Short Communication
Volume 12:3, 2022

Journal of Bioengineering & Biomedical Science

ISSN: 2155-9538

Open Access

Biometric Recognition Based on ECG during Activity and Rest

Jean Sebastien*

Department of Biomedical Science, University of Lorraine, France

Introduction

Human biometric recognition, which is based on a variety of biometric traits such as fingerprints, faces, and retinas, has become the focus of researchers' interest in the field of information security in recent years. Electrocardiogram (ECG) has a significant potential to be used in identification because to its high difficulty of fabrication, despite the fact that only experiments on its resting state have been done. In this paper, we address prior research's oversimplifications by creating our own ECG dataset with signals from both exercise and rest, and evaluating the resulting performance on ECG human identification (ECGID), particularly the impact of exercise on the entire experiment. By using a variety of well-known learning algorithms to our own ECG dataset, we discover that current methods, while capable of identifying individuals during rests, do not perform as well during activity, highlighting the shortcoming of existing ECG identification algorithms.

With the growing demand for high information security, which is sometimes thought to be vulnerable to fabrication and spoofing assaults, the reliability of defensive mechanisms has become a hot topic in the area. Traditional identification technologies, such as certificates and passwords, which are prone to being forgotten or stolen, jeopardize personal information and hence fail to meet the security criterion. Biometric identity technology has arisen at the same time, based on an individual's unique anatomical, physiological, or behavioural features that are practically hard to fake [1].

Description

Even though popular and advanced biometric traits such as face, fingerprint, and voice have excellent recognition rates, they are far from flawless. A Face ID, for example, may be tampered with by photo manipulation or make-up; a fingerprint can be cloned and replicated with latex; and a voice can be captured and imitated. To improve the security of such identification technology, some researchers combine multiple biometric technologies to make systems more difficult to crack, while others have been experimenting with new techniques for the past 20 years, such as ECGID, which we can guarantee its reliability by generating from living bodies [2].

Several studies have confirmed the uniqueness of ECG to an individual using various methodologies, providing us with a theoretical foundation for ECG-based human identification.

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

The suggested technique was compared against traditional algorithms, such as the original SVM and the template update approach. In comparison to the original SVM, the suggested technique produced nearly equal results with a significantly faster training process. Furthermore, it was shown that the proposed incremental learning methodology outperformed the traditional continuous learning algorithm, the template update method. The proposed technique was also compared to prior ECG authentication investigations that

***Address for Correspondence:** Jean Sebastien, Department of Biomedical Science, University of Lorraine, France, E-mail:Jseastien@yahoo,com*

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Received: 05 March, 2022, Manuscript No. jbbs-22-61736; **Editor Assigned:** 07 March, 2022, PreQC No. P-61736; **Reviewed:** 21 March, 2022, QC No. Q-61736; **Revised:** 26 March, 2022, Manuscript No. R-61736; **Published:** 01 April 2022, DOI: 10.37421/2155-9538.22.12.294

used the MIT-BIH and CYBHi databases. Using MIT-BIH and CYBHi, the suggested algorithm obtained accuracy of 97.7% and 99.4%, respectively, indicating that the technique could be as trustworthy as the others. We demonstrated that our suggested algorithm is a reliable authentication approach in terms of FAR and TAR, with the added benefit of new data training.

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How to cite this article: Sebastien, Jean. “Biometric Recognition Based on ECG during Activity and Rest.” J Bioengineer & Biomedical Sci 12 (2022): 294.