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An Analytical Survey on Vein Pattern Recognition

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***Abstract*—** Biometric is term of science to identify a person identity using their physiological features. Currently, vein pattern recognition has attracted the attention of the technology and industry all over the world. A vein is network of blood vessels under the skin of an individual. The vascular pattern is different for every person in the same part or region of the body. It is stable till very long age. As the veins are underneath the skin it is very difficult for intruder or forger to copy the feature. This uniqueness and strong immunity from intruders make it more potent biometric system which avails us secure features for individual identity verification. This paper involves the description of vein pattern recognition, its requirement and its importance in biometric system. Different feature extraction algorithms are reviewed as independent component analysis, principal component analysis method. For classification in vein pattern recognition we have reviewed support vector machine and neural network techniques. Parameters are described based on which results are computed like true positive, false positive, true negative, false negative, accuracy and precision.

Keywords: *Vein pattern Recognition (VPR), Near-infrared rays (NIR), False Rejection rate (FRR)*

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I. INTRODUCTION

In the era of the biometric technology, the importance and acceptance of these technologies such as fingerprinting, iris recognition, hand geometry and facial recognition has become widespread and due to their emergence the demand for other modalities is very less now. Among these biometric technologies the vein pattern recognition technology is the fastest –growing technologies. Vein pattern recognition technology has maintained its position due to its own features and benefits.

Vein pattern Recognition is the modern biometric technology in the market place. The palm position is just underneath the hand so it can be used as an alternative to hand geometry recognition. Vein pattern recognition is now becoming serious competition to the old previous technology such as finger print recognition and iris recognition. It is considered to as 'Automatic physical biometric' [1]. No direct is required for taking the raw image of the veins. Hence, it makes this technology as potentially appealing and is very secure due to which potential customers are using biometric technology for security purposes. Veins have structure which is closer to surface to skin. Veins transport deoxygenated blood throughout the body so more clear images of vein structure are captured. To extract the unique features of vein pattern (it can fingerprint or palm) near infrared light is passed through area. The NIR light is absorbed by the haemoglobin in blood stream. Haemoglobin the primary component responsible for carrying oxygen in the blood stream and is composed of iron. Arteries have more amount of haemoglobin than veins that is why veins absorb the NIR light in higher amount [4]. Hence, the raw images seem to be much darker and robust when captured by Vein recognition system. The formation of this unique pattern in vein is due to first eight week of gestation.

The component of VPR contains 4 main elements that are discussed as follows.

1. Device consist of sensor which emit the NIR light to the surface of fingerprint or palm.
2. A camera which is high-resolution charge-coupled.
3. A processing unit to extract the unique pattern from the fingerprint or palm.
4. Biometric databases that consist of enrolment and verification templates.

In 2000, first paper about the vein pattern recognition was published which described the new technology which use subcutaneous blood vessels in the back of the hand and it became the first official vascular pattern recognition system. The identification of vascular pattern is find either on hand or on fingers back [1]. The reflected near-infrared rays create an image processing methods which lead to extraction of vascular pattern. This whole process is due to the difference in absorbance of blood vessels and tissues. Various feature rich data like vessel branching points, branching angels and vessel thickness are extracted from the vascular pattern which is stored as a template [3].

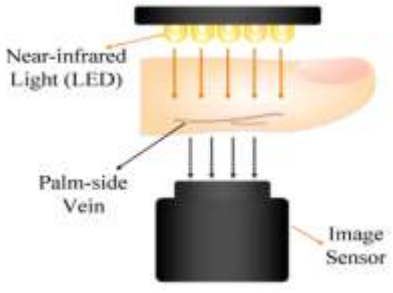

Fig. 1 Finger vein imaging (Light Transmission method)

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1.1 Requirement of vein pattern recognition

As this technology is highly secure and suitable means of personal verification.

