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New Approach for Identity Verification System Using the Vital Features Based on Entropy

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Abstract

Many persons can easily access their information anytime and anywhere through its network society which spread in the world. On the other side, there is a very risk on this information, because of legitimate users and quacks, who are trying to seize the information. The passwords and numbers can be guessed or forgotten. Also, Personal Identification Numbers (4-digit PIN numbers) cards can be stolen. Biometric authentication technology used to solve these problems, it identifies people by their unique biological features. In this paper, the proposed approach consists of two main phases. First phase, we will construct a biometric authentication technique. To increase the accuracy factor of security recognition in this system, the features of palm veins is used. We use in the proposed approach, the properties of the types of entropy such as Shannon and Renyi entropies in second phase, to achieve the desired goals of the research. Hence, expected that the proposed approach can give new and useful ways to identity verification. In addition to increase the accuracy factor of security recognition. We will provide experimental results of the proposed technique and compared the results against some leading verification methods to illustrate the quality and flexibility of it.

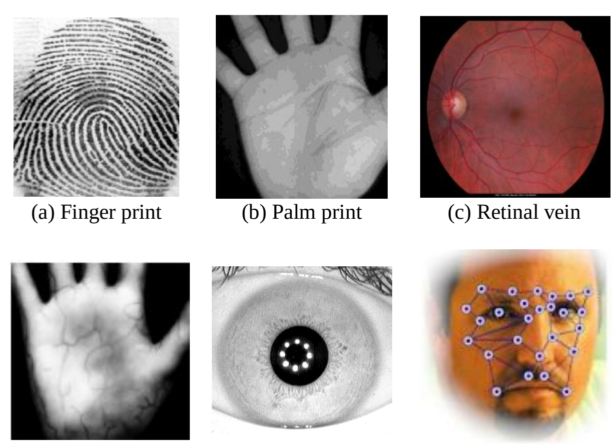
Keywords: *identity verification system, vital features, entropy, factor of security recognition.*

1. Introduction

Identity verification is a general task that has many real-life applications such as access control, transaction authentication (in telephone banking or remote credit card purchases for instance), voice mail, or security.

Most of the biometric applications are related to security and are used extensively for military purposes and other government purposes. The goal of an automatic identity verification system is to either accept or reject the identity claim made by a given person. Biometric identity verification systems are based on the physiological or behavioral characteristic of a person, such as its face, fingerprints, hand geometry, veins, iris, retinal, handwriting, gait, and voice [1]. See Figure 1.

Among the various biometric characteristics that can be used to recognize a person, the human hand is the oldest, and perhaps the most successful form of biometric technology [2]. The features that can be extracted from the hand include hand geometry, fingerprint, palm print, knuckle print, and vein. These hand properties are stable and reliable. Once a person has reached adulthood, the hand structure and configuration remain relatively stable throughout the person's life [3]. Apart from that, the hand-scan technology is generally perceived as non-intrusive as compared to iris- or retina-scan systems [4]. The users do not need to be cognizant of the way in which they interact with the system. These advantages have greatly facilitated the deployment of hand features in biometric applications.



(a) Finger print (b) Palm print (c) Retinal vein

(d) Palm vein (e) Iris print (f) Face recognition

Fig. 1. Various Biometric Systems

A key advantage of biometric authentication is that biometric data is based on physical characteristics that stay constant throughout one's lifetime and are difficult to fake or change. It is not easy to determine which method of biometric data gathering and reading does the "best" job of ensuring secure authentication. Each of the different methods has inherent advantages and disadvantages [5].

Palm vein authentication uses an infrared beam to penetrate the users hand as it is held over the sensor; the veins within the palm of the user are returned as black lines. Palm veins authentication has a high level of authentication accuracy due to the uniqueness and complexity of vein patterns of the palm. Because the palm vein patterns are internal to the body, this is a difficult method to forge. Also, the system is hygienic for use in public areas. It is more powerful than other biometric authentication such as face, iris, and retinal [6].

