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Finger Vein Recognition System-A Review

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Abstract
In today's world, personal information security is major topic of concern. In this regard many advanced techniques are used but still in all of those biometric is most reliable. Biometric identification is the study of physiological and behavioural attributes of an individual to overcome security problems. This system includes human finger, vein, iris, hand and many other as its identifiers. Biometric system using finger-vein as one of its traits is most widely accepted. The finger vein technology is different for each individual and even it is different for the twins. This paper reviews the various method of feature extraction in finger vein recognition. Most of the existing work is functionally described and compared in three parts i.e., Finger vein image acquisition, pre-processing and feature extraction.
Keywords: *Biometrics, Finger vein, Feature extraction, Matching,Recognition*

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I. INTRODUCTION:

In modern world,the fast development of internet and increase of threats on citizens and access control areas, identifying a person is becoming key to protect privacy and property. Unlike traditional identification means such as keys and passwords, behavioural and physiological biometrics (e.g., fingerprints,face, iris, signature are difficult to steal or copy and cannot be lost.Several types of biometric techniques have been presented based on these anatomic/behavioural features such as fingerprint, 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 Biometric authentication has been widely investigated and successfully applied for personal identification.Physiological biometric modalities can be either (a) extrinsic, e.g., face, fingerprint, palm print, and iris, or (b)intrinsic, e.g., finger-vein, hand-vein and palm-vein. Extrinsicmodalities are prone to spoof attacks at the sensor level. Forexample, it is quite easy for an attacker to produce a fakeversion from a stolen fingerprint template. The verificationsystem itself can be attacked by scanning the fake finger.Therefore, extrinsic biometric modalities raise serious problemson privacy and security in practical applications. Unlikeextrinsic modalities, intrinsic ones are under the human skinwhich makes them very difficult to steal and forge, and thusmuch more secure. Among intrinsic modalities, finger-veinbiometrics is the most convenient in practical applications.

In this Paper section -II Finger vein system to be explained. In section-III various recognition techniques are analysed. In section-IV performance evaluations are discussed and finally conclusion and future scopes are addressed.

II. FINGER VEIN SYSTEM:

Finger vein based biometric system has several benefits when compared with other hands based biometric methods. First, the finger vein pattern is hard to replicate since it is an internal feature. In addition, the quality of the captured vein pattern is not easily influenced by skin conditions. Fig.1 illustrate functional diagram of finger vein system.

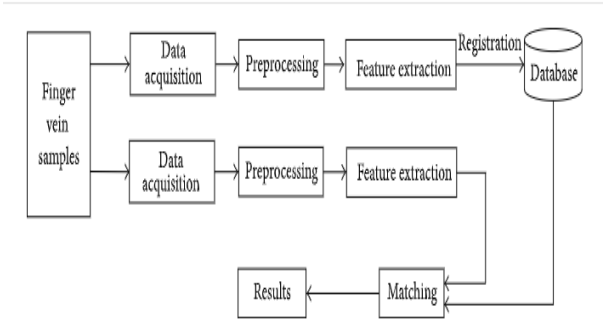

Fig.1.Functional diagram of Finger vein system

i. Finger vein sample:

The finger vein data are collected from both public data base and typical data base. There are many finger vein public databases such as SDUMLA-HMT, HKPU-FV,UTFV , MMCBNU_6000 , THU-FV, FV-USM University developed their finger vein database called (HKPU-FV), which consists of finger vein and low texture images. In 2010, Shandong University released one multimodal trait database SDUMLA-FV. The second data base HKPU-FV was developed by Hong Kong Polytechnic University.The third database UTFV is presented by University of Twente. In the recent past, two finger vein databases, THU-FV and MMCBU_6000 , were published by Tsinghua and Chunbuk Nation University respectively. All these public databases provide more than 100 subjects of finger veins, except UTFV database which provides 60 subjects. FV-USM was the infrared finger vein image dataset which was developed by University Sains Malaysia in 2013. In 2014, the VERA database was produced by the Idiap Research Institute in Martigny and Haute EcoleSpecialisee de Suisse Occidentale in Sion, in Switzerland.Fig.2 illustrate finger vein sample images.

