iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** II **Month of publication:** February

DOI: http://doi.org/10.22214/ijraset.2019.2065

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue II, Feb 2019- Available at www.ijraset.com

Palm Vein Recognition System for Human Authentication: A Review

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***Abstract:** Palm vein technology is the upcoming technology that is extremely secure and unique because one cannot forged the pattern of veins. No doubt there are numerous biometric recognition techniques such as palm vein, iris, fingerprint, retina etc., which will be used as biometric identifiers to confirm the human's identity, but those methods didn't produce satisfactory results, so we need a technology that secure our information more efficiently from an unauthorized access. This paper presents an analysis of palm vein pattern recognition, its development, principle & general framework of palm and finger vein recognition, its techniques, its applications, and advantages of using this technology.*
***Keywords:** biometrics; feature extraction; palm vein recognition; pattern matching.*

I. INTRODUCTION

In today's world, to maintain the human's security is a big challenge. There are various types of frauds and threats related to the identity of any person are increasing frequently. To avoid these frauds there should be some methods available to improve the security and biometrics is one of the best approaches. Biometrics has gained a lot of attraction during past decades in both commercial and academic domains. It offers an automatic method of recognizing and identifying the persons that are based on physiological or behavioral characteristics. Physiological characteristics includes iris, face, retina, fingerprints, and behavioral characteristics includes voice feature, gait recognition, signature. The classification of biometric techniques is shown in fig.1

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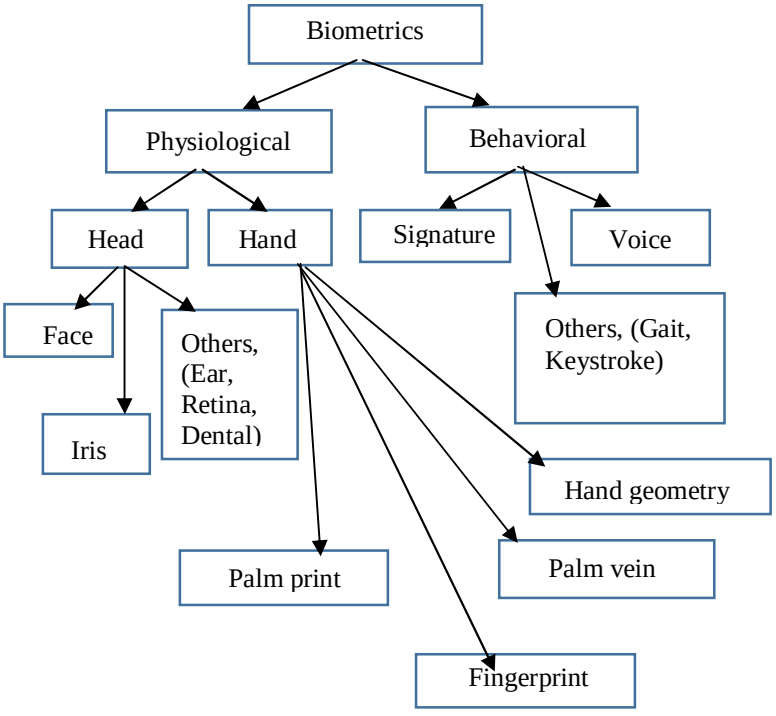

Fig. 1 Classification of biometric techniques [26].

To provide the best security these traits are used to control the access in many fields. Palm vein recognition is the part of the biometric system, which is extremely secure because it uses information contained internal to the human skin. It works by equating the vascular patterns in the palm of the person being legitimated with the original pattern of the person stored in a database. The most essential preferred standpoint of palm vein is human vein qualities stays steady all through one's lifetime. It might be hard to change. Biometric identification is used in several fields of medical sciences, offices, banking and in various applications where security and authenticity is critical reasons [1] [2] [25]. The vein design is accessible at each sound human, however it can't be seen utilizing ordinary, obvious beams of light since it is available under the skin's surface. Wang Lingyu, [25] investigated two infrared imaging technologies, the first one is far-infrared (FIR) thermographs and the second one is near-infrared (NIR) imaging. The spectrum range of far-infrared camera lies between 8-14nm for catching the successful vein pictures and the range scope of close infrared lies between 700-1000nm for catching the better perspective of finger veins and palm veins. The Palm and finger veins easily acquired with the help of the near infrared light device is shown in fig.2. Once the user's hand is held over the scanner, the vein inside the Palm of the user appears black and then it is registered as an "identity card" in a database. Finally, it's matched with previously registered patterns of people in the existing [3] [4] [5].

