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Biometric-based Human Identification using Ensemble-based Technique and ECG Signals

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Abstract: User authentication has become necessary in different life domains. Traditional authentication methods like personal information numbers (PINs), password ID cards, and tokens are vulnerable to attacks. For secure authentication, methods like biometrics have been developed in the past. Biometric information is hard to lose, forget, duplicate, or share because it is a part of the human body. Many authentication methods focused on electrocardiogram (ECG) signals have achieved great success. In this paper, we have developed cardiac biometrics for human identification through a deep learning (DL) approach. Cardiac biometric systems rely on cardiac signals that are captured through the electrocardiogram (ECG), photoplethysmogram (PPG), and phonocardiogram (PCG). This study utilizes the ECG as a biometric modality because ECG signals are a superior choice for accurate, secure, and reliable biometric-based human identification systems, setting them apart from PPG and PCG approaches. To get better performance in terms of accuracy and computational time, we have developed an ensemble approach based on VGG16 pre-trained transfer learning (TL) and Long Short-Term Memory (LSTM) architectures to optimize features. To develop this authentication system, we have fine-tuned this ensemble network. In the first phase, we preprocessed the ECG biosignal to remove noise. In the second phase, we converted the 1-D ECG signals into a 2-D spectrogram image through a transformation phase. Next, the feature extraction step is performed on spectrogram images through the proposed ensemble DL technique, and finally, those features are identified by the boosting machine learning classifier to recognize humans. Several experiments were performed on the selected dataset, and on average, the proposed system achieved 98.7% accuracy, 98.01% precision, 97.1% recall, and 0.98 AUC. In this paper, we have compared the developed approach with state-of-the-art biometric authentication systems. The experimental results demonstrate that our proposed system outperformed the human recognition competition.

Keywords: Biometric Identification; ECG; PPG; Deep learning; Transfer learning; VGG16; Long-term Short-term (LSTM) model

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1. Introduction

In an era characterized by ubiquitous digital interactions, the need for robust and secure human identification systems has become paramount. Traditional recognition methods like personal identification numbers (PINs) [1] and passwords have become vulnerable to attacks and can be lost or forgotten. As a result, there is a need to develop a biometric system that is more secure. PINs are increasingly protected using biometrics to address the threat of loss or theft. These technologies safely manage personal information and verify the user's identity. Biometric recognition is an approach that provides a unique