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Exploration of finger vein recognition systems

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Abstract
Finger vein recognition is a method that identifies an individual using the finger vein pattern. Finger veins are unique to an individual. The friction ridges which create finger veins are formed while inside the womb and grow proportionally as the baby grows; even identical twins have different finger veins. The era of biometrics has been going on, various authentication algorithms has been proposed for security purpose, as time and technology has improved. In this paper proposes an analysis of various Finger vein recognition systems. Some finger vein techniques are multi-image quality assessment, Deep learning, Back propagation neural network and Adaptive threshold. This paper gives a detailed proposal of the techniques that are used in the proposed systems of finger vein recognition technology and also future enhancement of the system.

Keywords: Biometrics, finger vein, deep learning, neural network, recognition

1. Introduction
Accurate recognition of human identity for security and control is a major issue of concern. Hence automatic authentication systems for control have found application in criminal identification, automated banking, etc. Biometric identification is the study of physiological and behavioural attributes of an individual to overcome security problems. There are several types of biometric techniques available such as finger print, palm print, hand veins, finger veins, palm veins, foot vein, iris, gait, DNA recognition, palates, voice recognition, facial expression, heartbeat, signature, body language, and face shape. The traditional authentication systems like identity card or password can be easily stolen or acquired by unauthorized person. All these traditional authentication systems are gradually replaced by biometric systems like finger prints, iris recognition, palm print and finger vein recognition.
Researchers focus on Finger Vein patterns as it is associated within body and hence it is difficult to spoof or forge the same under normal processing environment. The vein pattern is generally captured by the near-infrared light, as the light can be intensively absorbed by the haemoglobin in the vein but easily transmit other finger tissue. The resulting vein image appears darker than the other regions of the finger, because only the blood vessels absorb the rays. The capturing device can be a compact type, and easily installed in public and private places without any access to direct sunlight. A finger-vein identification system offers a guaranteed recognition process that is safe, simple and highly accurate. Fig.1 illustrated block diagram of finger vein recognition process.

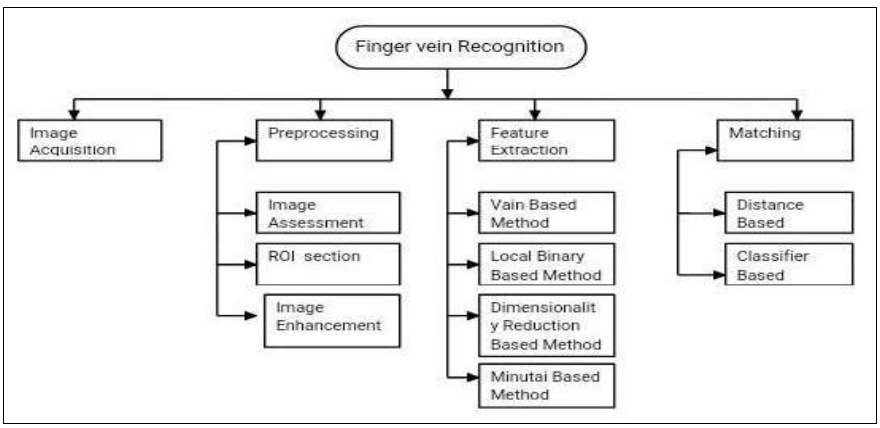

Fig 1: Block diagram of finger vein recognition

Finger vein is an excellent biometrical characteristic for human identification, as a new generation recognition feature, it has too many outstanding advantages:

- Its topological structure is unique.
- Its recognition accuracy rating is pretty high.
- Its obtained only in living body.
- It's located in body and difficult to steal.

For all the reasons as above, finger vein recognition has attracted the attention of increasing researchers recently.
In addition, vein recognition technology has the following features

1. Non-contact
2. Identification of living body
3. High Security and
4. Small device size

The comparison between different biometric system is as shown in Table 1:

Table 1: Comparison of biometrics method

Biometric	Security	Accuracy	Speed	Cost	Sensor
Face	Normal	Normal	Normal	Low	Non-Contact
Finger print	Good	Normal	Normal	Low	Contact
Iris	Excellent	Good	Normal	High	Non-Contact
Vein	Excellent	Good	Good	Low	Non-Contact

In this Paper section-II Fundamental functions of finger vein Biometrics topics to be discussed. In section-III various recognition techniques are explained. In section-IV performance evaluations are discussed and finally conclusion and future scopes are addressed.