Biometric acts and policies are being progressed and some other production principles are performed very well, by Chih-Lung Lin et al. [7]. Identification of a human being through his body involving that the human being body is superficially well-known personality structures of an extraordinarily influential tool for personality administration of biometric appreciation [8].

Ishani Sarkar et al [9] presented a review on the palm vein authentication device that uses blood vessel patterns as a personal identifying factor. As biometric technology matures, there will be an increasing interaction among the market, technology, and the applications. This interaction will be influenced by the added value of the technology, user acceptance, and the credibility of the service provider. It is too early to predict where and how biometric technology would evolve and get embedded in which applications. But it is certain that biometric-based recognition will have a profound influence on the way we conduct our daily business.

Palm vein verification system established as a fresh biometric techniques employing the vein prototypes surrounded by one‘s palms for delicate recognition. Vein prototypes are dissimilar for each palm vein and for each human being [10] is concealed bottom of the skins exterior position, falsification is tremendously not easy. These exclusive characteristics of palm vein model detection set is separately from preceding appearances of some other methods and enclose led to its embracing the foreign country economical associations as their most recent protection knowledge.

Identification systems [11] are offering biometric procedures using extraction of palm vein constructions. For conservative procedures, it is essential to utilize luxurious-quality of figures, which insist of expensive collection of procedures. The implementation way is to making to inexpensive plans are probable. The product of this method is demonstrates that they could be extracted the palm vein arrangements are as profitably as using luxurious quality of figures.

The palm vein authentication system using the palm vein verification tool that uses blood container prototypes as individual categorizing aspects. Achievement of some classification systems are allows as an appliance in open places or in atmospheres [12].

Y. Zhou and A. Kumar [13] presented two palm vein representations, using Hessian phase information from the enhanced vascular patterns in the normalized images, and secondly from the orientation encoding of palm vein line-like patterns using localized Radon transform. The experimental results suggest that the proposed representation using localized Radon transform achieves better or similar performance than other alternatives while offering significant computational advantage for online applications. The proposed approach achieves the best equal error rate of 0.28%. Finally, they proposed a score level combination strategy to combine the multiple palm vein representations, thus achieved consistent improvement in the performance, both from the authentication and recognition experiments, which illustrates the robustness of the proposed schemes.

Y. Zhang et al [14] proposed a scheme of personal authentication using palm vein. The proposed system includes: 1) Infrared palm images capture; 2) Detection of Region of Interest; 3) Palm vein extraction by multiscale filtering; 4) Matching. The experimental results demonstrate that the recognition rate of their system is fine but not good enough to be a real system. The capture device is very sensitive to the outside lights. The outside lights can affect the inside infrared light source so that some images have very poor quality. If the capture device can be improved, the system performance should be better. Further, the database is too small to be convincible. More data are required to be collected for the evaluation of the system.

M. I. Razzak et al [15], presented multimodal face and finger veins recognition systems in which multilevel score level fusion was performed. Since there is no database for finger veins and face, thus they test the Cairo employer and students. The imposter and genuine score are combined using Fuzzy fusion to increase the face recognition system.

The outline of the paper is as follows. Introduction about identity verification system and previous work in the related are as is presented in section 1. Section 2 presents Rényi Entropy concept and its relation with information. Section 3 introduces the structure of the proposed system. Section 4 illustrates preparation phase: image acquisition, preprocessing, and feature selection. Section 5 presents training phase. Section 6 describes testing phase. Section 7 analyzes the obtained results. The paper is terminated by a conclusion summarizing the obtained results in Section 8.

2. Rényi Entropy And Information

In this section, we describe the concept of the entropy which related to the proposed method. The seminal work of Shannon [16], based on papers by Nyquist [17, 18] and Hartley [19], rationalized these early efforts into a coherent mathematical theory of communication and initiated the area of research now known as information theory. The set of all source symbol probabilities is denoted by P, $P=\{p_1, p_2, p_3, ..., p_k\}$. This set of probabilities must satisfy the condition $\sum p_i = 1$, $0 \le p_i \le 1$. The average information per source output, denoted $S(P)$, Shannon entropy may be described as [20]:

$$S(P) = -\sum_{i=1}^{k} p_i \ ln \ p_i \tag{1}$$

being k the total number of states.

