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Multimodal biometric recognition system using palm print and inner-knuckle print

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Abstract- Biometric security plays a vital role for the protection system and will become an inexorable trend in future. Multimodal biometric is an upcoming technique to overcome the drawbacks of the unimodal biometrics system such as non-university, spoof attack and noisy data. Multimodal biometrics system possess more efficient and accurate when compared to unimodal systems. In this paper we proposed multimodal biometric recognition system using palm print and inner-knuckle print. The two traits were captured from single sensor without touching. The features of palm print is extracted using Gabor function and also the texture features of Inner-knuckle print are extracted using canny edge detection and Range Filter. The feature ofpalm print and inner-knuckle print are fused using Sum rule. Finally the decision is made whether the user is genuine or imposter. The experimental results has been observed by the parameters of FRR and FAR.

Index Terms-Canny edge detection, Gabor function, inner-knuckle print, multimodal biometrics, palm print.

1. Introduction

Multi-modal information fusion is an efficient way to improve the performance of the biometric system [1,2]. In recent years, many biometric system for security are emerged. In hand based biometrics system, the commonly used traits in the marketplace are finger print and hand geometry [3]. Using finger print biometrics rises to spoof attack.

Using hand geometry doesn't provide much information for identification when the enrollments grows larger. The feature presents in palm print are principal lines, wrinkles and ridges. While in inner-knuckle print the flexion shrinks were used as features.

These features are both originated from birth and there won't be any changes throughout his or her life time. By using these traits, a multimodal biometric recognition system can be built with high accuracy and performance. In 2007, R. Chu, Z. Lei, Y. Han, S.Z. Li, "Learning Gabor magnitude features for palm print recognition" has extracted the feature of the palm print via Gabor filter method [4]. In the same year, A. Kong, "Palm print Identification Based on Generalization of Iris Code" did the feature extraction via Gabor filter [5].

The palm print is classified into three types such as line based, sub-space based and transform based. In this paper we are concentrating on sub-space based approaches. Some of the techniques under this approach are principle Component Analysis (PCA) [6] and Independent Component Analysis (ICA) [7].

By using Independent Component Analysis (ICA) the features of Palm print are extracted.In 2007, Stockwell proposed an approach to address the redundancy of the S-Transform by using orthogonal set of basic function [8]. In past decade only few approaches evolved based on S-Transform in 2D images.

In 2004, Q. Li, Z.D. Qiu, D.M. Sun, proposed Personal identification using knuckle print, in that four IKP and palm print are extracted at a time. Using Gabor transform the line frequency are extracted [9].In 2010, a contactless palm print and knuckle print recognition is proposed by G. Kal One Michael, T.Connie, A.Teoh BengJin [10]. In 2014, multimodal biometrics using iris and Inner-knuckle print is proposed and fusion is done at matching score level [11].

The rest of the paper is organized as follows. In section 2 an overview of proposed work is given. Finally performance metrics is given under section 3 and conclusion is given under section 4.

2. Proposed Work

In this paper, we proposed a contactless multimodal biometrics recognition system using Palm print and Inner-Knuckle print with single sensor. The hand image is captured, with the captured image two traits can be extracted such as palm print and inner-knuckle print. From this two traits the unique features can be extracted.

In palm print, the principal lines and wrinkles are extracted. Whereas from inner-knuckle print the flexion lines are extracted. In our proposed system the fusion is done at Feature level. Finally the decision is made whether the user is genuine or imposter.

The proposed multimodal biometric recognition system is shown in Figure 1. The proposed system extracts the feature from two traits simultaneously and there won't be any time delay. Apart from this the proposed system show high performance in recognition. The main advantages of proposed system are doesn't need of multiple sensors, cost of implementation and maintenance are very low and two independent features originate from same part of body [12].

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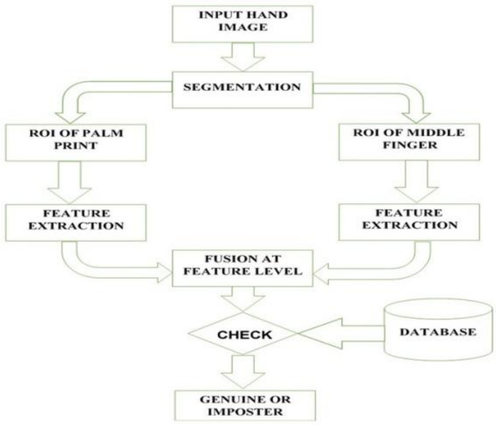


Figure 1. The block diagram of the proposed system

2.1 Segmentation

The Region of Interest of palm print is extracted using competitive hand valley detection (CHVD) algorithm which is proposed by [13]. Using the landmark points P1, P2, P3 and P4 on hand contour as shown in Figure2. The ROI of the palm prints determined to extract. The extracted palm print ROI is shown in Figure 3.