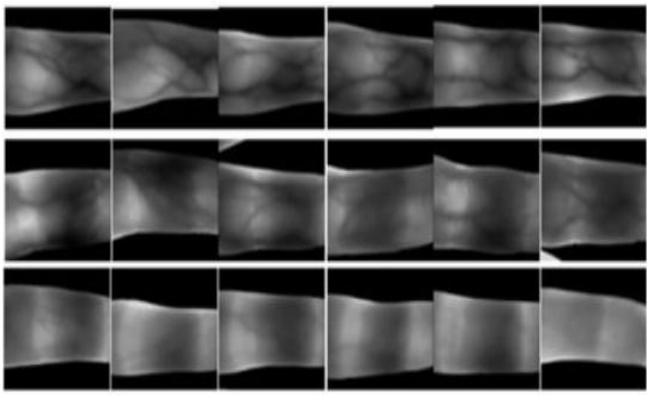

Fig.2.Finger vein sample

ii. Data Acquisition:

The Data acquisition device consists of an NIR(Near Infra-Red) assembly part for placement of the finger, and a charge-coupled device (CCD) pre-processor camera is then used to obtain an image of the finger vein. In image acquisition, there arethree methods are mainly used: light transmission method, light reflection method and two-way radiating method.Among these methods, a high contrast image is captured using the transmission method, therefore most of finger vein imaging devices employ the light transmission method.

iii. Pre-processing:

The aim of image pre-processing is to provide a Robust Region of Interest (ROI) image for featureextraction. Acceptable performance of a finger vein image depends on the finger vein image quality.The finger vein image normally consists of noise, shades and low contrast. This is because of light fluctuation, a rotational and translational variation of the finger and also the performance of the capturing device. The pre-processing step is applied to reduce these problems.

iv. Feature Extraction:

Feature extraction is one of the most important major steps of finger vein recognition. It has different methods and different parameters can be used. Principally all these methods are divided into three categories they are dimensionality reduction based, local binary based and vein based.Dimensionality reduction is a process used for feature reduction which transforms image from higher dimension to lower dimension. Local binary based method presents the extracted feature in binary format, various techniques used for this are

personalized best bit maps (PBBM), local directional code (LDC), personalized weight maps (PWM) and local binary pattern (LBP). In Vein based method, at first segmentation of vein pattern is done and then the topological structure or geometric shape of vein pattern is used for matching purpose.Fig.3 illustrate feature extracted images.

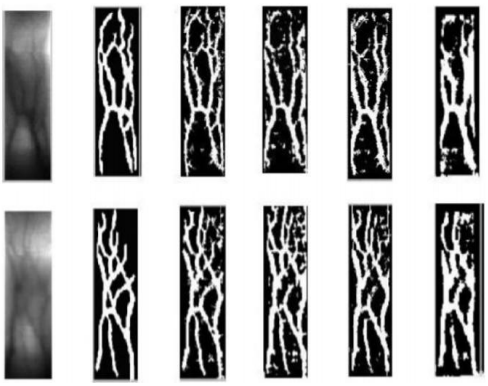

Fig.3.Feature extracted images

v.Matching:

In the matching process, the extracted pattern is converted into matching data, and these data are compared with recorded data.

Properties of Finger vein:

The vein images of most people remain unchanged despite ageing. Hand and finger vein detection methods do not have any known negative effects on body health. The condition of the epidermis has no effect on the result of vein detection.Vein features are difficult to be forged and changed even by surgery. These desirable properties make vein recognition a highly reliable authentication method.

