FINGER VEIN PATTERN RECOGNITION USING CONVOLUTIONAL NEURAL NETWORK

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ABSTRACT

Finger vein identification is a recently developed biometric technology and has become an essential field in biometrics, garnering increasing attention in recent years. As a biometric trait, using vein patterns allows for personal recognition with high security. In this paper, we have employed an improved deep network, named Merge Convolutional Neural Network (Merge CNN), which uses several CNNs with short paths. The scheme is based on the use of multiple identical CNNs with different input images qualities, and the unification of their outputs into a single layer. To achieve this, we designed different networks and trained them with the FV-USM dataset. The most optimal CNN architecture was used to build our final merged CNN labelled A, which is a combination of original image and image enhanced with Contrast Limited Adaptive Histogram (CLAH) method. Using six images for training, satisfactory performances were obtained from the FV-USM database with a recognition rate of 96.75%. Our proposed approach showed better performance than other methods exist in the literature, for the SDUMLA-HMT database with a recognition rate of 99.48%, when using five images for learning. Our proposed scheme can compete with state-of-the-art methods with recognition rate of 99.56% for the THU-FVFDT2 database.

INTRODUCTION

Biometric authentication has become a crucial aspect of security systems, providing reliable identification methods beyond traditional passwords or PINs. Among various biometric techniques, finger vein pattern recognition is gaining attention due to its high security, uniqueness, and resistance to forgery. Unlike fingerprints, which are external and can be replicated, finger vein patterns exist beneath the skin and are nearly impossible to counterfeit.

In this project, we employ Convolutional Neural Networks (CNNs) to develop an accurate and efficient finger vein recognition system. CNNs are a type of deep learning model that excels in image processing and pattern recognition, making them ideal for identifying unique vein structures. The system captures near-infrared (NIR) images of finger veins, processes them through a deep learning model, and classifies individuals based on their unique vascular patterns.

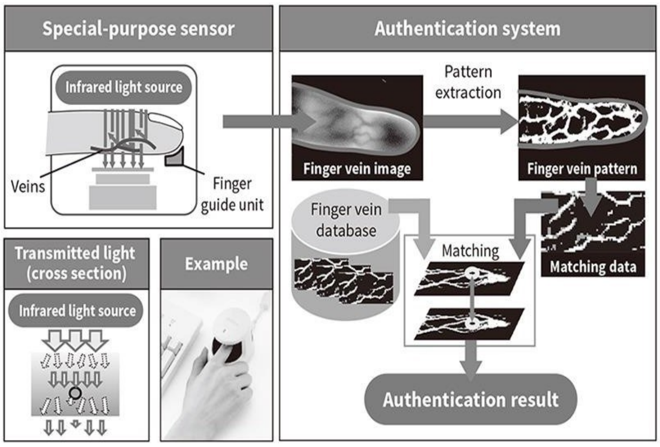

Figure.1 Finger vein recognition using sensors

LITERATURE SURVEY

Traditional methods involve vein pattern extraction using edge detection, thresholding, and morphological operations. Techniques such as Gabor filters, local binary patterns (LBP), and wavelet transforms were commonly used.

- Miura et al. (2007) proposed a repeated line tracking method to extract vein patterns from near-infrared (NIR) images.
- Yang et al. (2012) introduced Maximum Curvature-Based Feature Extraction, improving feature reliability.
- Kumar et al. (2013) used Principal Component Analysis (PCA) to reduce dimensionality and classify features using SVMs.
- Ratha et al. (2015) explored Feature Fusion-Based Approaches, combining multiple biometric traits for better security.

Early CNN-Based Approaches:

- Zhang et al. (2016) first implemented CNNs for finger vein recognition, demonstrating improved accuracy over traditional methods.
- Li et al. (2018) proposed a Deep Learning-Based Triplet Network, ensuring better generalization by minimizing intra-class variations.