1. Resistant to criminal tempering: As the veins are inside the body, there is less risk of forgery.
2. High accuracy: For the False Rejection rate (FRR), the authentication accuracy is very less than 0.01 % and 0% for failure to enrol.
3. Unique and constant: Even among the identical twins the vein pattern are distinct and remains same lifelong.
4. Contactless: When the image are captured through the near-infrared light, it allows contactless imaging that guarantees full convenience and cleanliness for the individual experience.
5. Ease of Feature extraction: The vein patterns are relatively stable and clearly taken due to which with low resolution vein images are taken.
6. Fast authentication speed: authentication devices takes less time as fingers or palm has to just touch the device and authenticate itself.

1.2 Importance in biometric

In this society of network, people can easily access the information of the individual so the risk are always involved. Nowadays, passwords, identification cards and personal identification numbers are used for individual identification. However the possibility of hacking of passwords and stealing of cards is very high. To solve this problem of accessing of information biometric technologies have gained much interest as it recognizes people with their unique body information. In biometric the holder's body characteristics are noticed and registered in the database. If anyone attempts to access the account then firstly the patterns are compared to authenticate if legitimate user is accessing [3].

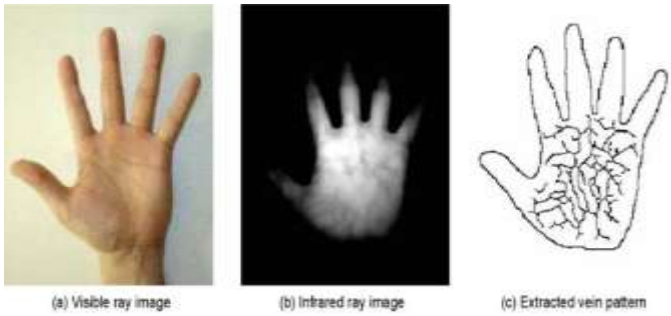

Fig.2 Palm vein recognition

Vein authentication in palm can be done with the use of vascular pattern on the back of hand or finger. The palm vein pattern is the complex authentication process. As the palm has no hair on it, the vascular pattern on the palm is easy to capture. No signification differences of skin color occur in palm as compared to fingers [11].

The work of technology starts by identifying the vein patterns in an individual's hand beneath the skin. The user's hand is placed on a scanner. A near-infrared light plots the position of the veins. The haemoglobin present in the veins absorb the rays and plot as black lines on the map, however the remaining hand structure is seen as white. After extraction of vein pattern, its comparison is done with the previously stored pattern and match is made [5].

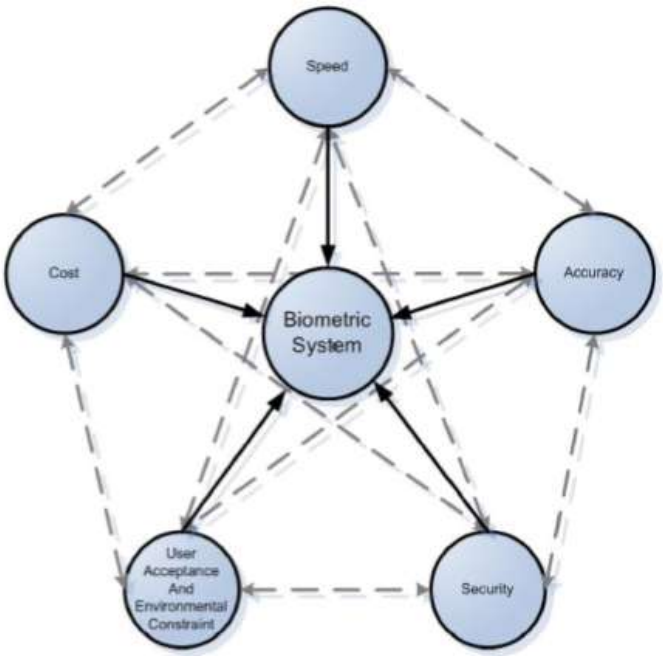

Fig.2 Inner relationship between different objectives for planning a biometric system

1.3 Feature Extraction Algorithm

a. **Independent Component Analysis-** Palm vein is the important and unique physiological feature. Its recognition is hard to be stolen which makes it more secure identification method. ICA solves the poor recognition cause due to poor palm vein image quality and computation complexity is decreased.

