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Abstract

ESTES, S., KALOBWE, E., UTSEY, K., ZHAO, X. and H. FINOTTI. An interactive Mathematica notebook for synthetic fetal electrocardiograms. National Institute for Mathematical and Biological Synthesis, Knoxville, TN; University of Tennessee, Knoxville, TN; LeMoyne-Owen College, Memphis, TN; Carroll College, Helena, MT.

Some of the most common and fatal birth defects are those related to the heart. In adults, possible heart conditions are often identified through the use of an electrocardiogram (ECG). However, due to the presence of other signals and noise in the recording, fetal electrocardiography has not yet proven effective in diagnosing these defects. This paper develops a mathematical model of three-dimensional heart vector trajectories which we use to generate synthetic maternal and fetal ECG signals. The dipole model is a useful simplification in which the electrical activity of the heart is viewed as a single time-varying vector originating at the center of the body. We use a system of ordinary differential equations whose numerical solution approximates this cardiac dipole vector. To simulate the cardiac activity of both mother and fetus, two sets of these equations must be implemented. When implementing this model, various physiological factors must be accounted for. After realistic maternal and fetal dipole vectors have been simulated, they are projected onto random unit vectors representing the lead axes of the fECG. Noise is then added to the signal. Using this model we have built a database of realistic, synthetic fECG signals with different parameter values and noise levels. Currently algorithms to extract the fetal signal from the fECG are tested on a database of clinical recordings. Our synthetic database will allow for algorithms to be tested on a broader set of data.