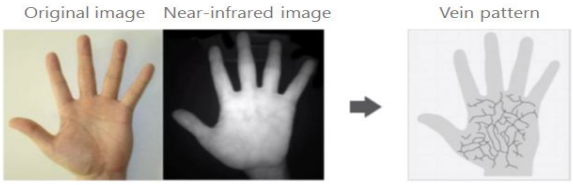

Fig. 2 A Process of extracting Palm vein pattern

Palm vein technology is the modern biometric technique with a high level of accurateness came into existence and becoming more popular nowadays. No doubt there are a lot of methods which developed either from the inside or outside to secure the information but those methods didn't produce satisfactory results so we need a technology that secure our information more efficiently from an unauthorized access.

A. Biometric Factors

Biometrics has seven factors: 1) Uniqueness 2) Universality 3) Performance 4) Measurability 5) Permanence 6) Circumvention 7) Acceptability. An assessment of biometrics is exposed in Table 1. Preferably, any physiological or behavioral characteristic can't be a biometric quality except if it fulfills the accompanying criteria [5] [24].

TABLE I
COMPARISONS BETWEEN DIFFERENT BIOMETRIC TRAITS [26]

Biometric Characteristic	Universality	Uniqueness	Permanence	Collect-Ability	Performance	Acceptability	Circumvention
Finger Print	M	H	H	M	H	M	H
Face Recognition	H	L	M	H	L	H	L
Hand Geometry	M	M	M	H	M	M	M
Iris Recognition	H	H	H	M	H	L	H
Retinal Scan	H	H	M	L	H	L	H
DNA	H	H	M	H	H	L	L
Keystroke	H	L	L	H	M	H	H
Signature	L	L	L	H	L	H	L
Voice	M	L	L	M	L	H	L
Palm and finger vein	H	H	H	H	M	H	L

1) Uniqueness − means that the biometrics features used for human recognize should be unique.
2) Universality −It indicates that each and every person has the unique characteristics, which cannot be reproduced.
3) Permanence – this parameter is mandatory for each and every biometric trait, and it ought to be consistent in the database for a specific timeframe period.
4) Collectability – means how easily the data of the traits can be collected.
5) Performance − It means that how well the security system works in terms of accuracy and robustness should be achievable.
6) Acceptability – relates how well users accept biometric technologies in the relevant population.

II. PRINCIPLE & GENERAL FRAMEWORK OF PALM AND FINGER VEIN RECOGNITION

A. *Vascular Pattern Recognition Principle*

Vein recognition is also known as vascular biometrics. Early years, numerous researchers found that the deoxidized hemoglobin in the vein vessels ingests light at a wavelength 750-960nm decreasing the capacity of the veins to mirror the light back and making them show up as a dark example. This vein design is then checked against a pre-enrolled example to confirm the person. This process makes the vein recognition possible [6].

Vein based recognition technique is much more secure and unique as compare to other technique because the authentication data present under the skin of a person. Vein based identification system is being mostly used nowadays because other techniques like palm prints, facial expression, skin, voice recognition, and DNA recognition are unable to identify the twin person. By using this modern technology, a person can save their personal information at any time and any place and the unauthorized person cannot take control of this information. This technology has many applications like in government offices, banking, in passport issuing, etc. [5] [7].

In this paper we also study numerous vein recognition techniques like palm veins [1]-[7], dorsal veins [8], wrist veins [9], forearm veins [10] and finger veins [11]-[13].

B. *General Framework Of Vein Recognition*

As shown in Fig. 3, the four Main components of this architecture are as follows [5].

