Visual Analysis of a Cardiovascular System Based on ECG and ABP Signals Using Evolvable Hardware Design

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Abstract

In this paper, visual data analysis was applied to raw medical data using probability theory to provide valuable information for preliminary diagnosis. The evolvable hardware design approach combined with information theory was applied to model an adaptive cardiovascular system. The cardiovascular system is modeled by a digital logic circuit based on ECG and ABP signal samples as input and output respectively. In our experiments, five patients' ECG and ABP data was chosen for the visual analysis. A user-friendly GUI was designed and the correlation of patient data was analyzed in the space and time domain. The digital circuit model was externally evolved using genetic programming as the evolutionary algorithm and mutual information as the fitness function. In our experiments using MATLAB, we demonstrated that the data analysis could provide valuable information for preliminary diagnosis, and the proposed method could fit the input-output relationship as recorded samples piece-wise in which each piece contains monotonic input data. The model we proposed is a self-reconfigurable digital circuit model based on input and output data. It's safe to conclude that the model is adaptive to changes based on different patient's unique ECG and ABP signals and the QI information is also changed. Furthermore, a "divide and conquer" method was employed to get a more accurate piece-wise model. Experimental results show that the method is feasible, scalable, and promising as a personalized medical simulation tool.

Keywords

modelling, medical data visualization, evolvable hardware, information theory, combinational logic circuits