2. Finger vein biometrics

Finger vein acknowledgment is an interaction where in an individual's finger vein designs are utilized as a reason for biometric validation. Pictures are taken of one's finger vein examples and afterward confirmed through design acknowledgment strategies. It has late acquired consideration and favour attributable to its high verification exactness, to such an extent that it has gotten wide acknowledgment as a safety effort in banks. This cycle is generally viewed as more secure than unique mark acknowledgment, as it can't be imitated or tricked since the example is stowed away from see. The techniques involved in the process of finger vein recognition is explained as follows.

A. Image acquisition

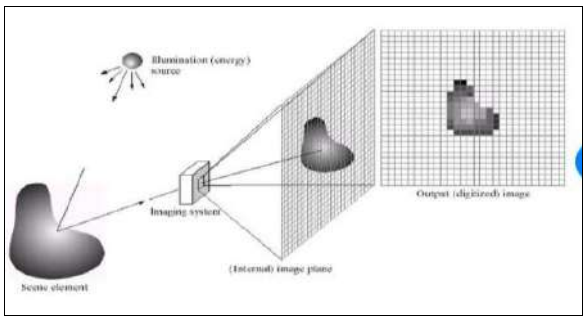

Fig 2: Image acquisition model

Picture securing is the primary essential advance in Finger vein recognition in which the finger vein picture is caught by utilizing NIR (close infra-red) light in the brightening exchange strategy. The procurement gadget comprises of a NIR get together part for position of the finger, and a charge-coupled gadget (CCD) pre-processor camera is then used to acquire a picture of the finger vein. The NIR light can go through a finger however haemoglobin in the blood can ingest more NIR light than different tissues (like bones and muscles). At the point when the vein of a finger retains infrared light, the picture of the finger vein can be gained as a dim line. NIR imaging is secure in light of the fact that it goes through the finger to catch the pictures. Three strategies are for the most part utilized for finger vein picture securing: light transmission technique, light reflection strategy and two-way transmitting strategy. In Fig.2Illustrate image Acquisition Model.

B. Pre-processing

The target of picture pre-processing is to give a vigorous Region of Interest (ROI) picture for highlight extraction. Great execution of a finger vein picture relies upon the finger vein picture quality. The finger vein picture normally comprises of commotion, shades and low difference. This is a result of light vacillation, a rotational and translational variety of the finger and furthermore the exhibition of the catching gadget. The pre-processing step is applied to mitigate these issues.
The three common pre-processing stages are

a. Image quality assessment
b. Region of interest (ROI) extraction, and
c. Normalization and enhancement

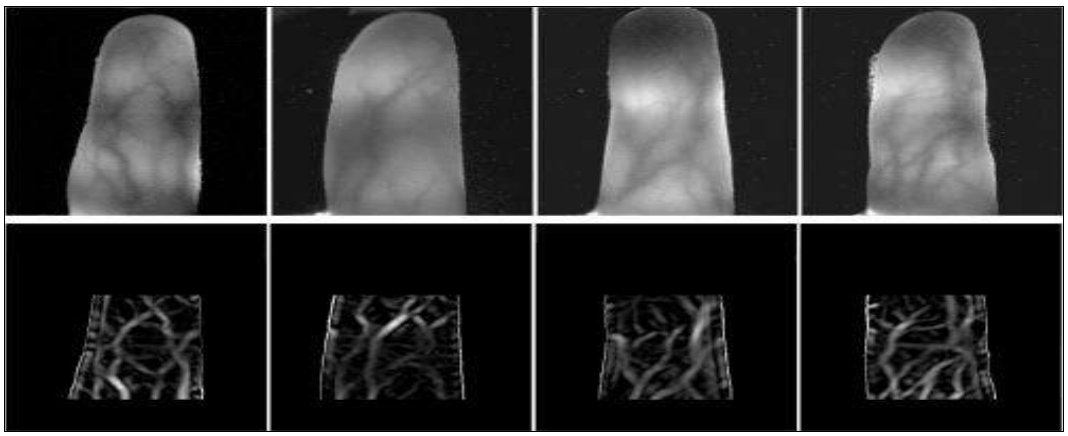

Fig 3: Finger vein images

C. Image enhancement

The essential objective of picture upgrade is to propel the interpretable or information on data in pictures for human watchers or to get the standard improved picture from the hazy obtained picture. In finger vein acknowledgment, picture improvement is needed to improve coordinating with execution. Improvement of a finger vein picture essentially centres around contrast upgrade and commotion expulsion. In Fig.3 Illustrate Finger vein Images.