PROPOSED SYSTEM

In this research work, a Dimensional Reduction-based deep Convolutional Neural Network (DR-CNN) framework is integrated for extracting critical features from feature datasets by lowering their dimensionality. The proposed algorithm can help distinguish between matching and unmatching veins patterns. To determine the effectiveness of the DR-CNN is at distinguishing finger vein patterns for authentication system, it is compared to existing deep learning classifiers. The proposed technique obtains an accuracy rate of 97.16%, while other existing methods such as CNN (Dung et al. 2019), Deep Neural Networks (DNN) (Rad et al.

2020), and Recurrent Neural Networks (RNN) (Chadha et al. 2020) produce an accuracy rate of 86%, 88.31% and 80.66% respectively. according to the results.

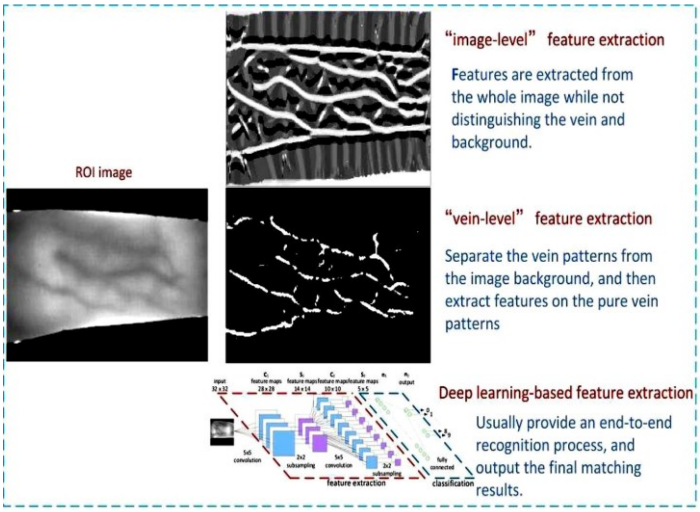

Figure.2 Finger vein patterns recognition methods

The vein pattern-based method involves segmenting the vein pattern from a picture of a finger's veins and matching the vein pattern using various techniques. Robust vein pattern extraction has recently seen a few upgrades. In order to increase accuracy and efficiency, Yang et al. (2012) created a finger vein coding index approach and merged it with finger vein patterns recognition method into an integrative framework shown in Figure 5.12. According to experimental findings, the integration framework significantly increases identification effectiveness while only slightly improving accuracy. In order to extract features from an image of a finger vein, repetitive line track and Gabor filter techniques were developed, and the combined result was superior to the results of the two techniques employed separately. These algorithms take a lot of time and are complicated. The repeating line tracking method was also used in the multimodal biometric system to extract features.

