PHYSICS INFORMED NEURAL NETWORK FOR ESTIMATION OF PHYSIOLOGICAL MODELS

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One of the most important tasks in biomedical signal processing is related to assisting clinical decision making by health care providers. To achieve this goal, we often utilize inverse models in which a vast amount of information that is available from physiological measurements (electroencephalography, electrocardiography, ultrasound, magnetic resonance imaging, etc.) is reduced to much smaller, but still meaningful, set of parameters. Depending on the phenomenon of interests the size of data may vary significantly thus affecting what kind of machine learning / artificial neural network techniques are applicable. In the case of limited amount of data (e.g. large patient-to-patient variability) we often need to utilize physics-based models in order to compensate for the lack of big data sets.

To this purpose in this paper we demonstrate several clinical applications in which physics-based models are utilized to estimate unknown physiological parameters. First, we demonstrate applicability of physics informed neural network for estimation of the electrical activity of the neonatal cortex using neural networks and finite-element-model of infant skull. Then we demonstrate the applicability of the proposed approach to estimating electromechanical properties of the heart using electrocardiography and tagged magnetic resonance imaging technique. We evaluate the performance of the proposed techniques for various scenarios for both simulated and real data measurements.