Rényi [21,22] was able to extend Shannon entropy to a continuous family of entropy measures.There is extensive literature on the applications of the Rényi entropy in many fields from biology, medicine, genetics, linguistics, and economics to electrical engineering, computer science, geophysics, chemistry and physics. The Rényi's entropy measure of order α of an image, $H_\alpha(P)$ is defined as (see Refs. [22,23]):

$$H_\alpha(P) = \frac{1}{1-\alpha} ln \sum_{i=1}^{k} p_i^\alpha \tag{2}$$

where $\alpha \neq 1$ is a positive real parameter.

Theorem 1: *Shannon entropy measure is a special case of the Rényi entropy for $\alpha \to 1$.*

At $\alpha \to 1$ the value of this quantity is potentially undefined as it generates the form 0/0. In order to find the limit of the Rényi entropy, we apply l'Hopital's Theorem $lim_{\alpha\to 1}\{f(\alpha)/g(\alpha)\} = lim_{\alpha\to 1}\{f'(\alpha)/g'(\alpha)\}$, where in this case $a = 1$. We put $g(\alpha)=1-\alpha$. Then $g'(\alpha)=-1$ and $f(\alpha)= ln\sum(p_i)^\alpha$, $i=1,2,\ldots,k$. The form a^x can be differentiated w.r.t. x by putting $d/dx(a^x)= d/dx(e^{x \ ln \ a})= a^x \ ln(a)$. Therefore $f'(\alpha)= d/dx\{ln\sum(p_i)^\alpha\}= \sum(p_i)^\alpha.ln(p_i)$. Letting $\alpha \to 1$, we have $H(P)=-\sum p_i.ln(p_i)$ which is the Shannon entropy. □

Theorem 2: *The Rényi entropy and information content converge to the Shannon entropy for $\alpha \to 1$.*

Kendall [24] defines the information content of a probability distribution in the discrete case as:

$$I_\alpha(P) = -\sum_{i=1}^{k} \frac{p_i^\alpha}{\alpha-1} + \frac{1}{\alpha-1} = \frac{1}{\alpha-1}(1-\sum_{i=1}^{k} p_i^\alpha) \tag{3}$$

In order to find the limit of $I_\alpha(P)$, we apply l'Hopital's Theorem. We put $g(\alpha)= \alpha -1$, and $f(\alpha)=1- ln\sum(p_i)^\alpha$. Then $g'(\alpha)=1$, and $f'(\alpha)= -d/dx\{ln\sum(p_i)^\alpha\}= -\sum(p_i)^\alpha.ln(p_i)$. Letting $\alpha \to 1$, we have $I(P)= -\sum p_i.ln(p_i)$ which is the Shannon entropy. □

3. Proposed System

The proposed approach is consisted of three main phases, the preparation phase, training phase and testing phase. As show in Figure 2, the preparation phase is consisted of three main parts, preprocessing, feature extraction and matching using Renyi entropy. Then based on the matching method, can verify the user. Due to the increase in security requirements, biometric systems have been commonly utilized in many recognition applications. Multimodal systems have great demands to overcome the issue involved in single trait systems and this has become one of the most important research areas of pattern recognition. This paper presents a single trait system which can apply to multimodal palm print and veins biometric verification system to improve the performance that fuses palm print and veins features for better authentication accuracy. The proposed system proceeds as follows:

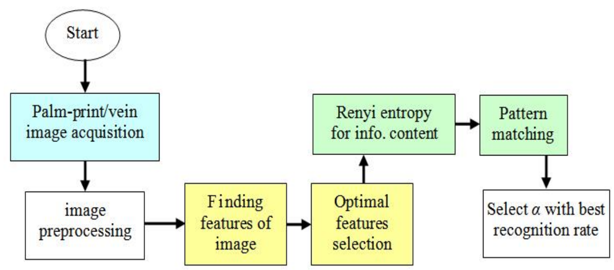


Fig. 2. Chart of processes of the preparation phase.