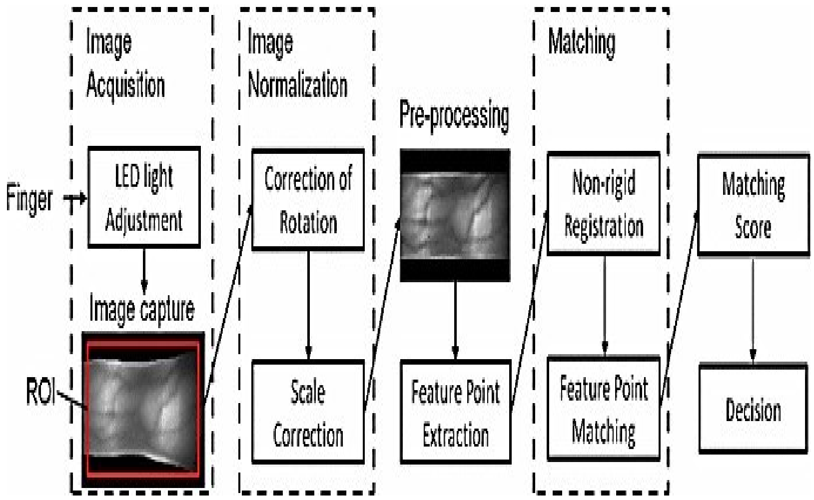

Figure.3 Architecture based on feature matching approach

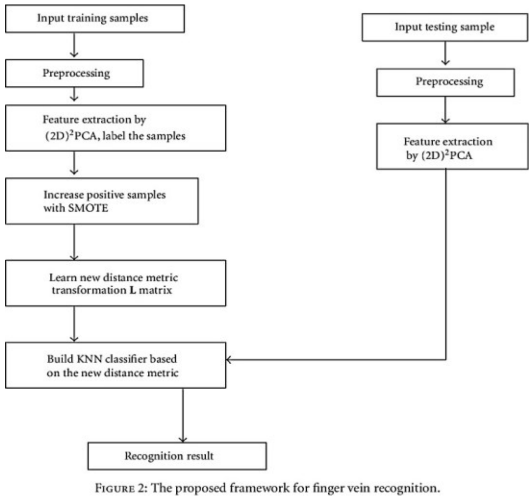

Figure.4 Flowchart based on metric learning.

STIMULATION RESULTS

The study utilizes a **5-fold cross-validation** approach, dividing the dataset into **70% training and 30% testing**. DR-CNN outperforms existing models like DNN, RNN, and CNN in accuracy and detection rate. Unlike previous methods, DR-CNN minimizes classification errors despite challenges like poor lighting and noise. However, training high-dimensional datasets remains computationally expensive. The findings show improved accuracy compared to prior approaches, making DR-CNN a promising model for finger vein recognition.