Independent component analysis is the unsupervised and geometric method for finding or searching the inside hidden factors in the data. It exploits higher-order dependencies that are statistical among data and searches for productive model for observed multidimensional data. In this model the data variables which are observed are linear mixtures of independent components. These independent components are supposed to be non-Gaussian and mutually independent [7].

ICA based feature extraction, assumption of independent component s_i as the i-th feature in the pattern vector X of the observed and recognized object. From the observed data pattern which has m independent components, a feature vector can be formed. This method of using ICA for feature extraction is motivated by the outcomes of neuro-science which reveal that pattern

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dimensionality can be noticed by the brain in the initial processing of sensory data [8].

b. Principal Component Analysis- Principle Component Analysis is a method which has been successfully applied on human faces. Whereas, hand geometry is applied on the hand vein pattern. PCA is used to obtain eigenveins that is a low dimensional representation of vein pattern features. CCD cameras of low cost were used to get the vein images [12].

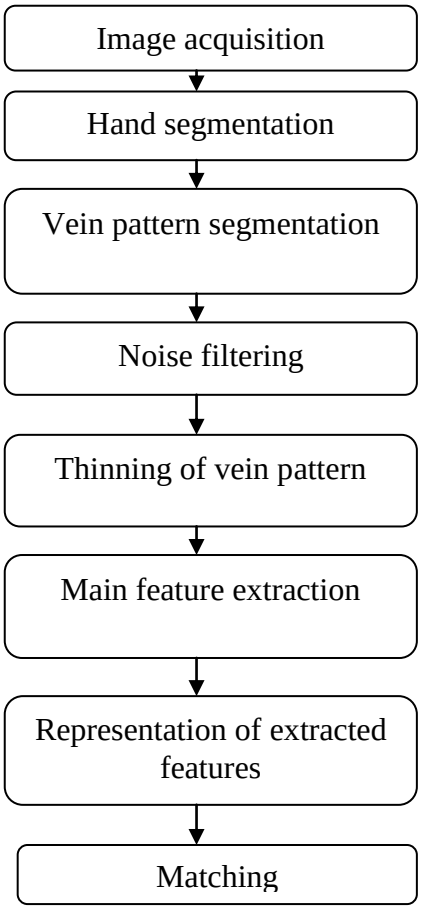

Fig.4 Biometric Procedure

By applying morphology the vein pattern was obtained during extraction. It is a widespread dimension reduction method that is used to reduce the number of components to represent the data. The benefit of this method is that it offers a simpler demonstration of data which leads to less storage space consumption and quicker classification..

PCA takes data from higher dimension space and maps it into lower dimension in a way that correlation in data variables are reduced and the errors are minimized between the original and estimated data. PCA is basically based on Eigen analysis which contains of uncorrelated components. The uncorrelated components are obtained by combining variables linearly and the values of eigenvectors are used as weights

1.4 Classification For VPR

a) SVM

SVM has been widely used for classification and pattern recognition. It is a group of related supervised learning algorithms and is generally known as hyper plane classifier. During the training of SVM classifier, it includes searching for hyper plane which separates the positive training set from the negative training set with high margin. It can easily handle the nonlinearly separable data [10].

A hyper plane is decided f(x) = 0 which separates the data for a linearly separable data.

$$f(x) = \sum_{f=1}^{n} w_i x_i + b = 0$$

where, w= n-dimensional vector, b=scalar value. The w and b decide the position of the hyper plane.

$w.x_i - b >= 1$ for x_i of 1st class.

$w.x_i - b <= 1$ for x_i of 2nd class.

