Design and Evaluation of a Multisensor Bioelectrical System for Diagnosis of Atrial Fibrillation

Chakravarthy, Vasu
Chakravarthy, Rohit

Atrial fibrillation (AFib) is the most common type of arrhythmia, where atria beat chaotically, resulting in an inefficient pumping action that causes blood to pool in the atria, increasing the risk of embolic stroke. Early diagnosis and treatment in the paroxysmal stage, reduces chances of stroke and other cardiovascular events, however its asymptomatic nature eludes identification. Furthermore, due to its intermittent pattern, it is frequently missed or undiagnosed in the electrocardiogram (ECG), as the episode may not be captured on ECG if the patient is not currently experiencing AFib. The objective of this research is to design and evaluate a low-cost multisensor system with capability to detect AFib in real time, when the patient is in Normal Sinus Rhythm (NSR). This system incorporates three sensors that utilize a combination of patient ECG, Peripheral Systolic Pressures, and patient medical history. The portable, low-cost multisensor system, integrating hardware and software components, provides a complete test platform that performs ECG signal acquisition, digitization, and parameter estimation in addition to Peripheral Systolic Pressure analysis to diagnose AFib. Out of several prototype designs tested, final hardware implementation accomplished ECG signal amplification with minimal electrical noise interference and reduced circuitry, to increase ECG signal stability, clarity and fidelity. Software algorithms for ECG signal processing and Peripheral Systolic Pressure analysis were developed, and implemented in MATLAB. Statistical analysis involving Chi-Square tests and Receiver Operating Characteristic analysis were applied to validate system capability to predict, detect, and assess severity of AFib.