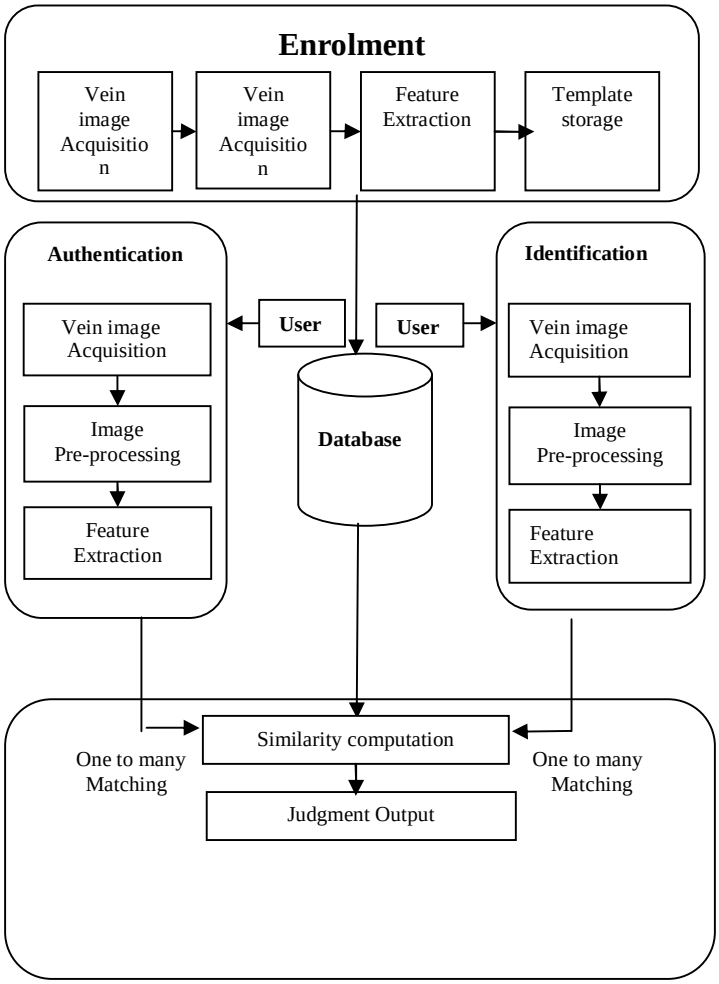

Fig.3 General Framework of palm and finger vein processing [5].

1) *Enrolment:* This is a first process that is very crucial and important for membership. If want to identify a user, so first we want to store the user's features in a database gathered by the activities of vein image acquisition, image pre-processing and feature extraction.
2) *Authentication:* This process is known as verification. It is a one-to-one matching process. It refers to confirming or denying a user's claimed identity. In this mode, the system performs one-to-one comparisons of the template computed from the acquired biometrics data with its own biometrics template stored in the database.
3) *Identification:* In the stage, the framework requires an incorporated database which permits the biometric information of several persons to be compared.
4) *Decision:* It calculates the similarity between the query feature templates and therefore counterparts read out from database one by one. Afterward, a result can be ready that is based on the computed similarity.

III. VEIN PATTERN RECOGNITION TECHNIQUES

The palm vein recognition techniques can systematically describe in three parts, which is preprocessing, feature extraction and pattern matching.

A. *Preprocessing*

This method is same as alternative biometric recognition techniques, the first, we need to gather all biometric tests (Infrared Images) and enroll them one by one with their associated owners. This method is typically referred to as enrollment.

Wu, Jian-Da, et.al, [12] presents a new pre-processing step i.e, vein Segmentation, Gamma enhancement, Gary-scale, contrast enhancement. The Gamma value method is useful for contrast measuring, and it gains enhanced image hue when the value adjusts applicability. The second step is the grayscale method convert RGB image to grayscale images to removing the hue and saturation to get clear a distribution of vein patterns.