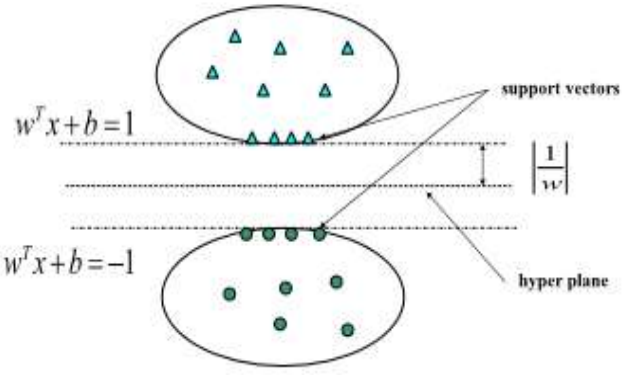

Fig.5 A linear separable Support Vector Machine

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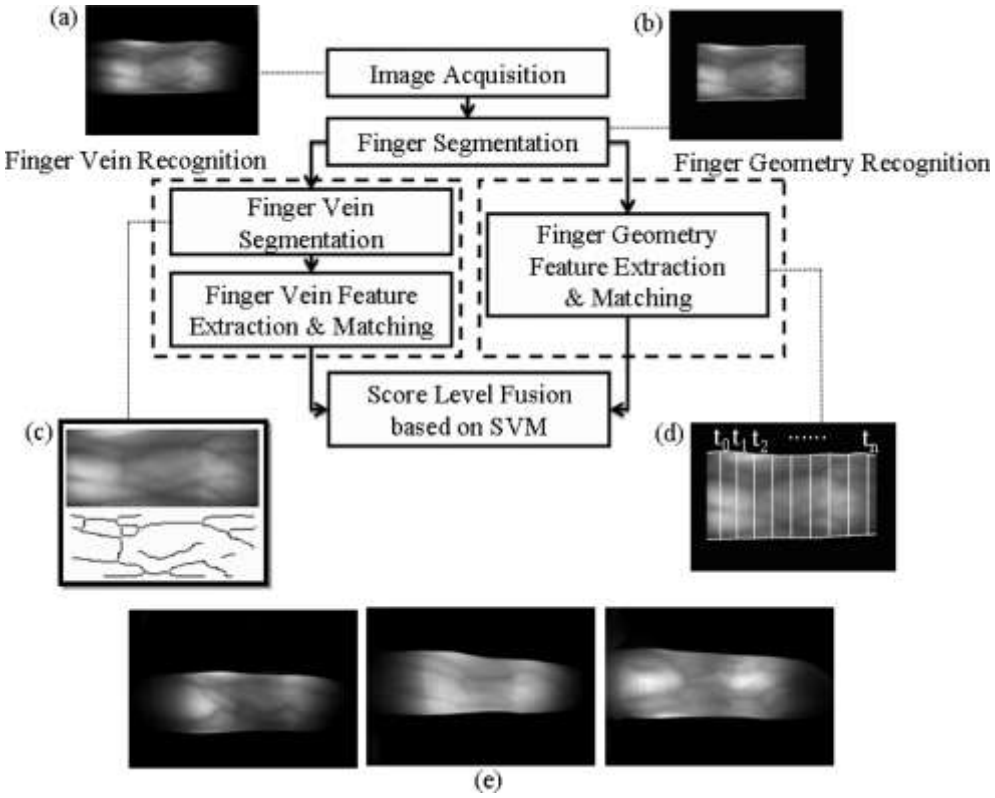

Fig. 6 Finger vein classification [7]

b) Neural

Obtained images are trained with the neural system and after that classification is done to check whether the data is matched with the trained database or not. Input layer neurons are directly fed into the hidden layers through a series of weights. At each node sum of product of weights and input is deliberated. The value which are calculated are directly fed to the output layer neurons through a series of weights. The process of training begins when the error between the output value and desired value is high than error ratio. When the desired error rate is obtained for all input combinations at that time the training set is finished [7].

