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Palm Print Recognition for Identity Verification Using Deep Learning Techniques

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Abstract

Biometric authentication methods are widely used today to improve security in digital systems. Among the available biometric traits, palm prints are considered reliable because the contain several unique features such as major palm lines, wrinkles, patterns, and texture details. These characteristics remain mostly unchanged over time and differ from person to person.

This paper describes a palm print recognition system developed using deep learning and proposed system includes image pre-processing, feature learning and classification. Pre-processing steps such as resizing, normalization, and noise removal are applied to enhance the quality of palm images. Unlike traditional palm print recognition methods that depend manually on extracted features, the CNN model automatically learns important features directly from the images.

The proposed system achieves more than 99% recognition accuracy and performs even in the variations in lighting conditions. The system can be effectively used in applications such as access control, digital banking and government-based identity verification systems.

Keywords: Keywords: Palm Print Recognition; Deep Learning; Convolutional Neural Network (CNN); Identity Verification; Biometric Authentication; Pattern Recognition.

How to Cite This Article

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Introduction

Increasing use of online platforms and digital services, secure identity verification. They are Traditional authentication methods such as passwords, smart cards, and PINs are easy to forget, steal, or duplicate. Due to this limitation or biometric authentication systems have gained attention as the work on unique physical traits.

Palm print recognition is an effective biometric technique because the human palm contains a large number of various features, including principal lines, ridges, and texture patterns. Another advantage of palm print systems is that image acquisition is simple and does not require strict user cooperation. This makes the technology suitable for real world and large-scale applications.

This progress in deep learning has significantly improved the performance of image recognition system and Convolutional Neural Networks are capable for learning complex features to image without manual help. CNN have shown strong performance in handling variations such as changes in rotation, and minor distortion. Due to these advantages, this work focuses on implementing a CNN-based palm print recognition system for identity verification.

Related Work

The Earlier palm print recognition systems mainly relied on handcrafted feature extraction methods such as well as to Principal Component Analysis (PCA) and Gabor filters, Local Binary Patterns (LBP). The techniques worked reasonably well as controlled environments. The performance reduced when images were affected by noise and lighting variations to incorrect hand placement.

To improve this recognition accuracy or coding-based methods like Competitive Coding and Ordinal Coding were later introduced. The methods reduced computational complexity and improved matching speed. Despite there were still sensitive to low-quality images and partial palm visibility to Multispectral and infrared-based palm print systems were also proposed to capture vein patterns or subsurface features. These systems achieved better accuracy or required specialized sensors and which is increased system cost.

In these recent years and deep learning approaches have been widely adopted for palm print recognition. The CNN-based models or including custom architectures and pretrained networks have to reported high accuracy on standard dataset. This models automatically learn discriminative features and compared to traditional techniques.

Proposed System

The proposed system in CNN-based palm print recognition framework designed to secure and efficient identity verification. This system architecture is modular and allowing easy integration to practical security applications.

- Image Acquisition: The Palm images are captured using a standard digital camera or palm scanner Multiple samples are collected each individual or handle variations in hand position, lighting and orientation.
- Preprocessing: This acquired images converted into grayscale and resized and fixed resolution. This Noise filtering and intensity normalization are applied to improve feature visibility and ensure consistent input to the CNN model.
- Feature Extraction & Classification: The Convolutional Neural Network is used to automatically extract important palm features. The network includes convolution layers, pooling layers, and fully connected layers and Softmax layer is used by classify the input image into corresponding identity class.
- Authentication Decision: The output from the CNN determines whether to input palm image matches a registered user and the match is found access is granted otherwise and authentication attempt is rejected.
- Secure Data Management: This all-biometric data or trained models are stored securely using to encryption methods to maintain data privacy

Methodology

This methodology follows to standard deep learning pipeline and starting from to data or performance evaluation.

- Dataset Collection: Palm print images are obtained to publicly available datasets or collected manually. Each subject provides multiple images captured under different conditions and improve model robustness.
- Preprocessing: This Images are converted to grayscale cropped and extract the palm region, resized or normalized. This Data augmentation techniques such as to rotation and flipping are applied to increase dataset size
- CNN Training: The CNN learns hierarchical features such as palm lines, ridges and texture information through multiple convolution and pooling layers and extracted features are passed to fully connected layers to classification.
- Model Evaluation: This model is trained using categorical cross-entropy loss and the Adam optimizer. Dropout is used to reduce overfitting. The Performance is evaluated using accuracy or precision, recall and confusion matrix analysis.