B. *Features Extraction*

Feature extraction is the process of finding the measured data and obtains derived values from the image. This information is non-redundant and used for subsequent learning. It would be used for better human interpretation. When the input data is too large and contains large attributes it is required to be transferred into a reduced set of features called feature extraction. The extracted features are available in to feature vector for further analysis. The most important characteristics of an object are taken as features and it should be extracted to provide a feature description of the object [24].

Shaheed, Kashif, et al, [14] in this paper, it represents some of the major steps of finger vein recognition. In this step, the quantifiable property of the basic biometric trait is created, which is known as template, this template is useful to identify a user.

Y. Zhou, et.al, [15] presents another feature extraction and coordinating methodology which separate two kinds of palm vein highlights to enhance the execution of palm vein based recognizable proof framework. The first approach is the hessian-phase-based approach and the Second approach is the neighborhood matching Radon transform approach. These both approaches performs very well even with the base number of enlistment pictures.

IV. APPROACHES FOR SIMLARITY MATCHING

Hamming distance: this is the most common method that is used to measure the similarity between two vein codes of the equal length is the number of position at which the corresponding symbols are different.

Hausdorff distance: This approach is the most common approach for pattern matching, it is very time-consuming in case of variation in position and rotation. Basically, Hausdorff distance is a natural measure to match the similarity of shapes between two objects to make matching more proficiently.

Histogram Intersection: Histogram Intersection calculates the similarity value between model and test data using histogram characteristic. E. C. Lee, et.al, [17] calculates a hamming distance which is used to match the enrolled codes with the extracted codes using the following-

$$LBP(X_c Y_c) = \sum_{n=0}^{7} S(i_n - i_c)2^n \qquad (1)$$

The Hamming distance is used as the dissimilarity measure between any two finger veins as represented by Eq. (2).

$$HD = \frac{\|(codeA \cup codeB) \cup codeA \cup codeB\|}{\|maskA \cup maskB\|} \qquad (2)$$

H. C. Lee, et.al, [18] explored an ID technique for finger vein designs utilizing a weighted LBP code dependent on SVM. While ascertaining the Hamming separation, we try to give different load to the LBP codes as indicated by the LA (Large sum), MA (Medium region), and SA (Small region). The HD is represented as-

$$HD = \frac{1}{N} \| W_i (codeA \otimes codeB) \| \qquad (3)$$

Where codeA and codeB are enrolled and the input codes, respectively, and ⊗ denotes an exclusive-OR operator.

V. CONCLUSIONS

After studying various research papers, we analyzed that palm vein recognition is a powerful biometric technique among all other techniques because the pattern of veins in the palm is complex and unique to each individual. Besides a number of palm vein recognition techniques are already been developed, there is as yet an extent of further enhancements. A new technique with higher accuracy, robustness and with more features will still be explored. In this paper, various biometric techniques are compared. The biometrics is becoming an advanced technology in the field of security though there are some problems with biometrics systems. The merits and demerits associated with each technique are listed in the Table II. Along with their applications and appropriate technique can be selected based on the application requirement.

TABLE II. A COMPARISON OF PHYSIOLOGICAL AND BEHAVIORAL BIOMETRIC TRAITS-[20] [21].

Modalities	Advantages	Disadvantages	Applications
Palm vein	1. High applicability 2. High user acceptance	1. Unfamiliar 2. Relatively expensive	1. ATM 2. Driver Identification 3. Financial and Bank Services
Face	1. The existing image capturing devices i.e. cameras can be used. 2. Convenience and Matured technology.	1. Need additional hardware 2. Will not work when using a mask or other face-covering veils.	1. Access Control Verification. 2. Human Computer Interaction.
Fingerprint	1. Small template size so matching is also fast 2. Popular	3. Easily deceived through artificial finger made of wax 4. Easily deceived through artificial finger made of wax	1. Authentication of Driver License. 2. Access control in organizations
Retina	1. Very quick Verification. 2. Cannot be forged	1. Most people suffering from severe eye illness 2. High cost special equipment for scanning	1. Security (FBI, CIA, and NASA) 2. Ophthalmological diagnostic
DNA	1. Provides the highest accuracy.	1. The processing time is very long. 2. No real time matching	1. Used in courts and law to prove guilt or innocence 2. Physical and network security.
Signature	1. Easy to restore the template if it is stolen. 2. Highly accepted	1. Signatures can be forged by the Professionals to deceive the system.	1. The First bank using Signature System.