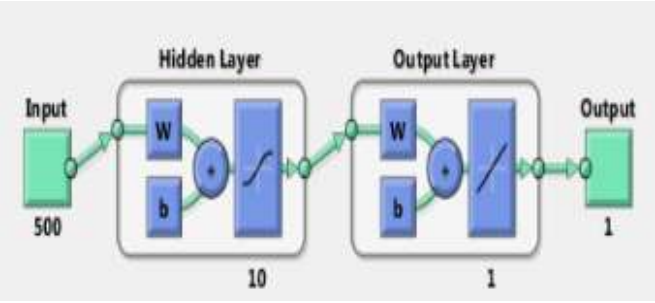

Fig. 7 Neural Network Architecture

1.5 Parametric Description

The validation metrics such as true positive, false positive, true negative, false negative are the validation metrics which are used for verifying segmented image quality. In an assumption, comparison is done between the segmented image and the ground truth image. Assumption of foreground= white pixels and background = black pixels in ground truth.

a) True Positive Rate (TPR): correctly segmented pixels as foreground
b) False Positive Rate (FPR): pixels segmented falsely as foreground.
c) True Negative Rate (TNR): background pixels correctly detected.
d) False Negative Rate (FNR): pixels are falsely detected as background.

True positive defines the case that was positive and forecast as positive (correctly identified individual) and False positive defines the case was negative but forecast as positive (incorrect individual identification through system). A system is called as ideal system only if it has high true positive and very low false positive rates.

$$True\ positive\ rate(TPR) = \frac{TP}{TP + TN}$$

$$False\ positive\ rate(FPR) = \frac{FP}{FP + TN}$$

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$$True\ Negative\ rate(TNR) = \frac{TN}{TN + FP}$$

$$False\ Negative\ rate(FNR) = \frac{FN}{FN + TP}$$

When conversation comes about a good classifier TPR and TNR, its value should be nearer to 100%. Though the values of FPR and FNR should be close to 0%. After the calculation of these metrics these are then used to calculate sensitivity, accuracy, precision and recall.

$$Precision = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

$$Recall = \frac{True\ Positive}{True\ Positive + True\ Negative}$$

II. RELATED WORK

Jian-da Wu, has presented a SVM method for finger-vein pattern recognition in System for personal identification. In this system the vein pattern of fingers has been CCD camera when infrared LED is passed through the fingers as they are not visible in simple light. The system has image pre-processing and pattern classification. PCA and LDA were applied to the image in pre-processing step for dimension reduction and feature extraction. SVM and adaptive neuro-fuzzy inference system was used for pattern classification. PCA was for noise removal which are found in discarded dimensions and preserve the important feature of LDA. These features was then used for classification of pattern and identification. The result has shown better performance as the accuracy using SVM in classification is 98% and time taken is 0.015 s.

Navjot kaur, has proposed the system which analyze the vascular pattern recognition with the use of Neural Network. MATLAB software was used for implementation of the proposed work. The aim of the system was to reduce the FAR, FRR to increase the accuracy of the authentication process. The database which has been taken is BOSPHOROUS database. NIR imaging method is used in the database. Images were converted into grayscale, histogram was made of hand vein images, and canny edge detector was used for edge detection. SIFT algorithm was used for feature extraction. Accuracy was evaluated and system gave 99.97% , 0.01 % of FAR, FRR= 0.0009% and 0.46 errors /bit stream. Siou-Huan Ye, has presented a driver identification system using finger-vein technology and ANN. The proposed system is dependent on the near infrared finger-vein patterns for biometric authentication. Author has propose hybrid approach of random transform for feature extraction and neural network for classification. Random transform concentrates on highly valued coefficients in the transformed domain whereas the neural networks were used to make training modules. The result showed that the system \which has been proposed was pretty well for driver identification system. The identification rate of PNN network was over 99.2%. Dun Tan, has proposed framework for automatically and roughly categorizing of finger-vein images. Two levels were described in the proposed level-based framework. First layer has image qualities and its contents and second layer has image feature representation. For image clustering of automatic finger-vein, k-mean was adopted. With the use of SVM method, correct classification rate was 99% for large image database. The result has proved for good performance of the recognition system. Sang-Kyun Im, has proposed an better vein pattern extracting algorithm that compensates the damage of vein pattern in particular area and gives better and enhances information for vein pattern. Filter was designed for solving the problem of iteration. Due to the designed filter the speed of recognition has become fast and hardware complexity was reduced. False acceptance rate was better than existing algorithm. Adams Kong, has provided an overview of existing palm-related fusion, real-time palm vein identification by the designed algorithms in big databases. Hyeon Chang Lee, has proposed an identification technique for finger vein pattern with local binary pattern and SVM. With the use of LBP technique holistic codes are extracted which reduces the processing time when finger vein pattern are extracted. With SVM classifier the local area codes are classified into three categories large amount, medium amount and small amount. The 0.049% error rate has been obtained and the processing time = 72.5 ms. LingyuWang, has proposed a method to examine the infrared vein pattern for biometric purpose. For recognition Minutiae features were extracted from vein pattern that consist of bifurcation points and last points. These are used for geometric representation of vein pattern. Modified Hausdroff distance algorithm was proposed to evaluate the discrimination power for individual verification method. Results showed that 0% Error Equal Rate has been achieved with the proposed algorithm.