4. Preparation Phase

4.1 Image Acquisition

Based on the related work, A database for the palm print/vein is to be selected. (This is important for evaluating the obtained results, compared with published work). The palm print images were captured for 30 persons. The vein patterns were captured for the same 30 persons; examples of the captured images are shown in Figure 3. Figure 4 shows part of the used data base. The palm vein images were captured using "M2-PalmVein™ Reader" [25].

4.2 Preprocessing

Palm print/vein images are preprocessing by enhancement vein pattern before feature extraction. As the quality of the palm veins images were very bad, several preprocessing techniques were used to enhance the image quality. In the propose method, the method that is used for vein image enhancement is histogram equalization as show in Figures 5-6.

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We implement this technique and applied to the chose database and we added salt & pepper noise with different factors such as : 0.01, 0.1, and 1 % noise. We start with data base consists of 30 images of palm print/vein. Then we generate different samples (270 images) with various noises using the filters (Gaussian, Salt & Pepper, and Speckle) with 1% , 2% , and 3% .
We repeat with the another cases, i.e with noise. We calculate the recognition rates by knowing the result of four cases by counting the correct cases and divide by four to obtain the recognition rate.

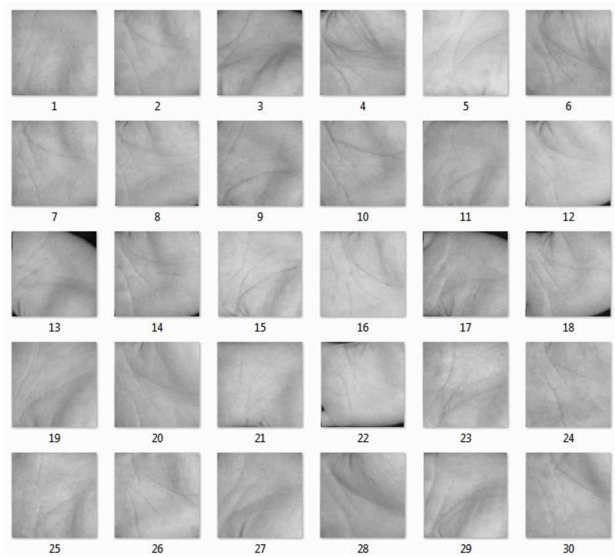

Fig. 3. Group of palm print data base.

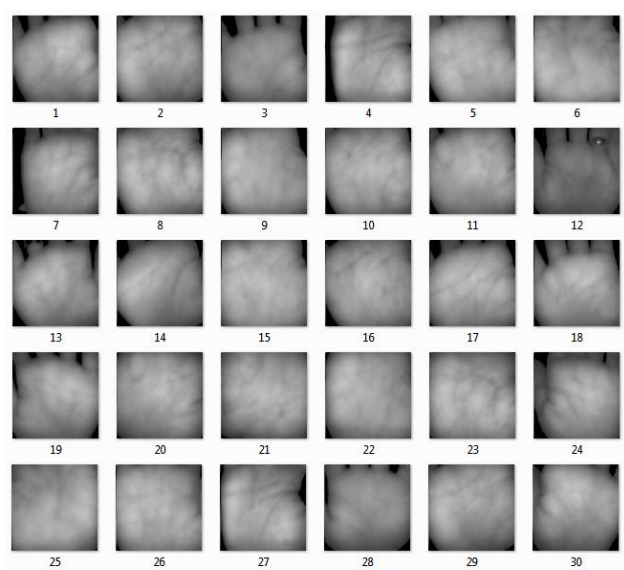

Fig. 4. Group of palm vein data base.

