SPECIMEN FORMAT FOR THESES OF MONTH

Faculty	**:**	**School of Engineering**
Department	**:**	**Computer Science and Engineering**
Branch/ Area:	**:**	**Deep Learning**
Sub Subject Heading:	**:**	**Finger Vein Biometric Authentication**
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Title of the thesis	**:**	Finger Vein Biometric Authentication using Deep Learning Techniques with Hybrid Labelling and Data Augmentation
(i) In Roman Script (ii) In roman Script		- -
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Designation of Supervisor	**:**	Professor and Head
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Abstract within 300 words:

Biometric systems, which authenticate individuals using unique biological or behavioral traits, play a vital role in modern security. Among these, finger vein recognition is particularly secure since vein patterns lie beneath the skin and are difficult to replicate. However, the performance of such systems depends greatly on feature extraction methods and environmental factors like motion artifacts, lighting, and finger placement.

This research proposes a motion-tolerant deep learning framework for finger vein authentication by leveraging advanced labelling and dataset augmentation strategies. Conventional approaches, which rely on handcrafted features and classical machine learning, often struggle under variable conditions. In contrast, deep learning can automatically capture complex vein structures, improving adaptability and accuracy.

The first phase compared a modified U-Net and VGG16 model on the benchmark SDUMLA-HMT and THUFV datasets. U-Net was extended with a fully connected layer for classification, but VGG16 delivered higher accuracy, precision, and recall, demonstrating superior capability in extracting detailed vein patterns.

In the second phase, a hybrid labelling algorithm was applied to improve dataset quality. Accurate labels allowed VGG16 to learn finer vascular features, reducing overfitting and enhancing generalization.

The third phase introduced dataset augmentation, combining traditional transformations such as rotation, scaling, and flipping with synthetic image generation through Generative Adversarial Networks (GANs). These methods significantly enriched dataset diversity, further boosting recognition performance.

The final phase integrated VGG16 with Long Short-Term Memory (LSTM) networks to form an adaptive recognition system. This hybrid model addressed real-world challenges, including finger movement and environmental variations, enabling robust

performance even under imperfect conditions. Evaluation on SDUMLA-HMT and THUFV datasets confirmed improved accuracy and resilience.

Overall, this work highlights the effectiveness of combining deep learning architectures with enhanced labelling and augmentation techniques, contributing to the development of reliable, scalable, and motion-tolerant finger vein recognition systems for practical biometric authentication.

i) Major objectives:

- To develop a motion-tolerant and efficient deep learning model for finger vein recognition that enhances performance in contactless acquisition scenarios.
- To identify and implement an effective finger vein labelling method for extracting baseline vein patterns from raw images, thereby reducing training time for deep learning models.
- To augment the finger vein dataset with diverse samples to improve accuracy, increase robustness, and prevent overfitting.
- To develop an efficient deep learning algorithm that accurately recognizes finger vein patterns.

ii) Hypothesis:

A motion-tolerant deep learning model that integrates advanced labelling, dataset augmentation, VGG16 for robust feature extraction, and LSTM networks for effective sequence learning will significantly improve the accuracy, robustness, and generalization of finger vein recognition systems in varying acquisition conditions, particularly in contactless finger vein scanners.

iii) Methodology :

The proposed model employs VGG16 for robust vein feature extraction, with datasetenhanced using hybrid labelling algorithm and advanced dataset augmentation using both traditional transformations and GAN-generated samples. These features are then passed to an LSTM network, enabling motion-tolerant sequence learning and improving recognition performance under varying acquisition conditions.

iv) Findings:

- VGG16 outperformed the modified U-Net model, achieving 92.5% accuracy on THUFV and 94.31% on SDUMLA, proving more effective for finger vein recognition.

- A hybrid labelling algorithm improved VGG16 performance by enhancing vein pattern clarity, raising accuracy to 96.34% (THUFV) and 95.45% (SDUMLA), while also reducing training time.

- Dataset augmentation using conventional and GAN-based methods further boosted accuracy to 98.6% (THUFV) and 97.1% (SDUMLA), and reduced overfitting, though it increased training time and left sensitivity to finger misalignment.

- The proposed motion-tolerant deep learning model integrated labelling, augmentation, VGG16, and LSTM, achieving near-perfect accuracy of 99.89% (THUFV) and 99.58% (SDUMLA), eliminating overfitting, reducing training time, and demonstrating robustness through ROC, AUC, and EER metrics.

Examiners

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