III. III.LITERATURE SURVEY:

A. LOW-COST MULTI-FINGER VEIN VERIFICATION SYSTEM

The Multi-Finger Vein Verification System has more advantages of its accuracy and security. However, almost all existing finger vein systems scan only one finger at a time, which may not be a reliable solution for more secure applications that require higher verification accuracy and reliability. In this work, author proposed a new multi-finger vein capture system that can capture three different fingers simultaneously in a single capture instance. The proposed sensor is based on the total internal reflection structure that can uniformly emit the light across all three fingers to improve the visibility of the finger vein pattern.The developed finger vein sensor is operated and verified by captured images of 20 unique identities and 600 finger vein images. Four different state-of-the-art verification algorithms are used to review the suitability of captured images for biometric applications. The results are compared and using data from various digital veins, and the availability of combining score levels to improve performance is also introduced. The results reported in this article support the expected improvement in multi-digital vein verification performance [1].

B. BIOMETRIC PERSONAL IDENTIFICATION SYSTEM BASED ON PATTERNS CREATED BY FINGER VEINS

This article author proposed a biometric system based on the recognition of the finger vein identification. The system uses a database of human index finger images collected in the infrared range. In this proposal, Sobel detector, enhancement filter and binarization process have been applied to obtain the vein pattern. The test result reached the equal error rate of 27.56%, with a false acceptance rate of 0% and a Genuine acceptance rate of 100% [2].

C. RESEARCH ON THE FINGER VEIN IMAGE CAPTURE AND FINGER EDGE EXTRACTION

Finger vein recognition technology has characteristics such as live capture, stability, difficulty of theft and imitation, etc., which is a new technology of biometric authentication, and has a wide range of application spaces in the field of information security. However, the quality of finger vein image capture and the accuracy of finger vein extraction are directly related to the accuracy of recognition. Depending on the requirements of finger vein capture principles and applications, finger vein image capture devices and algorithms can be designed to capture finger vein images quickly and accurately. For the background area of the finger vein image that affects the extraction and recognition of vein features, author propose a finger area extraction algorithm according to the edge characteristics of the finger image that can accurately extract the finger area in the

background. Through other finger tests, the device can capture clearer finger vein images to obtain a more accurate finger vein area [3].

D.REVIEW OF PERSONAL IDENTIFICATION BASED ON NEAR INFRARED VEIN IMAGING OF FINGER

Finger vein identification system has the advantages of high efficiency, stability, concealment and so on. It hasa new cutting-edge topic in biometric generation technology. This article reviewed the methods and steps of 2D and 3D finger vein recognition systems. The paper begins with the stages of finger vein recognition, the following four stages: image acquisition, pre-processing, extraction and vein matching are introduced. Meanwhile, summarizes the methods used by scholars from all walks of life. Then, evaluation of the finger vein system activity is introduced. Finally, present existing problems of technology and focus on forecasting future development trends [4].

E. A STUDY ON THE INDIVIDUALITY OF FINGER VEIN BASED ON STATISTICAL ANALYSIS

In this paper author proposed score level fusion strategy. The major importance of study is to verify the individuality of finger vein.In this research author construct a large-scale finger vein data base consisting of 718,399 finger vein images form 363,703different fingers. In this design also compared distributed computing system for more than 83 billion imposter comparisons. The results demonstrated that finger vein from different fingers, at a scale of 300 thousand, could be perfectly distinguished with a fusion of two reliable algorithms.In future study, analyse the alternative fusion strategies to get a lower FNMR and greater time efficiency. In addition, specific attention could be paid to distinctiveness between twins and family members, who are considered of great similarity in physical and behavioural characteristics [5].

F. BIOMETRIC RECOGNITION FOR SAFE TRANSACTION USING VEIN AUTHENTICATION SYSTEM

The most securable biometric system must identify the person based on their physiological or behavioural characteristics. Today, security has become the most important aspect of the world, which is why most countries use biometrics as a tool. Vein technology is a rapidly developing technology today and veins can be worn under a person's skin. Finger veins are drawn from patterns that exist within the skin, so compared to finger and facial biometric technology, the authentication rate is high. Two important methods for imaging finger veins are the contact method and the non-contact method. Non-contact methods are becoming popular with people around the world. Contact information is like fingerprint registration technology. Among biometrics, finger vein technology encourages researchers to develop more applications [6].