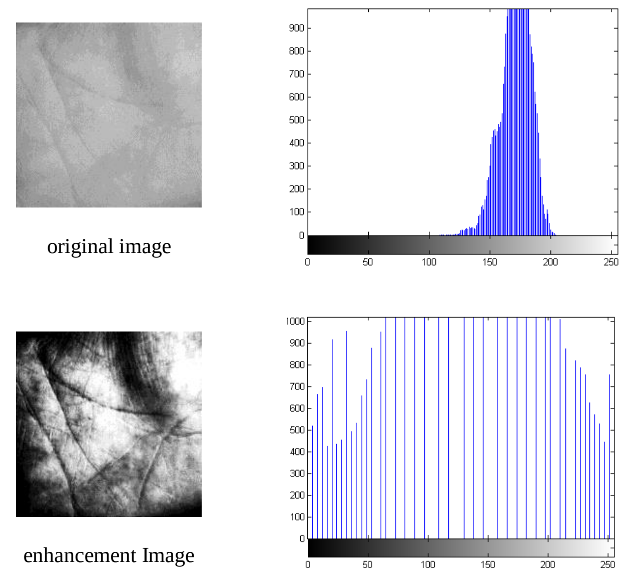

Fig. 5. Palm print Image Enhancement

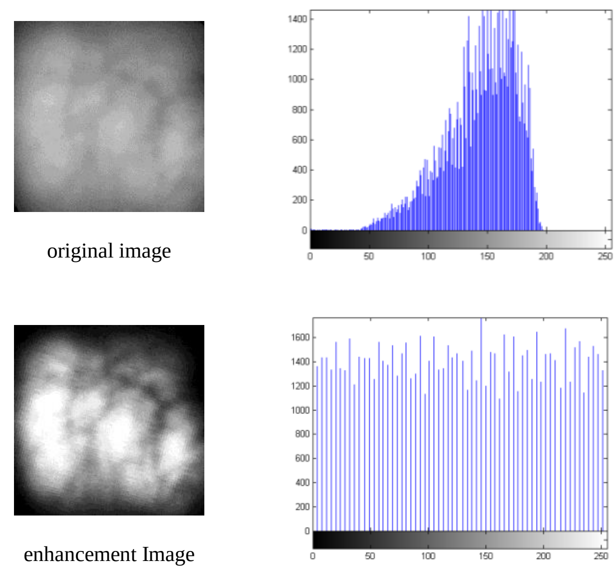

Fig. 6. Palm Vein Image Enhancement

4.3 Feature Selection

The paper aims at finding the best parameter α with the best performing approach for both biometrics. For that, we distorted the original images with three different types of noise; each with different noise levels. Salt and pepper, Speckle and Gaussian noise types with intensity of 1%, 2%, and 3% are used throughout the study. The statistical features set (SFS), is used in our system [26]: “Mean, Variance, Smoothness, Skewness, Kurtosis, Uniformity, and Entropy" . The following seven equations describe the calculation of the features for the program based on statistical features.

a. Mean $\mu = \overline{X} = \frac{1}{N}\sum_{i} X_i$

b. Variance $\sigma^2 = \frac{1}{N-1}\left(\sum\left(X_i - \overline{X}\right)^2\right)$,

Standard Deviation $\sigma = \sqrt{\frac{1}{N-1}\left(\sum\left(X_i - \overline{X}\right)^2\right)}$

c. Smoothness $R = 1 - \left(1 + \sigma^2\right)^{-1}$

d. Third Moment (Skewness) $\mu_3 = \frac{\sum (X-\mu)^3}{N\sigma^3}$

e. Fourth Moment (Kurtosis) $\mu_4 = \frac{\sum (X-\mu)^4}{N\sigma^4} - 3$

f. Uniformity $U = \sum_{i=0}^{L-1} p^2(z_i)$

g. Entropy $S(P) = -\sum_{i=1}^{k} p_i \ ln \ p_i$

After generation of the features of the samples, we calculate the information content of each image applying Renyi entropy with different parameters of α .

5. Training Phase

The training phase algorithm is described as the following. In this phase: The palm print and veins images are captured in the same way as in the preparation phase . The captured images pass through the same preprocessing stages. The feature vectors are extracted using the technique selected in the preparation phase. The sets of features of both biometrics are fused. The fused feature vector is stored in database for future comparisons.