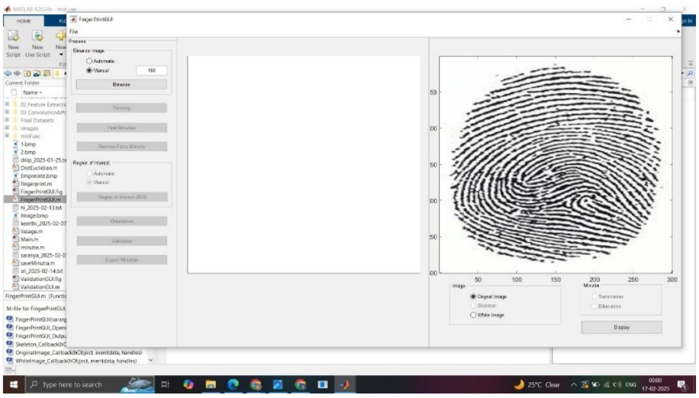

Figure.5 Original Image

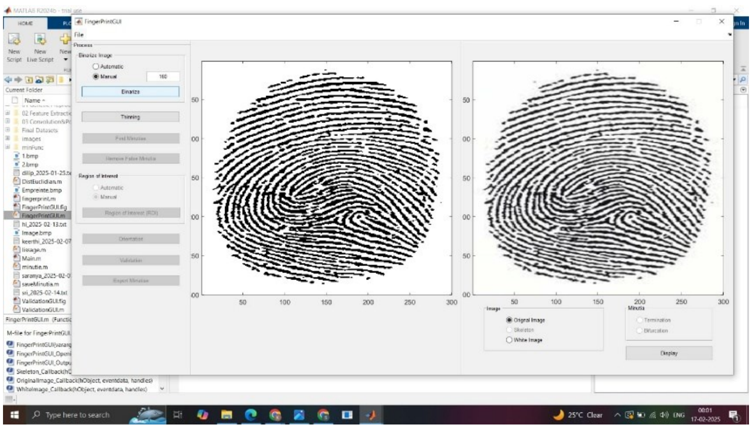

Figure.6 Comparing images

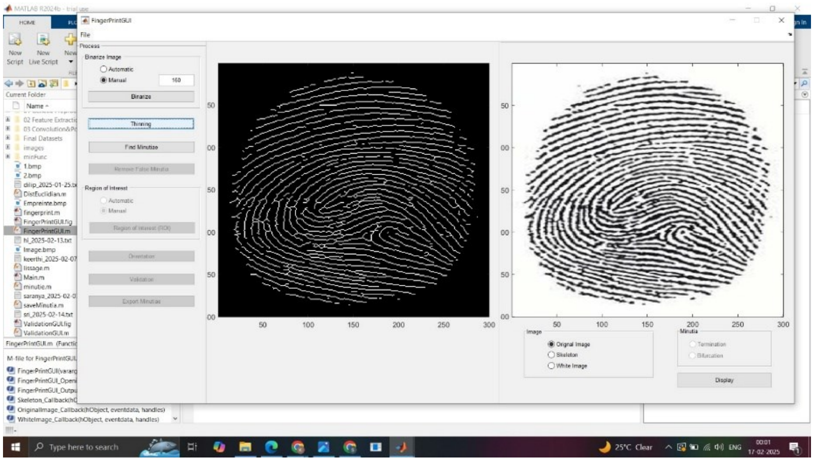

Figure.7 Scanning the Veins

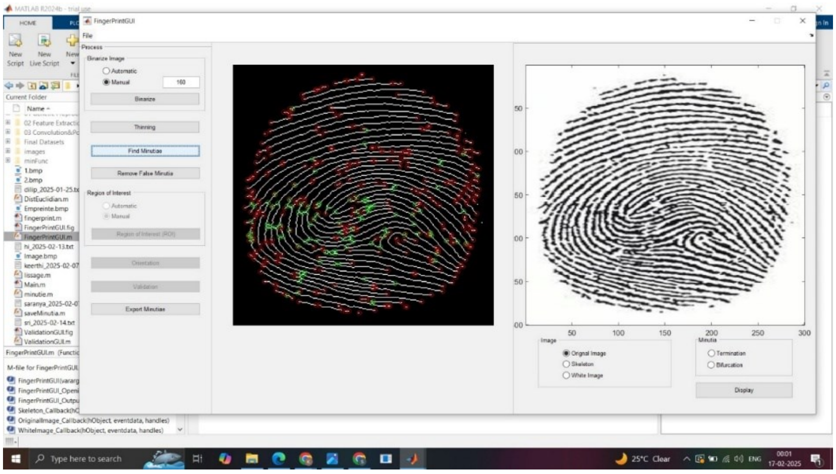

Figure.8 Finding Minutiae

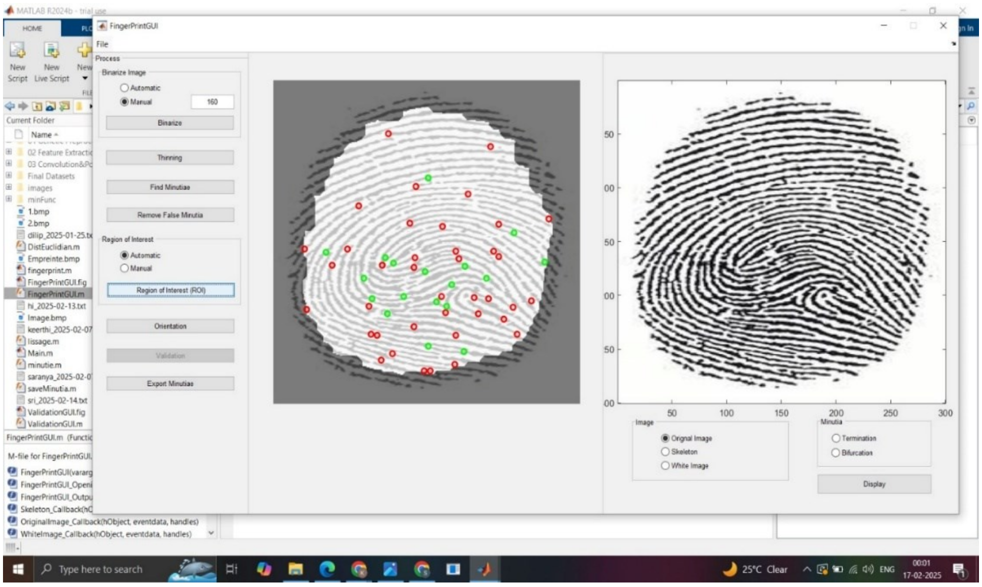

Figure.9 ROI

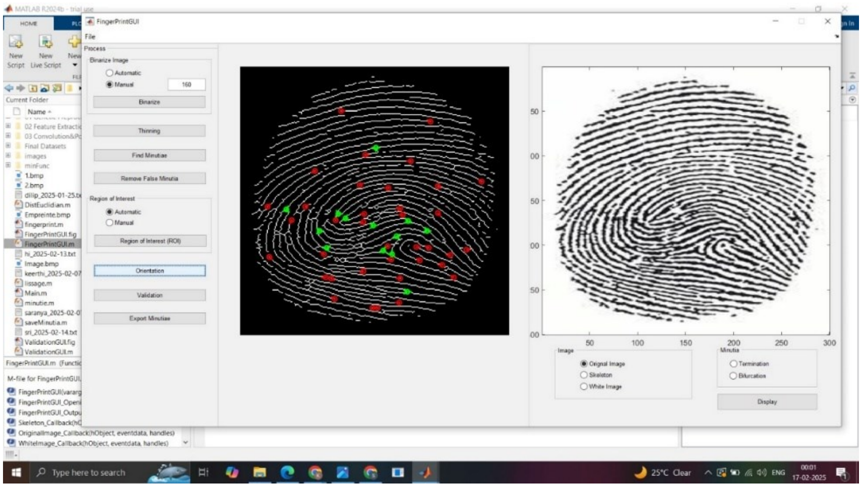

Figure.10 Orientation

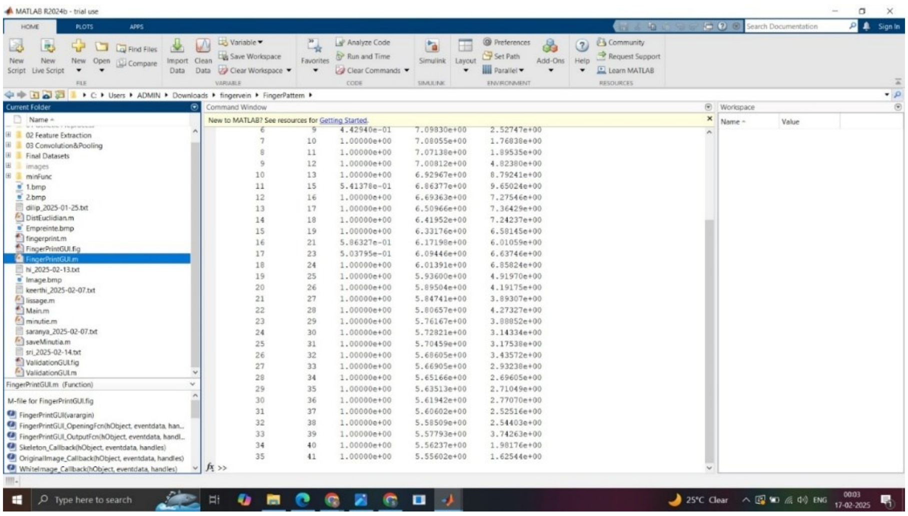

Figure.11 FingerPrintGUI values

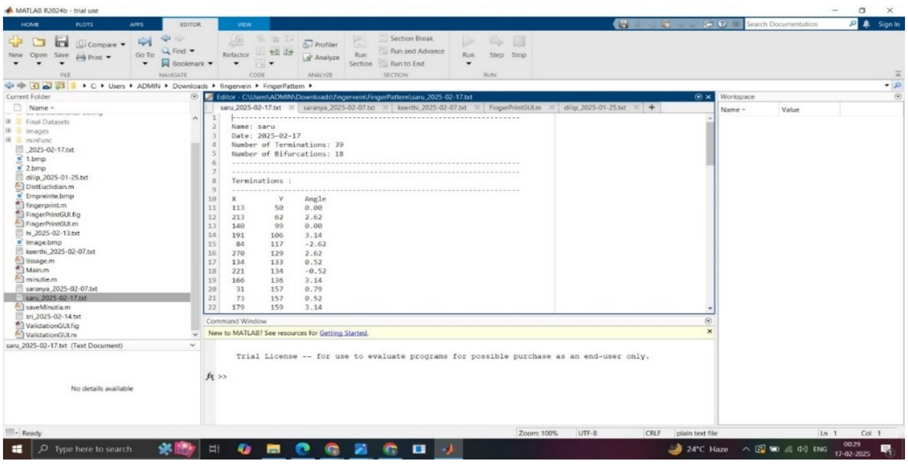

Figure.12 Terminations values

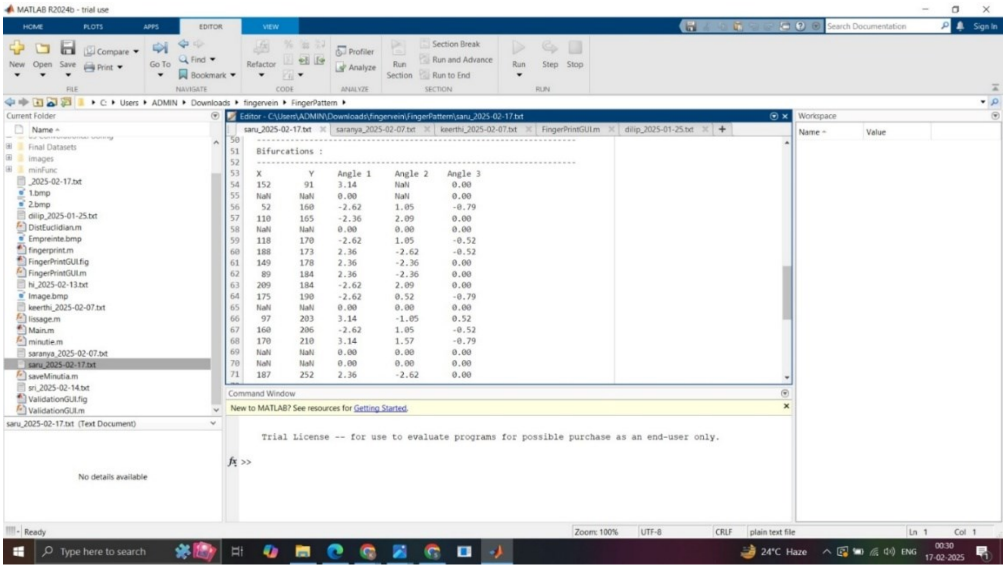

Figure.13 Bifurcations Values

CONCLUSION

This research work provides a novel solution of efficient finger vein recognition. DR-CNN is a vein pattern categorization system that allows for reliable individual authentication. To enable supervised learning can enhance the patterns on classification, the suggested method used optimal labels. The extraction of ideal features was made possible by this clever CNN method, which included further dimensionality reduction of features. The matching and unmatching vein patterns were eventually classified by the DR-CNN. The simulation outcomes showed that proposed technique outperforms existing classifiers in terms of F1-score, specificity, sensitivity, recall, accuracy, and MAE. Additionally, DR-CNN finger vein detection method is compared with the existing approaches. However, compared to conventional finger vein recognition methods, the proposed method shown a significant improvement in accuracy and other measures. Furthermore, numerous training data are needed in order to successfully train the suggested deep CNN model. However, it is frequently the case that gathering this much data is challenging in many experimental settings. In order to reflect the properties of the original training data, the increment of training data through correct data augmentation is required. To solve this issue, dimensionality reduction-based method termed as DR-CNN method is proposed and achieved quantitative results. CNN method is trained on various standard finger vein datasets. The accuracy of proposed CNN method achieved 95.39% with execution time of 2.43 ms. Simulations and analysis were carried out using MATLAB 2019b or above which achieved quantitative results.

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