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Heart sound as a biometric

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Abstract

In this paper, we propose a novel biometric method based on heart sound signals. The biometric system comprises an electronic stethoscope, a computer equipped with a sound card and the software application. Our approach consists of a robust feature extraction scheme which is based on cepstral analysis with a specified configuration, combined with Gaussian mixture modeling. Experiments have been conducted to determine the relationship between various parameters in our proposed scheme. It has been demonstrated that heart sounds should be processed within segments of 0.5 s and using the full resolution in frequency domain. Also, higher order cepstral coefficients that carry information on the excitation proved to be useful. A preliminary test of 128 heart sounds from 128 participants was collected to evaluate the uniqueness of the heart sounds. The HTK toolkit produces a 99% recognition rate with only one mismatch. Next, a more comprehensive test consisting almost 1000 heart sounds collected from 10 individuals over a period of 2 months yields a promising matching accuracy of 96% using the proposed feature and classification algorithm. A real-time heart sound authentication system is then built and can be used in two modes: to identify a particular individual or to verify an individual's claimed identity.

Keywords: Biometric; Authentication; Identification; Recognition; Verification; Heart sounds

1. Introduction

In recent years, the use of a reliable authentication and identification system to identify legitimate user is becoming increasingly important in commercial application, personnel security, military, finance, airport, hospital, digital right management systems and many other important areas [1]. In fact, performance-based biometric systems whereby a person is automatically recognized by him performing a pre-defined task using his own biometrics, are preferred over knowledge-based (e.g., password) or possession-based (e.g., key) access control methods. As a result, conventional biometrics systems like fingerprint, iris, face and voice that provide recognition based on an individual behavioral and/or physiological characteristics are becoming more popular [1–4]. However, a common weakness of these system is their vulnerability to the possibility to falsify these features [2,3,5,10,11].

For increased reliability and added security, one approach is the use of multimodal biometric systems which uses multiple biometric modalities (such as face and iris of a person or multiple fingers of a person) [2]. New biometrics such as hand vascular pattern, vein, gait, human tissue, knuckle, ear canal and even evoked brain signals have also been proposed [6,7]. Current works on these areas are mainly focused on increasing the reliability and convenience of data capturing, as well as improving the system accuracy and robustness.

Beside these, the study of using the electrocardiogram (ECG) [8,9] as a biometric has also been carried out, which yields a relative high result for human identification tasks [8,9]. In Ref. [8], ECG measurements are collected from 20 male and female adults over a six week period. The training and testing set consist of 85 and 50 measurement sets, respectively, and produce a 98% recognition rate. Israel et al. [9] further investigated the effect of the state of anxiety of an individual on its ECG features through a series of high and low stress tasks. Test results show that the features extracted from the ECG signal are unique

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