6. Testing Phase

The testing phase algorithm is described as the following : The images of the person under test are acquired and preprocessed typically as in the preparation phase. The feature vector of the adopted approach is calculated. The resulting feature vector is compared with those stored in database and the person is recognized.

7. Results And Discussion

For palm print, the following Table 1 show the sample results of average recognition rates (AvRR) of palm print with different values of α={0.01, 0.02, …, 5} using Salt and pepper, Speckle and Gaussian noise types with intensity of 1%, 2%, and 3% . The obtained results are shown in Table 1 and the Figure 7. It is clear that when $0<\alpha\leq 0.15$ the recognition rate is better.

Table 1: AvRR of palm print samples with different values of α

α	Salt & pepper noise rate					Speckle noise rate					Gaussian noise rate				
	0%	1%	2%	3%	AvRR	0%	1%	2%	3%	AvRR	0%	1%	2%	3%	AvRR
0.01	100	96.7	86.7	83.3	91.7	100	96.7	83.3	83.3	90.8	100	76.7	56.7	30.0	65.8
0.02	100	86.7	83.3	86.7	89.2	100	93.3	83.3	90.0	91.7	100	80.0	56.7	30.0	66.7
0.03	100	93.3	90.0	86.7	92.5	100	100.0	83.3	93.3	94.2	100	80.0	60.0	40.0	70.0
0.04	100	93.3	76.7	83.3	88.3	100	93.3	80.0	86.7	90.0	100	76.7	53.3	20.0	62.5
0.05	100	96.7	96.7	86.7	95.0	100	93.3	86.7	93.3	93.3	100	76.7	63.3	26.7	66.7
0.06	100	100.0	100.0	76.7	94.2	100	93.3	80.0	90.0	90.8	100	80.0	70.0	26.7	69.2
0.07	100	96.7	96.7	90.0	95.8	100	90.0	86.7	93.3	92.5	100	76.7	66.7	33.3	69.2
0.08	100	86.7	90.0	90.0	91.7	100	96.7	86.7	93.3	94.2	100	83.3	63.3	20.0	66.7
0.09	100	93.3	86.7	86.7	91.7	100	96.7	90.0	90.0	94.2	100	76.7	70.0	23.3	67.5
0.1	100	90.0	96.7	83.3	92.5	100	96.7	86.7	90.0	93.3	100	73.3	43.3	26.7	60.8
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

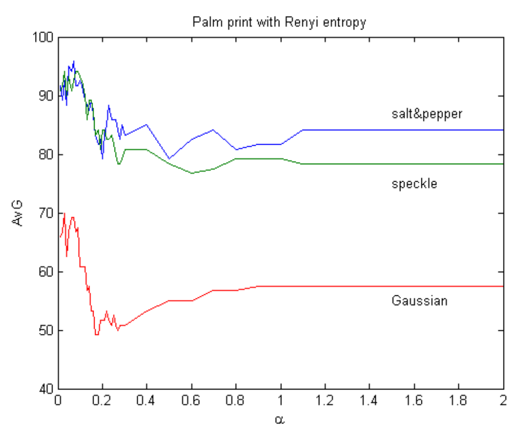

Fig. 7. chart of AvRR and different values of α in palm print dataset

For palm vein, the following Table 1 show the sample results of average recognition rates (AvRR) of palm print vein with different values of α={0.01, 0.02, …, 5} using Salt and pepper, Speckle and Gaussian noise types with intensity of 1%, 2%, and 3% . The obtained results are shown in Table 2 and the Figure 8. It is clear that when $0<\alpha\leq 0.1$ the recognition rate is better.

