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Biometric Identification Using ECG Data from Activity and Rest

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Introduction

In recent years, researchers' interest in the field of information security has shifted to human biometric recognition, which is based on a variety of biometric characteristics like fingerprints, faces, and retinas. Despite the fact that only experiments on its resting state have been conducted, the electrocardiogram (ECG) has a significant potential for identification due to its high difficulty in fabrication. By creating our own ECG dataset with signals from both exercise and rest, we address the oversimplifications of previous research and evaluate the performance on ECG human identification (ECGID), particularly the effect of exercise on the entire experiment. Using our own ECG dataset and a variety of well-known learning algorithms, we discover that current methods can identify individuals at rest but do not perform as well during activity, highlighting a weakness in current ECG identification algorithms.

The dependability of defensive mechanisms has become a hot topic in the area due to the growing demand for high information security, which is sometimes thought to be vulnerable to fabrication and spoofing attacks. The security requirement is not met by traditional identification technologies like passwords and certificates, which are easily forgotten or stolen and put personal information at risk. Biometric identity technology, which is based on an individual's distinct anatomical, physiological, or behavioral characteristics that are virtually impossible to fake [1], has emerged simultaneously.

Description

Even though popular and advanced biometric characteristics like a person's face, fingerprint, or voice have high rates of recognition, they are far from perfect. Photo manipulation or makeup, for example, can be used to alter a Face ID; With latex, a fingerprint can be cloned and replicated; and it is possible to record and imitate a voice. Some researchers combine multiple biometric technologies to make identification systems more difficult to crack, while others have experimented with new techniques for the past 20 years, such as ECGID, whose reliability we can guarantee by generating it from living bodies [2]. Both methods aim to enhance the security of such identification technologies.

We now have a theoretical basis for ECG-based human identification thanks to a number of studies that, employing various methods, have demonstrated the individuality of an ECG.

ECG waveform

The ECG waveform, which contains a wealth of information about an individual's identity, includes four key properties that are required for biometric identification:

(1) Universality: Every living human's heart continuously generates ECG signals.

(2) Uniqueness: ECG differences between individuals are primarily influenced by body shape, age, weight, emotion, gender, heart location, heart size, geometric shape, physiological characteristics, chest structure, and sports status, among other factors, determining the Uniqueness of ECGs generated by different people [3].

(3) Stability: Unless one's heart has lesions, the structure and size of the adult heartbeat are essentially fixed, and ECG waveforms stay stable.

(4) Measurability: ECG equipment can lower the cost and time of ECG capture via downsizing, portability, and high precision, making measurement more convenient. Due to its excellent non-replicability and uniqueness, the ECG signal has become the subject of substantial research in the field of human identification technology in recent years [4].

ECGID's approaches are classified into two categories:

(1) Fiducial approach: ECG signals are composed of three main waves, the P, QRS, and T waves, and each peak, slope, boundary, and interval are depicted by Fiducial features, which are used for human identification by the fiducial method;

(2) Non-fiducial approach: these methods treat ECG signals as a whole without taking into account the details of waveform, and in most cases process signals in the frequency domain.

In the last decade, electrocardiograms (ECG) have developed as a novel biometric identification technique with a high level of uniqueness and permanence. Furthermore, because ECG has an intrinsic feature of a person's liveliness, it can provide a superior answer when compared to other biometric techniques. This study includes ECG pre-processing, feature extraction, feature reduction, and classifier performance in order to give a complete systematic strategy for ECG-based person identification in varied cardiac situations. R-peak detection is used in ECG segmentation; however the system is not dependent on fiducial detection and does not require a high level of computing complexity [5].

Fusion of Discrete Wavelet Transform (DWT) of cardiac cycle and heart rate variability (HRV) based features is required for feature extraction. Best first search is used for feature reduction, and Random Forests are used for classification. All participants are examined on three publicly available databases, including MIT-BIH/Arrhythmia (MITDB), MIT-BIH/Normal Sinus Rhythm (NSRDB), and ECGID database (ECG-IDDB). To deal with cardiac illnesses that cause problems in identification, HRV effects were removed from MITDB, and accuracy of 95.85% was reached with a false acceptance rate (FAR) of 4.15 percent and a false rejection rate (FRR) of 0.1 percent. The system is also evaluated on typical population databases; with accuracy of 100 percent for the NSRDB database and 83.88 percent for the more difficult ECG-ID database [5].

Conclusion

Traditional algorithms, such as the initial SVM and the template update approach, were contrasted with the suggested method. The proposed method yielded results that were nearly identical to those of the original SVM, but it

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trained much faster. In addition, it was demonstrated that the template update method, a common continuous learning algorithm, performed worse than the proposed incremental learning methodology. The MIT-BIH and CYBHi databases were also used to compare the proposed method to previous ECG authentication studies. The suggested algorithm had an accuracy of 97.7% and 99.4% when tested with MIT-BIH and CYBHi, respectively, indicating that it might be as reliable as the others. With the added benefit of new data training, we demonstrated that our suggested algorithm is a trustworthy authentication strategy in terms of FAR and TAR.

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Conflict of Interest

None.

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