CONCLUSION

The heading of the Acknowledgment section and the References section must not be numbered.

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REFERENCES

[1] Wu, Jian-Da, and Chiung-Tsiung Liu. "Finger-vein pattern identification using SVM and neural network technique." *Expert Systems with Applications* 38, no. 11 (2011): 14284-14289.

[2] Kaur, Navjot, and Amardeep Singh. "Analysis of Vascular Pattern Recognition Using Neural Network." (2015).

[3] Wu, Wei. "Palm Vein Recognition Based on Independent Component Analysis." In *Applied Mechanics and Materials*, vol. 333, pp. 1106-1109. Trans Tech Publications, 2013.

[4] Crisan, Septimiu. "A Novel Perspective on Hand Vein Patterns for Biometric Recognition: Problems, Challenges, and Implementations." *Biometric Security and Privacy*. Springer International Publishing, 2017. 21-49.

[5] Sheetal, R., G. Parkash, and G. Kanwal. "Image processing in hand vein pattern recognition system." *Int. J. Adv. Res. Comput. Sci. Softw. Eng* 4, no. 6 (2014

[6] Wu, Jian-Da, and Siou-Huan Ye. "Driver identification using finger-vein patterns with Radon transform and neural network." *Expert Systems with Applications* 36, no. 3 (2009): 5793-5799.

[7] Tan, Dun, Jinfeng Yang, Yihua Shi, and Chenghua Xu. "A hierarchal framework for finger-vein image classification." In *Pattern Recognition (ACPR), 2013 2nd IAPR Asian Conference on*, pp. 833-837. IEEE, 2013.

[8] Im, Sang-Kyun, Hyung-Man Park, Soo-Won Kim, Chang-Kyung Chung, and Hwan-Soo Choi. "Improved vein pattern extracting algorithm and its implementation." In *Consumer Electronics, 2000. ICCE. 2000 Digest of Technical Papers. International Conference on*, pp. 2-3. IEEE, 2000.

[9] Kong, Adams, David Zhang, and Mohamed Kamel. "A survey of palmprint recognition." *pattern recognition* 42, no. 7 (2009): 1408-1418.

[10] Lee, Hyeon Chang, Byung Jun Kang, Eui Chul Lee, and Kang Ryoung Park. "Finger vein recognition using weighted local binary pattern code based on a support vector machine." *Journal of Zhejiang University SCIENCE C* 11, no. 7 (2010): 514-524.

[11] Wang, Lingyu, Graham Leedham, and David Siu-Yeung Cho. "Minutiae feature analysis for infrared hand vein pattern biometrics." *Pattern recognition* 41, no. 3 (2008): 920-929.

[12] Khan, M. Heenaye-Mamode, R. K. Subramanian, and NA Mamode Khan. "Low dimensional representation of dorsal hand vein features using principle component analysis (PCA)." *World Academy of Science, Engineering and Technology* 49 (2009): 1001-1007.