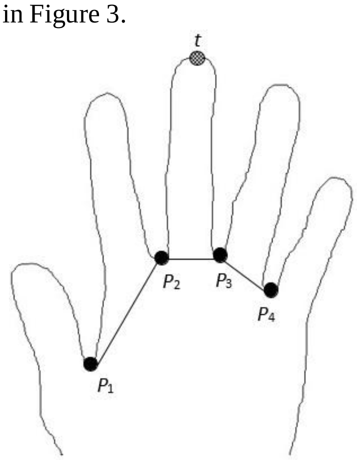


Figure 2. Locations of the four hand valley points

After extraction of palm print we took extended CHVD algorithm [10, 12] to track the inner-knuckle print. In our work we limited the tracking of all fingers except middle finger. The finger tip of the middle finger is found using projectile search approach. This approach is an upward search method.

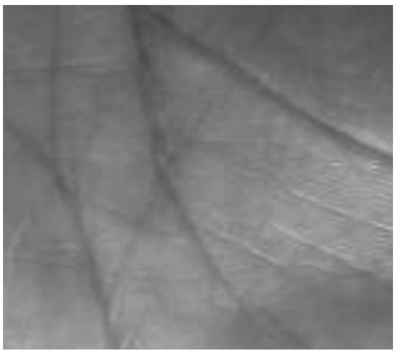


Figure 3. ROI of Palm Print

First the midpoint "m" is found between the valley of P2 and P3. The P2 and P3 gives the middle finger region. "m" is calculated using $(x_{P2}+x_{P3})/2$, $(y_{P2}+y_{P3})/2$. On the next step from m there is a projection point to reach the t as shown in Figure4(a). After projection point touches t, a vertical line L is drawn to connect m and t as shown in Figure4(b). On the next step a horizontal line L⊥ as shown inFigure 4(c) is drawn with the help of the below equation

$y_{L\perp}=y_t+0.1\ \|L\|$

Where ||L|| denotes the magnitude of the line.

$\nabla L\ \perp_i = -\frac{1}{\nabla L_i}$ Using the constrain

L⊥ is made perpendicular to L. similarly another horizontal line L'⊥ near base as shown in Figure 4(d) is drawn using the

$y_{L'\perp}=y_{P2P3}+0.005\ \|L\|$

So simultaneously the rectangle profile in middle finger is found as shown in Figure 4(e). To form rectangle the condition must be

$$\text{wt} = \begin{cases} wb\, if\, wb < wt \\ wt\, otherwise \end{cases} \text{and} \text{wb} = \begin{cases} wt\, if\, wt < wb \\ wb\, otherwise \end{cases}$$

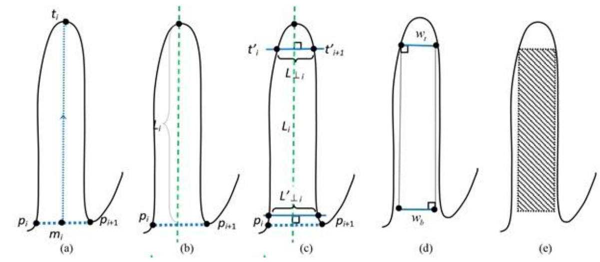


Figure 4. Projectile search algorithm

The w_t is the top line segment near the top of middle finger and w_b is the base line segment near the valley. So finally by cropping the rectangle region we get the middle finger region as shown in Figure 5.

Figure 5. ROI of IKP of middle finger

2.2 Feature Extraction for Palm Print

In this section the feature of the palm print are extracted, the feature are extracted by texture analysis. Gabor function is widely used in the field of image processing and pattern recognition. Gabor function provides accurate line frequency location [14,15]. The 2D Gabor filter is applied to the extracted ROI of palm print.

$$G(x,y,\theta,u,\sigma) = \frac{1}{2\pi\sigma^2}\exp\left\{-\frac{x^2+y^2}{2\sigma^2}\right\}\ \text{expr}\ \{2\pi i(ux\cos\theta + uy\sin\theta)\}$$

Where i= $\sqrt{-1}$,
u is the frequency of sinusoidal wave,
θ Controls the orientation of the function;
σ isthe standard deviation of the Gaussian envelope.

The main use of Gabor filter to the ROI palm is to provide robustness against varying brightness and also in contrast of the image. The Gabor filter is used in various application [16, 17]. After this process we can get the features of palm print such as principal lines and wrinkles, which is specific to each individual are stored as feature vector. The texture of the palm print is shown in Figure 6.