D. Feature extraction

Highlight extraction addresses perhaps the most essential and significant strides of FVR. During this progression, the quantifiable property of the fundamental biometric characteristic is made, called the format, which is useful for distinguishing the person. For instance, in a unique finger impression biometric framework, position and direction of details focuses in a finger impression picture is the key element which should be not the same as someone else. A productive element extraction strategy is a stage which upgrades the accuracy of finger vein acknowledgment. In Fig. 4 Illustrate Finger vein extracted images.

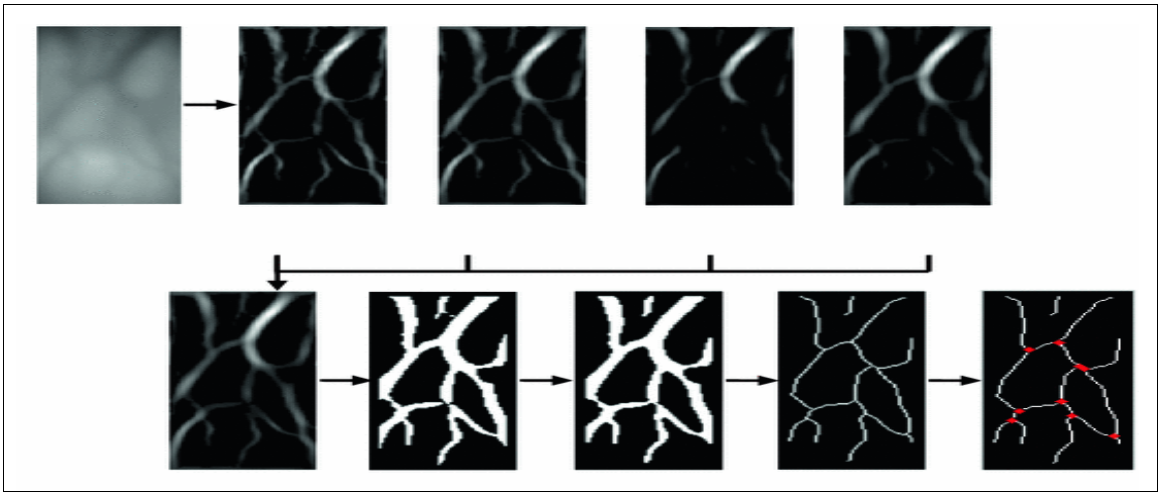

Fig 4: Finger vein extracted images

E. Matching

The matching technique is the last step of recognition to decide whether an input image is genuine or an imposter for one enrolled image, in which a matching score is generated. A matching score measures the likeness between the enrolled template and the input image.

3. Literature survey

A. New verification strategy for finger-vein recognition system

A finger vein recognition system is the proposed system that utilizes a binary robust invariant elementary feature which is extracted from accelerated segment test feature points and this system uses an adaptive thresholding strategy. For second stage verification, the proposed system applies the technique, a Multi-image Quality assessment (MQA). The recognition system uses MQA process for an efficient feature points matching with robust feature and rigorous verification. The computation time of this system is reduced.

The system explains about a verification system that combines a POHE algorithm with a feature point-based method along with MQA voting strategy. An adaptive FAST algorithm extracts the corner coordinate from its features and by using BRIEF patch, a feature point descriptor in generated. This gives bit string features. The number of matched descriptors are evaluated by feature point matching process. It also verifies the homography matrix. For effective verification, MQA voting strategy will give a second stage verification. This system reduces the complexity of computation, by ROI normalization process, in which it does not require any morphological operation. By experimenting the proposed system with public data base, it provides the great EER value as 0.13%. The EER indices also gives the state-of-the-art systems.

B. A study of finger vein biometric for personal identification

In this paper author, describes how the image quality is enhanced by eliminating the flows by worse light effects and web camera noise is eliminated. The vein pattern is segmented using adaptive threshold method and it is matched with template matching. The results conclude that as long the vein is clear, the image quality is good. Hence 100% identification accuracy is still need to be considered. Basically, for biometric purposes, the images are captured from CCD camera or any high-quality camera but here web camera is used in this paper. Hence the image quality depends on the clearance of the vein patterns. For biometric personal identification suit devices are used to penetrate through veins and then the web camera captures the images of veins. The results achieved as follows, 0% of FAR, 0.275% of FRR and identification rate is up to 100%. The response time of this biometric device is good as it responses at less than 0.5. The future enhancement of the paper concentrates on the quality of the image, so that high quality cameras are needed and also incorporating this system with various algorithm increase the accuracy of identification and to identify shrinked veins and unclear vein patterns.

