixel can be obtained by the following two equations

$$m(x, y)_{Gabor} = \min(I(x, y) * G(x, y, \theta_k)) \quad (9)$$
$$\theta(x, y)_{Gabor} = \arg\min_k(I(x, y) * G(x, y, \theta_k)) \quad (10)$$

where * means the convolution operation.

If we use m(x,y)Gabor and θ(x,y)Gabor to replace m(x,y) and θ(x,y) in (3) and (4), the HOL descriptor will be created. The HOL descriptor created the real part of Gabor filter bank can be denoted as HOL_{Gabor} .

The HOG or HOL can be created as a matrix , in which each row is NHB*j* . We can call HOG or HOL in matrix form as 2DHOG or 2DHOL. Using 2DHOG and 2DHOL, some matrix or tensor-based subspace learning methods, such as 2DPCA [15], 2DLDA [16], TSA [17], CSA [18], and MDA [19], can be performed for dimensionality reduction.

Applications

Palm prints are unique to individuals. They remain unchanged throughout atleast a certain period during the adult life of an individual. This unique feature makes it useful for many applications.

- Around 50 diseases have palm print associations. This method is used to correlate palm patterns with medical disorders such as genetic disorders and Down's syndrome, to detect genetic abnormality.
- From capturing and scanning latent palm prints from the evidences confiscated from the crime scene, the identification of criminals through this method has become an area of increasing interest among the law enforcement community.
- It has a major application for personal identification as palm prints are much larger than finger prints and details can be easily obtained.
- The hereditary basis of dermal patters has been studied, which has since been confirmed by numerous genetic studies. Because of the closer resemblance of dermatologlyphics among the relatives than among unrelated persons, the possibility of using this method as a complementary means in establishing paternity has been suggested.

Fig. 3 Palmprint of a person suffering from Down's Syndrome

Performance and experiments

We created a database consisting of sample images of palm, taken from three individuals. The sample images are trained. In this training process, the image gradient is taken. The x directional gradient and y directional gradient are extracted and put into the Gabor filter formula as mentioned above. We need to make sure that shadow is not present in the images included in the database. If an image is given as input but the same is not present in the database, then no feature of such is extracted and we won't be getting any output.

Fig.4 A sample from the database

A GUI was created in which we give an image as the input. The code analyses the image by taking its gradient and tries to match it with those of the images present in the database by comparing the Gabor filter output. If it matches, then the result is displayed on the screen mentioning the person with whom it matches.

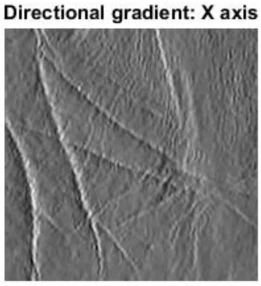

Fig.5 (a)

Fig.5 (b)

Fig.5 (c)

Fig.5 (d)

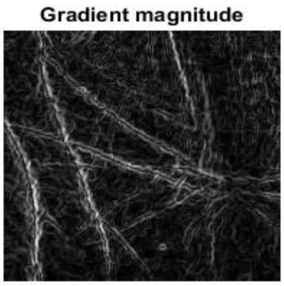

Fig.5 (e)

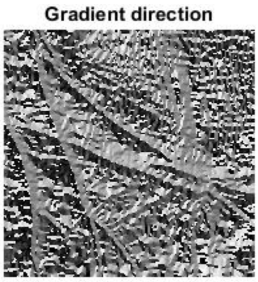

Fig.5 (f)

Fig 5 (a) and (b) are the x directional gradient and y directional gradient of ROI (fig.5 (d)) of Fig.4.
After extracting the line features and gradient of the sample image, the Gabor output (fig 5 (c)) is generated.

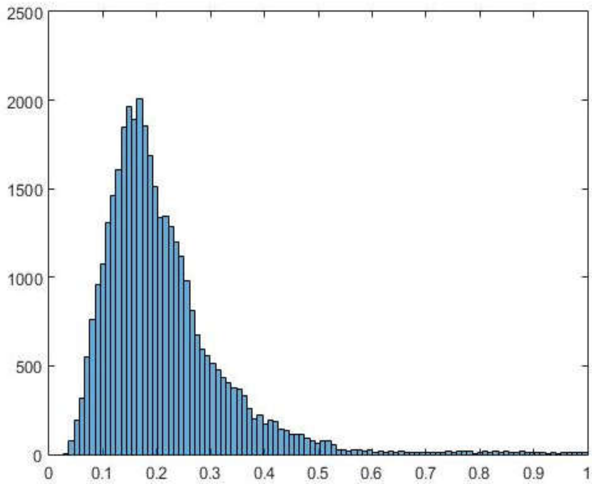

Fig.6 Histogram of the ROI

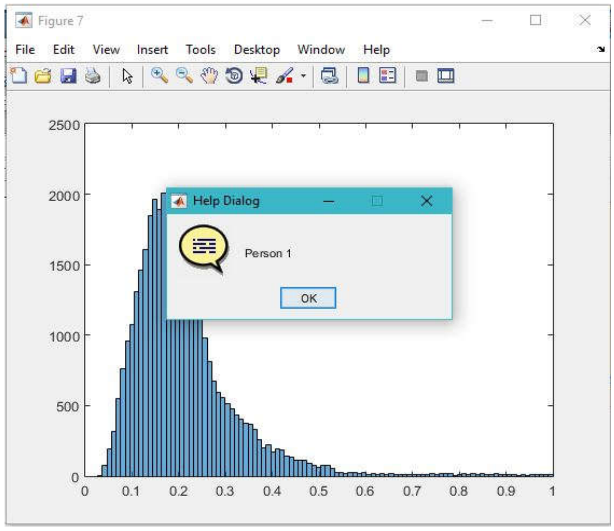

Fig.7 The final Result, including the information given about the sampled image in the database

CONCLUSION

This paper investigates how to develop a method for palmprint recognition. For this, we used HoL, a new method to detect the line and oriented features as HoL which is strong to rotation of the palmprint, translation and slight variance in the appearance of the print. In the future, we will implement more strategies to further extract clear features using HoL methodology. HoL is a very promising descriptor in this field of biometric recognition.

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