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PlexNet: A fast and robust ECG biometric system for human recognition

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ABSTRACT

Researchers have explored the potential of electrocardiogram (ECG) to use as biometrics from past two decades. ECG has the inherent feature of vitality for securing the biometric system from fraudulent attacks. This paper proposes a novel ensemble of the state-of-the-art pre-trained deep neural networks *i.e.*, ResNet and DenseNet for ECG biometric recognition. The principle of transfer learning is utilized to prepare fine-tuned models. The gathered knowledge of four fine-tuned models is fused to prepare one stacking model *i.e.*, 'PlexNet'. The PlexNet takes advantage of transfer learning along with ensemble learning, thus making a novel model for ECG biometrics that is robust and secure than other methods using deep networks. Two public datasets PTB and CYBHI are tested on the proposed ensemble for human identification. The experimental results demonstrate the efficacy of the model with identification accuracy reported the best as 99.66% on healthy and unhealthy subjects. Finally, the proposed ECG biometric method proves its robustness from signal acquisition methods, size of datasets, and subject health statuses.

1. Introduction

The researchers have explored the feasibility of electrocardiogram (ECG) to use as biometrics for secure and robust human recognition [2–4,8–36,43–48]. The ECG is a recording of heart electrical activity representing the repetitive patterns of heartbeats. The ECG has the inherent property of vitality detection that ensures the acquisition of a biometric sample from a legitimate and live individual. Use of ECG as biometrics improves the system reliability and makes it non-vulnerable to fraudulent attacks.

The researchers have proved the uniqueness of ECG among individuals utilizing signal processing, pattern recognition and machine learning techniques [3,4,8–36]. The distinctiveness of ECG morphology among individuals can be seen through naked eyes as shown in Fig. 5, [9]. The distinctiveness of the ECG morphology is visible due to the change in ionic potential, the plasma levels of electrolytes, and the rhythmic differences [1]. Further, the physiological differences of an individual thorax such as chest geometry, heart position, size, and physical condition can also manifest a unique characteristic in the rhythm of an individual heartbeat [1]. The accumulated effect of this distinctiveness reflects the change in morphology, the difference in amplitudes and the variation in time intervals of the dominant fiducials in individuals' heartbeat [2]. Fur-

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