C. Finger vein pattern learning models and techniques - A study

Finger Vein Pattern (FVP) learning play a major role for security purposes as authentication and validation. This paper, author explains about the structural and linear approaches of finger vein techniques and also brief about finger vein matching and processing algorithm. This Finger

Vein Patterns are unique and the accuracy level for matching is up to 0.35% to ratio in similar and with spoofing ratio. This paper is a documented protocol which is surveyed under linear method approach.

D. Finger vein recognition based on deep learning

In recent days finger vein recognition has become a new era for biometric technology. Deep learning is an end-to-end system and by using deep learning great results are achieved in fields like face recognition and target detection. Here this paper uses finger vein recognition with the help of deep learning. The CNN layers that need in this technique in seven layers in which it also includes five convolution layers and two fully connected layers act of seven layers. The result achieved for vein recognition is about 95.53% with better performance by comparing with existing algorithm. The future works that are planned into cultivate more ideas of CNN technique for finger vein recognition.

E. Review on finger vein authentication system by applying neural networks

Biometric technologies are used for recognizing a person with their biological and behavioural characteristics. Identification of human, automatically has become more difficult nowadays. It should be reliable and convenient. This proposed system captures the image of finger vein with the help of infrared light and identifying the authorized person by training the images with Back propagation Neural Networks (BPN). This system can be used in applications like authentication purposes in door access control and in e-banking operations to provide greater security.

F. Finger vein recognition based on Gabor filter

This paper aim for finger vein images includes a plurality of lines and regarded as a type of texture image. The better recognition result proposed in finger vein images for use of 2D Gabor filter process. Euclidean distance matching is performed. This paper testing results demonstrate the effectiveness of this method. This paper proposed a finger vein recognition algorithm based on Gabor filter. This algorithm used by utilizes a filter in different directions on the normalized image and then extracts feature values from the image after filtering. The Euclidean distance of the feature values then determine the matching level between two images by comparing. The testing show that the algorithm has a high recognition rate of 0.79% Equal Error Rate, this is more accurate than the results of existing algorithm.

4. Performance analysis

Performance is an important way to recognize whether these algorithms are good or not. The following various performance metrics are, Receiver Operating Characteristic curve (ROC) instinctively addresses the harmony between False Accept Rate (FAR) and False Reject Rate (FRR). The threshold is utilized to settle on a choice of the matching algorithm. If the threshold is reduced, FAR or false match rate (FMR) increased and FRR or False Non-Match Rate (FNMR) decreased. Additionally, the higher limit expands the FRR or FNMR and diminishes the FAR or FMR. Equal error rate (EER) value can be simply attained from Receiver Operating Curve (ROC). The lower the EER, the better the framework works. Fail to enroll (FTE) rate indicates the proportion of users that cannot be successfully enrolled in a finger vein recognition system, and Fail to acquire (FTA) or Fail to capture (FTC) is the error in which the finger vein biometric sensor cannot capture the sample [7].

Table 2: Performance Metrics

Ref	Paper	Performance
1	New verification strategy for Finger-Vein Recognition	Method-Multi-image Quality assessment (MQA) User-Public data base EER Value-0.13% Future work-Liveness detection
2	A Study of finger vein Biometric for Personal Identification	Method-Adaptive threshold FAR-0%, FRR-0.275% Identification rate-up to 100% Response time-Less than 0.5s
3	Finger vein Pattern Learning Models and Techniques-A Study	Method-Structural and Linear approaches Accuracy rate-0.35%
4	Finger Vein Recognition Based on Deep Learning	Method-Deep Learning Recognition rate-95.53%
5	Review on finger vein Authentication system by applying Neural Networks	Method-Back propagation Neural Networks (BPN)
6	Finger Vein Recognition Based on Gabor Filter	Method-Euclidean distance matching Recognition rate-0.79% Equal Error Rate

5. Conclusion

In this paper presents an analysis of different techniques of finger-vein recognition for biometric authentication and identification. It gives the fundamental principle, various finger vein techniques and performance evaluation metrics. The recent work in literatures and commercial utilization experiences, different Finger-vein recognition Techniques offer different levels of performance parameter such as Recognition rate, Equal error rate, Response time, FAR and FRR.

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