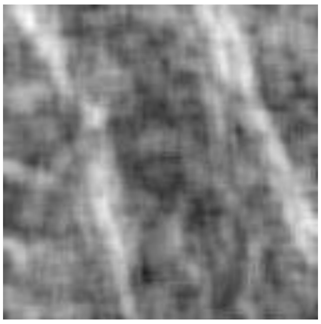


Figure 6. Texture Feature of Palm Print

2.3 Feature Extraction for Inner Knuckle Print
Withthe extracted ROI of IKP of middle finger, we adopted prominent algorithm to extract the features. With the extracted ROI the canny edge detection method is applied. The canny edge detection shows the weak edges of the inner knuckle print surface. Canny detection is an optimum edge detector, and it also has low error rule and also find distance between edge pixels. In the knuckle print the horizontal lines is the flexion lines which is differs from others. After applying canny edge detection to the ROI of IKP we get the horizontal lines of the IKP. And Range Filter is used to the ROI. Finally it is stored as feature vector for fusion. The Figure 7 shows the texture content of the IKP. Edge detection using mask is used widely in the fields of image processing. The number of edges in the region provides a measure of signal "edgyness or busyness". The texture content is stored as feature vector for fusion.

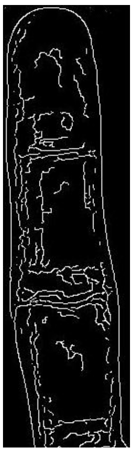


Figure 7. Texture Feature of Inner Knuckle Print

2.4 Fusion of Palm Print and Inner Knuckle Print
There are several levels of fusion rules for combining palm print and inner knuckle print feature. In this paper we used sum rule, in order to sum two feature vector first the both feature vector should be normalized to a range. Some of the commonly used normalization techniques are min-max rule, Tan h rule and Z-score [18]. In this paper we applied min-max method.

S'=(s-min)/(max-min)

After the normalization, the feature vector are fused at feature level and generated a fused feature template which is stored in database for recognition in future. The Figure 8 shows the fused feature template of palm print and inner knuckle print.
Sum=$\sum_{i=1}^{n} S_i$

Figure 8. Fused Feature Template

2.5 Recognition
In Recognition same process is carried out till fusion and the fused feature template is verified with the database by using hamming distance whether he or she is genuine or imposter. The hamming distance [19] is calculated between the fused feature templates from the recognition with the fused feature template which is present already in database.
HD=$\frac{1}{n}\left(\sum_{i=1}^{n}(pi\oplus qi)\right)$

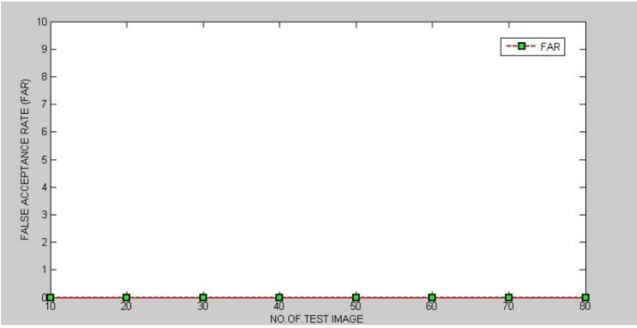
3. Performance Metrics
In common the performance of the biometrics system are measured by the parameters of False Acceptance Rate (FAR), False Rejection Rate (FRR) [20, 21], Genuine Acceptance Rate (GAR) and Total Error Rate (TER).

FAR (%) = $\frac{\text{no.of accepted imposter}}{\text{total no.of imposter test}} X\ 100\%$

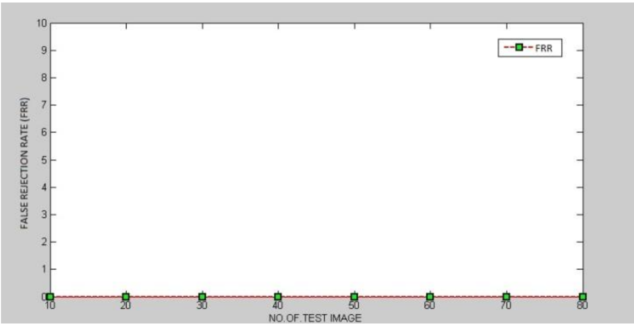
FRR (%)= $\frac{\text{no.of rejected test}}{\text{total no.of test}} X\ 100\%$

Genuine Acceptance Rate:
The Genuine Acceptance rate is calculated by the below formula, the GAR is somewhat same FRR. The GAR of this System is
GAR (%) =100-FRR (%)

Total Error Rate:
The Total Error Rate (TER) shows the sum of both False Acceptance Rate (FAR) and False Rejection Rate (FRR).
TER=FAR+GAR
The performance metrics of FAR and GAR are shown in graph 1 and 2.



Graph1. False Acceptance Rate (FAR)



Graph2. False Rejection Rate (FRR)

4. Conclusion
In this paper, we proposed the accurate multimodal biometric recognition system using Palm print and Inner-Knuckle print with single sensor. Both the traits are originated from the same part of the user. This system reduces the redundancy and use of multiple sensor. Both the features can be extracted at same time. The traits can be captured in low resolution camera so the cost of this multimodal is low when compared with other system which has multiple sensors. This proposed system can be used in any commercial fields to gain high security. The future enhancement can be adding optimization algorithm for feature extraction to improve the efficiency of the system.

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