EMBEDDED SYSTEM FOR INDIVIDUAL RECOGNITION BASED ON ECG BIOMETRICS

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Abstract: Biometric recognition has recently emerged as part of applications where the privacy of the information is crucial, as in the health care field. This paper presents an embedded system for individual recognition based on Electrocardiographic (ECG) biometrics. The proposed system implements a real-time state-of-the-art recognition algorithm, which extracts information from the frequency domain, on an architecture based ARM Cortex 4. The system is designed to be free-standing, non-intrusive and easy to use on different environments. Preliminary results show the successful on-the-fly implementation in a embedded platform, enabling its usage on a myriad of operations.

1 EXTENDED ABSTRACT

Many of our daily tasks are becoming dependent of automatic and accurate identity validation systems. Traditional strategies for recognition include PIN numbers, tokens, passwords and ID cards. Despite the wide deployment of such mechanisms, the means for authentication is either entity-based or knowledge-based which raises serious security concerns with regard to the risk of identity theft [3][5][8].

The major benefit of security systems based on biometrics is the full dependency on the individual. There are no dependencies on objects or memories as it occurs on the traditional strategies. This leads to a higher use of biometric systems in order to increase the difficulty in falsification of credentials. Currently one of the major flaws of these systems is the ease of falsification of credentials. By example, a photo can fake a face, the iris can be falsified by contact lenses and even the fingerprint may be exchanged for a gel finger [4].

This paper proposes an ubiquitous biometric recognition system based on the Electrocardiographic signals. The acquisition system is based on two electrode to acquire the ECG on the user hand. In order to make this an ubiquitous solution, we propose an autonomous embedded system for human authentication based on ECG. Usually, ECG based systems use hardware capable of acquiring the signal and a micro controller to send the data to a computer. The data analysis task is then processed in the computer to retrieve an authentication score [6].

The problem of human recognition based on a biometric system, can be formulated in the pattern recognition framework. The steps involved in such a system are: 1) first the signal is acquired by the sensors; 2) the signal is preprocessed and described in a convenient representation; 3) features are extracted; 3) from the extracted features the most discriminative are selected; 4) a classification block processes the features and delivers a decision corresponding to the recognition of the subject [9].

The proposed approach follows a partial fiducial approach [1], using the wave onset, peak (the R complex, included in QRS, the names of the custom ECG waves) as characteristic point for segmentation. Two segmentation algorithms are studied, Hamilton [2] and Slope Sum Function (SSF) [10], being the SSF the one implemented on the embedded system for its real-time properties. Other particularity is that this SSF algorithm was first developed to detect onset waves of arterial blood pressure pulses and is herein adapted for the R complex detection.

The feature extraction is based on a frequency ap-

proach, and follows Odinaka algorithm [7]. In [7] each single heartbeat is segmented into 64ms windows with an overlap between of 54ms. The analysis is performed in the frequency domain computing the short time Fourier transform (STFT) for each window (an Hamming is used for better estimation), in order to estimate a mean and a variance of each frequency bin. A custom algotithm for spectral zoom of the STFT is also presented and described. This algorithm adds resolution to the low frequencies were the ECG signal is preponderant without adding complexity.

In this paper the real-time constrain must be fulfilled. Samples cannot be lost and the authentication procedure must be as close as real time as it can be. Memory is also a need, in order to store the characteristics of the subjects. The microprocessor was discarded for his low versatility and costs to manufacture the embedded system, such as the FPGA for their high costs. The embedded platform is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. By contrast, a general-purpose computer is designed to be flexible and to meet a wide range of end-user needs. The proposed system implements a real-time state-of-the-art recognition algorithm, which extracts information from the frequency domain, on an architecture based ARM Cortex 4. The development MCU board, STM32F4-Discovery, was chosen due to its versatility, low power consumption, high speeds and DSP integration.

The system is designed to be autonomous, non-intrusive and easy to use on different scenarios. This is achieved combining the two electrode placement, one in each upper limb, with a battery powered embedded system with on-the-fly processing.

Preliminary results show the successful real-time implementation on the embedded platform enabling its usage on a myriad of applications.

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