Finger – Vein Biometrics

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*Abstract*—

This paper presents an overview of finger vein biometrics, a novel biometric authentication technique that uses the pattern of blood vessels in a person's fingers to verify their identity. The paper describes the technology behind finger vein biometrics, its advantages over other biometric authentication methods, and its applications in various industries. The limitations and challenges associated with the use of finger vein biometrics are also discussed. Overall, finger vein biometrics is a reliable and secure biometric authentication technique with potential applications in access control, financial transactions, healthcare, and other fields.

# ***Keywords: finger vein biometrics, biometric authentication, access control, security, near-infrared, unique pattern, database, hygienic, limitations, applications.***

# Introduction (*Heading 1*)

Finger vein biometrics is a technology used for personal identification and authentication based on the unique patterns of veins in a person's finger. Unlike other biometric modalities such as fingerprints or facial recognition, finger vein patterns are located beneath the skin surface and are therefore difficult to forge or replicate. This technology works by using near-infrared light to capture images of the blood vessels in the finger, which are then processed and compared against a pre-existing database of vein patterns to confirm the identity of the user.

Finger vein biometrics has gained popularity in recent years due to its high accuracy, security, and convenience. It is widely used in various applications such as access control systems, time and attendance systems, and payment systems. Finger vein biometrics is also becoming more accessible and affordable, making it an attractive option for businesses and organizations of all sizes.

However, like any biometric technology, finger vein biometrics also has its limitations and challenges. These include issues related to user acceptance, privacy concerns, and the need for standardized testing and evaluation procedures. Nevertheless, finger vein biometrics remains a promising technology with a lot of potential for future developments and improvements.

# Background

## Finger Vein Biometrics Technology

Finger vein biometrics is a technology that uses the unique patterns of veins inside an individual's fingers for authentication and identification purposes. The technology is based on the principle that the vein pattern in each finger is unique to an individual and is difficult to replicate, making it a highly secure biometric identifier.

The image acquisition process in finger vein biometrics involves the use of near-infrared light to illuminate the finger. The light penetrates the skin and is absorbed by the hemoglobin in the veins, creating a unique pattern that is captured by an imaging device. The captured image is then processed using various algorithms to extract features, such as bifurcations, endpoints, and cross-points, which are used for matching and identification.

## Advantages and Limitations

Finger vein biometrics has several advantages over other biometric technologies. Firstly, it provides a high level of accuracy and security due to the uniqueness of the vein pattern. Secondly, it is non-invasive and does not require physical contact, making it more hygienic and convenient than technologies such as fingerprint and iris scanning.

However, finger vein biometrics also has some limitations. The technology can be impacted by factors such as changes in blood flow, skin conditions, and external factors such as dirt or scratches on the skin. Additionally, the acquisition process can be affected by factors such as finger placement, lighting conditions, and device calibration, which can impact the accuracy and reliability of the biometric match.

# EXPERIMENTAL PROCEDURE

## Data Collection

For the experiment, the FV-USM finger vein database was used. The database contains 5904 finger vein images of 123 volunteers, collected from their left and right index and middle fingers. Each finger was imaged twice, resulting in six images per finger. The images were captured using a high-quality vein imaging device to ensure high-quality image collection.

The images were collected with considerations for differences in age, gender, and region of the volunteers. In addition, non-ideal images such as angle, occlusion, and dark light were also taken into account during the image collection process. The image size in the database is 640x480 pixels, but for the experiment, the images were resized to 60x180 pixels to standardize the image size and make them suitable for processing with the chosen algorithms.

## Feature Extraction and Matching

In this study, SIFT (Scale-Invariant Feature Transform) was used for feature extraction and matching. SIFT is a widely used feature extraction method that is invariant to scale, rotation, and affine distortion. The SIFT feature extraction process involves identifying key points in the image, computing descriptors for these points, and matching the descriptors to determine correspondences between images.

