Neural Network Learning of Decision-Making Management Algorithms in Non-Invasive Smart Devices for Cardiovascular System Diagnostics

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Abstract

Cardiovascular diseases (CVDs) are the leading cause of death globally, necessitating the development of efficient and interpretable diagnostic tools for real-time and out-of-hospital monitoring. This paper presents a hybrid neural network model that integrates clinical diagnostic logic directly into its architecture to enhance explainability and accuracy. A formalized algorithm based on biosignals - such as electrocardiography (ECG), photoplethysmography (PPG), and heart rate variability (HRV) - was developed to emulate expert decision-making. The algorithm was embedded into a Rule Injection Layer (RIL), enabling the network to combine expert knowledge with data-driven learning. Experiments using synthetic and real datasets demonstrate high diagnostic performance (up to 97.1% accuracy) and robustness under varying signal conditions. The model is optimized for deployment in low-power embedded systems, providing a reliable solution for non-invasive CVD monitoring with interpretable outputs. Explainability is further supported using the LIME framework, which highlights feature contributions for clinical validation.

Author keywords

biomedical signal processing; decision-making algorithm; embedded systems; explainable artificial intelligence; heart rate variability; hybrid model; medical logic; neural networks; non-invasive monitoring