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Human Identification Using Local Roughness Patterns in Heartbeat Signal

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Abstract : Despite having some progress in human authentication, conventional biometrics (e.g., facial features, fingerprints, retinal scans, gait, voice patterns) are not robust against falsification because they are neither confidential nor secret to an individual. As a non-invasive tool, electrocardiogram (ECG) has recently shown a great potential in human recognition due to its unique rhythms characterizing the variability of human heart structures (chest geometry, sizes, and positions). Moreover, ECG has a real-time vitality characteristic that signifies the live signs, which ensure legitimate individual to be identified. However, the detection accuracy of the current ECG-based methods is not sufficient due to a high variability of the individual's heartbeats at a different instance of time. These variations may occur due to muscle flexure, the change of mental or emotional states, and the change of sensor positions or long-term baseline shift during the recording of ECG signal. In this study, a new method is proposed for human identification, which is based on the extraction of the local roughness of ECG heartbeat signals. First ECG signal is preprocessed using a second order band-pass Butterworth filter having cut-off frequencies of 0.00025 and 0.04. A number of local binary patterns are then extracted by applying a moving neighborhood window along the ECG signal. At each instant of the ECG signal, the pattern is formed by comparing the ECG intensities at neighboring time points with the central intensity in the moving window. Then, binary weights are multiplied with the pattern to come up with the local roughness description of the signal. Finally, histograms are constructed that describe the heartbeat signals of individual subjects in the database. One advantage of the proposed feature is that it does not depend on the accuracy of detecting QRS complex, unlike the conventional methods. Supervised recognition methods are then designed using minimum distance to mean and Bayesian classifiers to identify authentic human subjects. An experiment with sixty (60) ECG signals from sixty adult subjects from National Metrology Institute of Germany (NMIG) - PTB database, showed that the proposed new method is promising compared to a conventional interval and amplitude feature-based method.

Keywords : human identification, ECG biometrics, local roughness patterns, supervised classification
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