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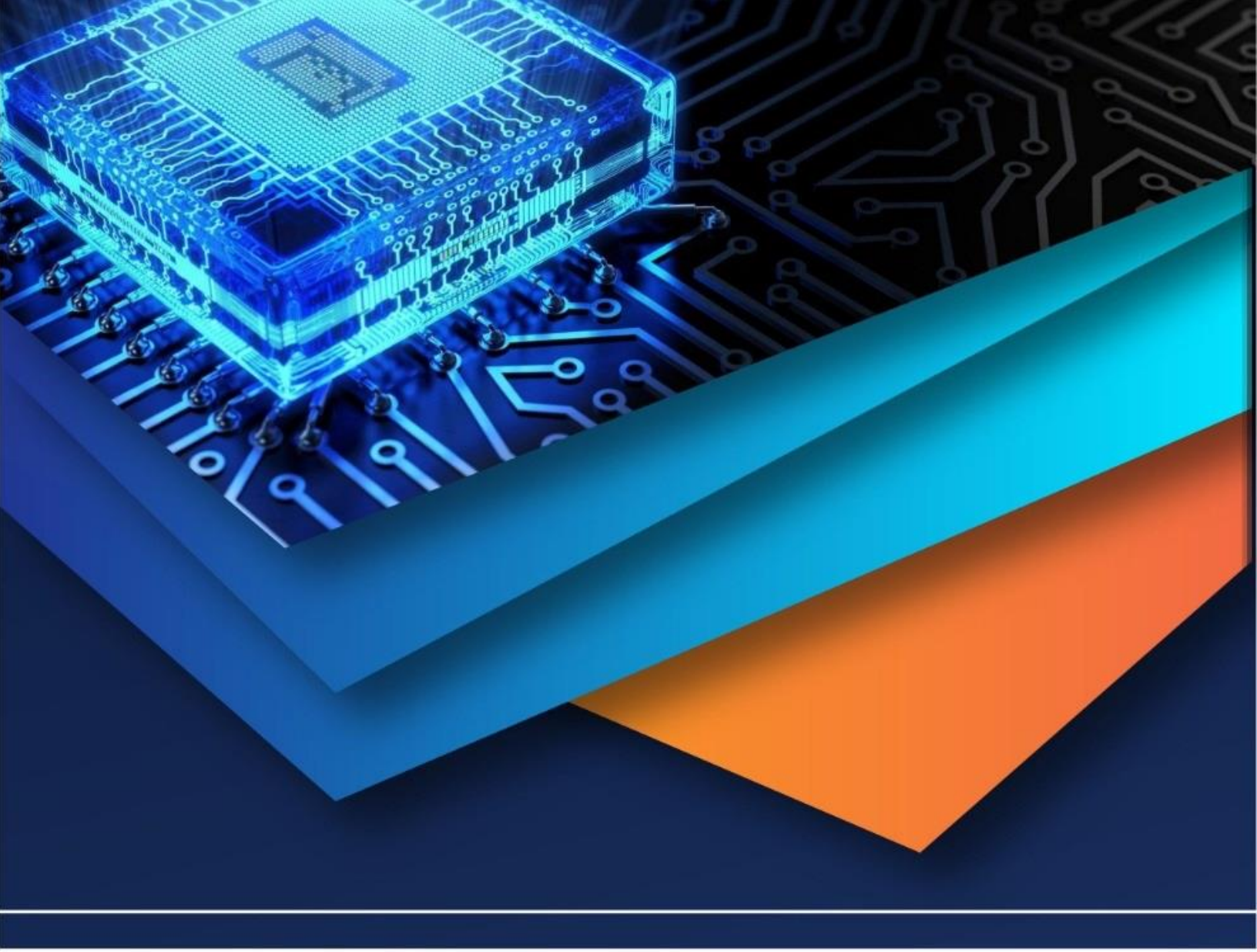

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