Block Diagram

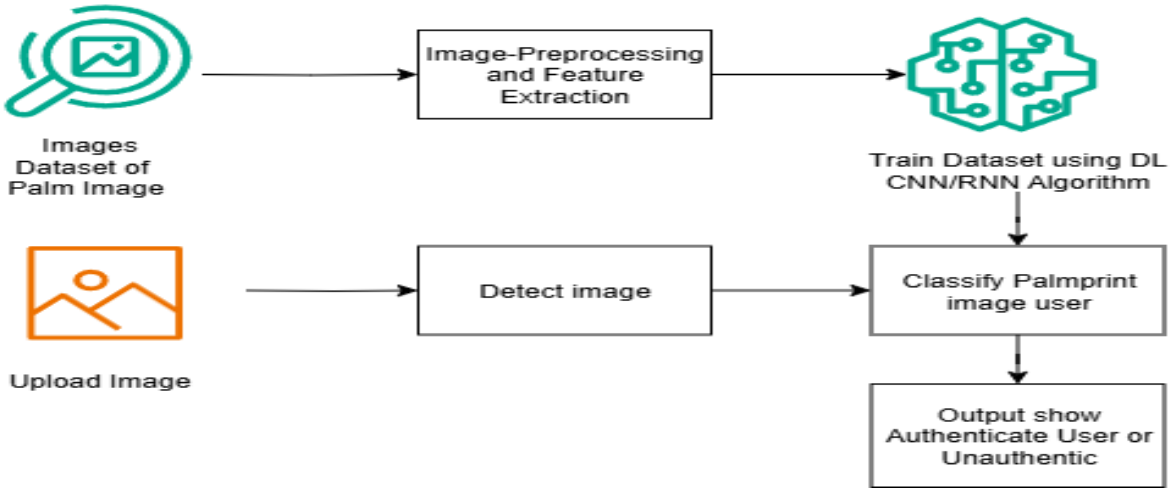

Fig. 1. *Block\system Architecture*

Experimental Results

The experiments were conducted using a CNN model implemented in Python with TensorFlow or Keras.

- Training Accuracy: 100%
- Testing Accuracy: 99%

These results indicate stable learning behavior to gradual reduction in loss values. This system performed well under moderate lighting changes and hand rotations. However, to performance slightly decreased when images were highly blurred or poorly captured.

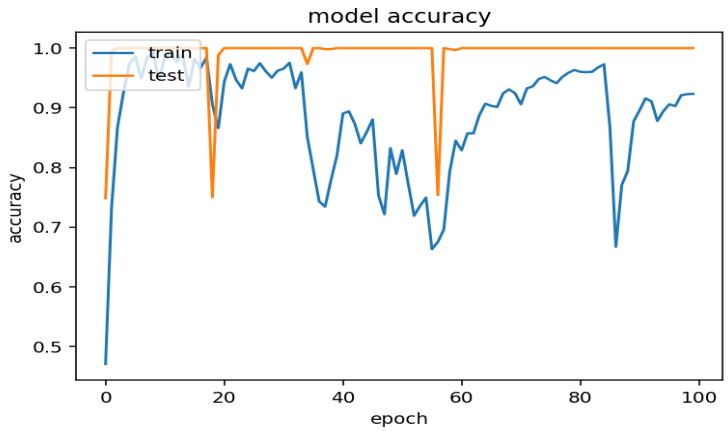

Fig. 2. *Model Accuracy of the System*

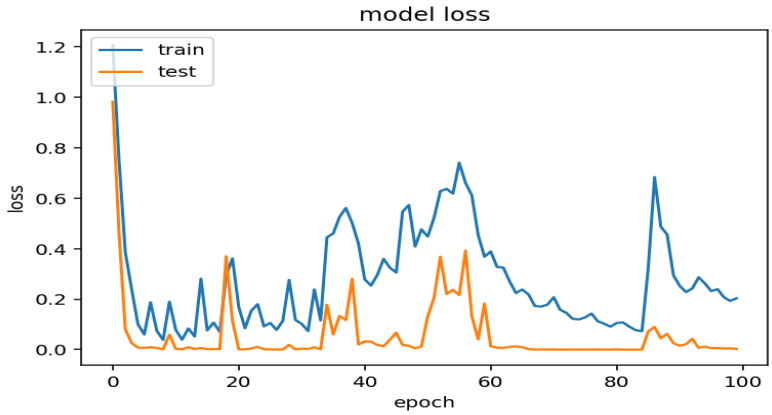

Fig. 3. *Model Loss of the System*

Discussion

This experimental analysis confirms that CNN-based palm print recognition systems provide better accuracy and robustness compared or traditional handcrafted feature-based methods. The Automatic feature learning allows the system to adapt variations in real-world data and although training the CNN requires more computational resources to testing phase is fast enough for real-time applications. The limitations include dependency to image quality and dataset size. The factors can be affecting performance or should be addressed in future improvements

Conclusion

The paper presented palm print recognition system based on deep learning for verification. System avoids manual feature extraction and achieves high recognition accuracy. Experimental results show accuracy greater than 99% demonstrating effectiveness of proposed approach. The system is suitable for applications such as access control or digital identity verification and secure authentication systems. The modular design allows further enhancement or practical deployment.

Future Work

The Future work may be include using larger or more diverse datasets, implementing lightweight CNN architectures for mobile devices and combining palm print recognition to other biometric modalities. The additional research can also focus on infrared imaging or explainable AI models and the secure biometric data storage techniques

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