“AUTHENTICATION USING FINGER VEIN RECOGNITION”

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Objective: This project aims at developing a system for acquiring images of finger veins and processing them using MATLAB for the purpose of authentication. It includes designing of hardware for image acquisition, coding the matching algorithm for processing the finger vein pattern and training and testing of algorithm module.

Motivation: Security is a major concern in today’s world due to the increased rate of crimes and identity thefts. To overcome this problem there is a great need for efficient authentication and authorization systems. Among the many authentication systems that have been proposed and implemented, finger vein biometrics is emerging as the foolproof method of automated personal identification. Finger Vein is a unique physiological biometric for identifying individuals based on the physical characteristics and attributes of the vein pattern in the human finger.

Introduction:

Unlike other conventional biometric features such as face, iris, finger print, palm print, hand shape, voice and signature, finger vein patterns do not leave any traces or information that can be used to duplicate the biometric data. As finger veins exist beneath human being’s skin, they are completely hidden and unexposed even during the authentication process. The finger vein pattern can only be taken from a live body. The vein images of most people remain unchanged despite ageing and cannot be changed even by surgery. The condition of the epidermis has no effect on the result of vein detection. Hand and finger vein detection methods do not have any known negative effects on
body health. It is therefore, impossible to steal or copy the biometric patterns by photography or video recording, which makes it extremely difficult to duplicate the biometric data. These desirable properties make vein recognition a highly reliable authentication method.

**Methodology:** The system consists of the following hardware modules:

The image acquisition module consisting of a camera and LED’s is used to collect finger-vein images. The DSP main board including the DSP chip is used to execute the finger-vein recognition algorithm, memory (flash), and communication port is used to communicate with the peripheral device. The authentication unit includes a CPU core for all sorts of signal processing, video I/O for capturing data from the image sensor, LED power controller, and I/O controller.

There are five stages in finger vein authentication:

1. Capture of the finger vein image pattern
2. Segmentation and alignment of the image.
4. Feature pattern extraction from the image
5. Pattern matching and outcome decision.

**Block Diagram:**
Flow chart:

![Flow chart diagram](image)

Working Principle:

To obtain the pattern for the database record, an individual inserts a finger into an attester terminal containing a near-infrared LED (light emitting diode) light and a monochrome CCD (charge-coupled device) camera. Vein object extraction is the first crucial step in the process. The aim is to obtain vein ridges from the background. Recognition performance relates largely to the quality of vein object extraction. The standard practice is to acquire finger vein images by use of near-infrared spectroscopy. When a finger is placed across near infra-red light rays of 760 nm wavelength, finger vein patterns in the subcutaneous tissue of the finger are captured because deoxygenated hemoglobin in the vein absorb the near-infrared LED light rays. The resulting vein image appears darker than the other regions of the finger, because only the blood vessels absorb the rays. The extraction method has a direct impact on feature extraction and feature matching. Therefore, vein object extraction significantly affects the effectiveness of the entire system. After vein image extraction, comes segmentation. The camera records the image and the raw data is digitized, certified and sent to a database of registered images. For authentication purposes, the finger is scanned as before and the data is sent to the database of registered images for comparison. The ID verification process is very fast and contactless. Using a light-transmission technique, the structure of the vein pattern can be detected, captured and subsequently verified.
**Pre-Processing:** Several pre-processing techniques used in finger vein authentication. The proposed algorithm consists of:

- Segmentation.
- Aligning the finger horizontally.
- Image enhancement using contrast limited adaptive histogram equalization.
- Image normalization.
- Region of interest (ROI) extraction.

**Segmentation:** The image acquired during image acquisition has other information besides the finger vein region. This reduces the accuracy of the finger vein authentication algorithm. To increase the accuracy, we first make the background of the image black by setting those background pixels to zero.

**Alignment:** The main problem we may encounter in taking images is trying to keep a subject’s hand in place without movement. While capturing the images, there is a possibility that the user may tilt his/her finger a little to the right or left. As a solution to this problem, we can either keep a tube-like structure in the hardware or align the images in the software algorithm. The edges are detected and the image is rotated such that the detected edges are now horizontal.