IV. PERFORMANCE EVALUATION:

Many different aspects of human physiology, chemistry or behaviour can be used for biometricauthentication. The selection of a particular biometric for use in a specific application involves a weighting of several factors.The finger vein recognition is considering various performance evaluation metrics.The following are used as performance metrics for biometric systems:

- **Equal error rate** or crossover error rate (EER or CER): The rate at which both acceptance and rejection errors are equal. The value of the EER can be easily obtained from the ROC curve. The EER is a fast way to compare the accuracy of devices with different ROC curves. In general, the device with the lowest EER is the most accurate.
- **Genuine Acceptance Rate:**It is the percentage of times a system correctly verifies a true claim of identity.
- **False match rate** (FMR, also called FAR = False Accept Rate): The probability that the system incorrectly matches the input pattern to a non-matching template in the database. It measures the percent of invalid inputs that are incorrectly accepted. In case of similarity scale, if the person is an imposter in reality, but the matching score is higher than the threshold, then he is treated as genuine. This increases the FMR, which thus also depends upon the threshold value.
- **False non-match rate** (FNMR, also called FRR = False Reject Rate): The probability that the system fails to detect a match between the input pattern and a matching template in the database. It measures the percent of valid inputs that are incorrectly rejected.
- **Receiver operating characteristic** or relative operating characteristic (ROC): The ROC plot is a visual characterization of the trade-off between the FMR and the FNMR. In general, the matching algorithm performs a decision based on a threshold that determines how close to a template the input needs to be for it to beconsidered a match. If the threshold is reduced, there will be fewer false non-matches but falser accepts. Conversely, a higher threshold will reduce the FMR but increase the FNMR. A common variation is the

Detection error trade-off (DET), which is obtained using normal deviation scales on both axes. This more linear graph illuminates the differences for higher performances (rarer errors).

- **Failure to enroll rate** (FTE or FER): The rate at which attempts to create a template from an input is unsuccessful. This is most commonly caused by low-quality inputs.
- **Failure to capture rate** (FTC): Within automatic systems, the probability that the system fails to detect a biometric input when presented correctly.
- **Template capacity**: The maximum number of sets of data that can be stored in the system.

TABLE I
Performance evaluation of various finger vein system

Ref	Paper	Performance
[1]	Low-cost Multi-Finger Vein Verification System	Method:multi-fingervein capture system Images:20 unique identities(subjects)with 600 fingervein images Algorithm: MCP-CRC (Maximum Curvature Pattern) EER:0.78%
[2]	Biometric personal identification system based on patterns created by finger veins	Method: Sobel detector,enhancement filter and a binarization process EER: 27.56% TEER:0.01683 Genuine Acceptance Rate:100% False Acceptance Rate:0%
[3]	Research on the Finger Vein Image Capture and Finger Edge Extraction	Method: Adaptive finger edge extraction
[4]	Review of Personal Identification Based on Near Infrared Vein Imaging of Finger	Method:2D and 3D finger vein recognition system
[5]	A Study on the Individuality of Finger Vein Based on Statistical Analysis	Method: Score level fusion strategy EER: A algorithm-0.45%, B algorithm-0.12% Database:718,399 finger vein images form 363,703 different fingers
[6]	Biometric Recognition for safe Transaction using Vein Authentication System	Method: Contact and non-contact

V. CONCLUSION:

In this paper provides a survey of Finger vein based biometric verification system. The proposed method for obtaining a finger vein pattern works on processing the input digital image and gets a final image in which it is shown a characteristic pattern. This paper comments that using highly secure authentication principle of finger vein authentication, any system utilizing finger vein recognition process can improve customer identity and data security.

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