Table 2: AvRR of palm vein samples with different values of α

α	Salt & pepper noise rate 0%	1%	2%	3%	AvRR	Speckle noise rate 0%	1%	2%	3%	AvRR	Gaussian noise rate 0%	1%	2%	3%	AvRR
0.01	100	86.7	76.7	76.7	85.0	100	93.3	96.7	86.7	94.2	100	30.0	46.7	66.7	60.8
0.02	100	83.3	80.0	76.7	85.0	100	93.3	86.7	90.0	92.5	100	30.0	43.3	70.0	60.8
0.03	100	86.7	70.0	80.0	84.2	100	100	93.3	90.0	95.8	100	30.0	46.7	70.0	61.7
0.04	100	83.3	73.3	80.0	84.2	100	96.7	96.7	90.0	95.8	100	26.7	40.0	73.3	60.0
0.05	100	86.7	80.0	83.3	87.5	100	96.7	93.3	93.3	95.8	100	16.7	36.7	60.0	53.3
0.06	100	86.7	86.7	86.7	90.0	100	100	96.7	100.0	99.2	100	16.7	16.7	50.0	45.8
0.07	100	90.0	83.3	83.3	89.2	100	100	93.3	100	98.3	100	16.7	16.7	36.7	42.5
0.08	100	86.7	80.0	76.7	85.8	100	96.7	100	96.7	98.3	100	13.3	20.0	40.0	43.3
0.09	100	86.7	73.3	73.3	83.3	100	96.7	96.7	93.3	96.7	100	20.0	23.3	33.3	44.2
0.1	100	90.0	76.7	53.3	80.0	100	96.7	93.3	93.3	95.8	100	13.3	16.7	26.7	39.2
...	...	...	...	...		...	...	...	...	...	...	...	...	...	...

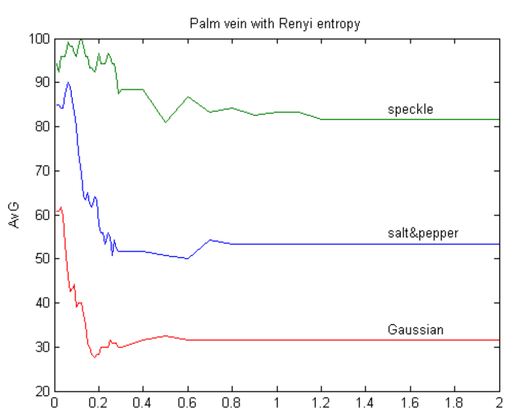

Fig. 8. chart of AvRR and different values of α in palm vein dataset.

Simultaneously, we calculated the recognition rate using the fused feature vector for the same type of noise with the same intensity levels. The results are shown in Table 4 and Figure 9. It is clear that an average of features fusion in the recognition rate is obtained with $\alpha<1.5$.

Table 3 : AvRR of palm vein/print and Features fusion with best $\alpha<1.5$

Vital feature type	AvRR Salt & pepper	Speckle	Gaussian
Palm print	95.8	94.2	70.0
Palm vein	90.0	96.7	61.7
Features fusion	99.2	99.8	89.2

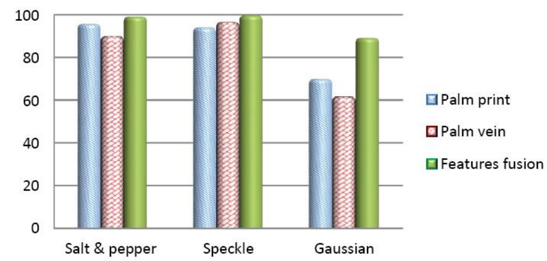

Fig. 9. Average recognition rates using features fusion

8. Conclusions

A new method of personal authentication based on as Shannon and Renyi entropies of palm print/vein has been discussed in detail. First phase, we constructed a biometric authentication technique. The features of palm print/veins are used to increase the accuracy factor of security recognition in this system. We used in the proposed approach, the properties of the types of entropy in second phase. Experiment results have demonstrated that the proposed scheme for ways to identity verification. The Renyi α coefficient can be used as an adjustable value and can play an important role as a tuning parameter in the image processing chain for the same class of images. In almost every image used, the proposed method yielded a good average recognition rates , 99.4 % , using features fusion for fractional $0<\alpha\leq 0.1$ coefficient.

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