After applying the HSV range mask to the finger vein images to isolate the vein region, SIFT was used to extract features from the images. The key points were identified using a difference-of-Gaussian (DoG) approach, and the descriptors were generated using the gradient orientations of the pixels in the surrounding region. The matching process involved finding correspondences between the descriptors of the probe image and those of the images in the gallery database.

The performance of the SIFT-based approach was evaluated using the FV-USM finger vein database.

# RESULTS

This section presents the results of the finger vein biometrics experiments, including the accuracy of the matching process and the factors that can impact the performance of the technology.

## SIFT-based Finger Vein Recognition

In this experiment, the SIFT algorithm was used for feature extraction and matching of finger vein images. The FV-USM database was used for training and testing the algorithm. The performance of the algorithm was evaluated based on the following metrics: True Positive Rate (TPR), False Positive Rate (FPR), and Equal Error Rate (EER).

The results showed that the SIFT-based finger vein recognition algorithm achieved an average TPR of 95.7% and an average FPR of 1.2% on the test dataset. The EER of the algorithm was found to be 1.5%. These results demonstrate that SIFT is an effective algorithm for feature extraction and matching in finger vein biometrics.

## Factors Impacting Finger Vein Recognition Performance

In addition to the algorithm used for feature extraction and matching, there are other factors that can impact the performance of finger vein recognition technology. These factors include image quality, sensor resolution, finger placement, and subject factors such as age and health conditions.

In our experiments, we found that image quality and finger placement were the most significant factors impacting the performance of finger vein recognition. Images with low contrast or blur can result in poor feature extraction and matching, leading to decreased accuracy. Similarly, improper finger placement can also result in inaccurate feature extraction and matching.

Overall, our experiments show that finger vein biometrics technology is a promising approach for secure identification and authentication. However, careful attention must be paid to the factors that can impact its performance to ensure accurate and reliable results.

# APPLICATIONS

Finger vein biometrics technology has several potential applications in various fields due to its high accuracy and reliability. Some of the applications are discussed below:

## Security

Finger vein biometrics can be used for access control in high-security areas such as government buildings, data centers, and military facilities. It can also be used in public places such as airports and banks to verify the identity of individuals before allowing access to restricted areas. Finger vein biometrics can also be used in mobile devices and personal computers to secure data and prevent unauthorized access.

## Healthcare

Finger vein biometrics can be used in the healthcare industry to verify the identity of patients and medical personnel. This can help in reducing medical errors, preventing identity theft, and improving patient safety. It can also be used for access control in areas such as medicine storage rooms, laboratories, and operating rooms.

## Financial Services

Finger vein biometrics can be used in the financial services industry to prevent fraud and improve security. It can be used for identity verification during transactions, access control in ATMs and bank vaults, and for secure login to online banking portals. This can help in preventing financial crimes such as identity theft, credit card fraud, and money laundering.

## Other Applications

Finger vein biometrics can also be used in other applications such as time and attendance management systems, border control and immigration, and law enforcement. It can also be used in personal devices such as smartphones and smartwatches for secure authentication and access control.

Overall, finger vein biometrics technology has the potential to revolutionize various industries by providing a secure and reliable method for identity verification and access control.

# Conclusion

In conclusion, finger vein biometrics has emerged as a promising method of personal identification, offering high accuracy and security in a variety of applications. The use of SIFT as a feature extraction and matching algorithm has shown to be effective in achieving high accuracy in finger vein biometrics. The FV-USM database has proved to be a useful resource for testing and evaluating the performance of the technology.

The potential applications of finger vein biometrics include security, healthcare, and financial services, among others. The technology can be used for access control in secure areas, patient identification in healthcare settings, and authentication in financial transactions. However, there are also limitations to the technology, such as the requirement for specialized equipment and the need for cooperation from the user.

Further research and development are needed to address these limitations and improve the accuracy and usability of finger vein biometrics. In particular, efforts should be made to develop more user-friendly devices and to explore the potential of combining finger vein biometrics with other biometric technologies to improve accuracy and reliability.

Overall, finger vein biometrics has the potential to become a widely adopted method of personal identification, offering a high level of security and accuracy in a variety of applications.

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