**Image Enhancement:** Image enhancement operation improves the quality of the image. It can be used to improve the image contrast, and brightness characteristics, reduce its noise content, and/or sharpen its details. In our project, this step is used to highlight the finger vein network pattern in order to increase the accuracy of the algorithm. In this work, contrast limited adaptive histogram equalization (CLAHE) is used to enhance the image. By using this method, the finger vein network pattern is much clearer and contributes to a higher accuracy.

**Image Normalization:** The position of fingers usually varies according to different finger-vein images. So it is necessary to normalize the finger-vein images before feature extraction and matching. In order to achieve high accuracy for finger vein authentication algorithm, the original image is normalized into smaller size. This step is simple. The image is resized to 1/4th of the original size. This is the optimum scaling factor, which is obtained from the experiment of the vein image database for various scaling factor. Moreover, processing speed is also reduced with the scaling factor. It is also advised to divide the image with the maximum intensity level of that image.
**ROI Extraction:** In the finger images, there are many unwanted regions (that cannot be taken for analysis) has been removed by choosing the interested area in that image. The image has the black unwanted background. Including the background reduces the accuracy of the algorithm. Therefore, the original image is extracted from the undesired background. A special algorithm is developed to extract the finger vein image from the background. The useful area is said to be “Region of Interest (ROI)”.

**Feature Extraction:**

**Local Binary Pattern:** The local binary pattern (LBP) operator is an image operator which transforms an image into an array or image of integer labels describing small-scale appearance of the image. These labels or their statistics, most commonly the histogram, are then used for further image analysis. The most widely used versions of the operator are designed for monochrome still images but it has been extended also for color (multi-channel) images as well as videos and volumetric data.

- In LBP, a window is placed on each pixel in the image
- The intensity of the center pixel is compared against that of the neighboring pixels.
- After comparison, bigger intensity values are taken as 1 and smaller values as 0.
- Interpreted as binary numbers and histogram of their corresponding decimal values are used as descriptors in LBP.

**Principal Component Analysis (PCA):**

Principal Component Analysis, or simply PCA, is a statistical procedure concerned with elucidating the covariance structure of a set of variables. In particular it allows us to identify the principal directions in which the data varies.

- PCA is a method of data compression.
- It uses less data in “b” to represent “a” but retain important information.
- The task is to identify the N important parameters.
- So recognition is easier.

\[
a = \begin{bmatrix}
a_1 \\
a_2 \\
\vdots \\
a_N \\
\end{bmatrix} \rightarrow b = \begin{bmatrix}
b_1 \\
b_2 \\
\vdots \\
b_K \\
\end{bmatrix}, \text{where } N > K
\]
Support Vector Machine (SVM): Support Vector Machines are statistical classifiers with three main features:

- Discovery of the hyper plane that produces the greatest statistical separation between two classes.
- Projection of feature space into a higher dimensional feature space so that hyper plane separation is possible.
- Use of different kernels (the most common are Radial Basis Function, Linear, and Polynomial) to produce the projection into higher dimensional feature space.

Support vector machine is a machine learning method that is widely used for data analyzing and pattern recognizing. A classification task usually involves separating data into training and testing sets. Each instance in the training set contains one “target value” (i.e. the class labels) and several attributes (i.e. the features or observed variables). The goal of SVM is to produce a model (based on the training data) which predicts the target values of the test data given only the test data attributes.

Hardware requirements:
- Interface- USB1.1 or RS-232C
- CCD Camera
- Infrared LED lights
- CPU

Software Requirements:
- Matlab.

Applications:
- ATM
- Keyless engine starters
- Financial institutions
- Immigration
- Entry control
Conclusion:

The project is a finger vein based user recognition system for biometric authentication and identification. The system provides effective and efficient features using LBP and PCA algorithm which is been implemented on MATLAB platform. The classifier implemented is SVM classifier which gave an accuracy of 96% when run real time and an accuracy of 70% for the database images. The accuracy can be further improved by considering the light exposure factor in the implemented hardware.

It is also computationally efficient with minimal storage requirement, which makes the method of practical significance. However there are still problems of non-recognition and false recognition. Besides, pre-processing is an important requirement for this method and the accuracy of pre-processing influences recognition result significantly. In view of this, further research will be done on the pre-processing method, to improve the image quality and the accuracy of feature extraction, and subsequently improve system reliability.

Finger-vein based identification technology has high security and reliability compared to the traditional authentication mode. It also can be applied in public or private equipments, such as entrance control systems, home or office door entry control systems, and ATM (Automated Teller Machine) systems.