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Development of fetal phonocardiography system for twin and multi pregnancy

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Abstract

Fetal phonocardiogram FPCG is the acoustic recording of mechanical activity of the fetal heart which facilitates the measurement of the instantaneous fetal heart rate, beat-to-beat differences and duration of systolic and diastolic phases. These measures provide information about the cardiac function and well-being fetus. This paper provides an algorithm to non-invasively estimate the phonocardiogram of an individual fetus in twin and multiple pregnancies. Many researchers have developed methods to detect and record the fetal heart beat and to separate the signals from the interfering mother's cardiac sounds but separation and identification of multiple fetal heart beat were not done. In our research study, a mixture of fetal phonocardiograms is simulated by a generalized pure delayed mixing model. Mutual independence of fetal phonocardiograms is assumed to apply blind source separation based techniques to extract the fetal phonocardiograms from their mixtures. The performance of the algorithm is verified through simulation results and on experimental data obtained from a phantom that is used to simulate a twin and multiple pregnancy. The mechanical activities in a pregnant woman's abdomen produce low frequency vibrations and sounds due to vibroacoustic signals from various sources of acoustic within the person as well as from fetal activity. The stethoscopes are used to record the acoustic signals. The acoustic signals are assessed from the anterior abdominal surface to get better signal strength. In a multiple pregnancy, the acoustic signals from the multiple fetal heart beats interfere with each other and also with mother's beat. The separation of the signals and identification of the individual fetal heart beat is a difficult task owning to the different phases of the fetal heart pulses and also due to the variability of the fetal heart rate. In our study we have developed a phantom with miniature speakers attached within in the phantom mimicking location of the multiple the fetal hearts and the mother's heart. The speakers are connected to an external electronic circuitry and triggered to produce variable fetal heart beat which can be modified through computer programmes. We have used both the recorded fetal heart beat acquired through a digital stethoscope as well as simulated acoustic signals. Variety of signals was created and the mixtures of the signals along with the noices were recorded at the surface of the phantom. The signals were electronically treated for filtration and amplification. We have used digital electronic stethoscope (the Thinklabs DS32A) in the detection of the heart sounds. We have used LabView and Think Labs software to separate the signals and identify the heart beats from individual fetus. The comparison of the results obtained by both the methods and algorithms developed would be presented.

Biography

Jamel Smida has received the degree in Electric Engineering and the Aptitude certificate for technology education in 1995, and the M.Sc. (Aggregation) degrees in Electric Engineering in 2000 from Tunis University. He has served various Engineering and Medical University at various teaching profession. Head of Electrical Engineering in the Graduate Institute of Technological Studies of Gafsa – TUNISIA from 2002 until 2006. He is Graduate Student Researcher with the Unit of Research CEREP at the ESSTT - Tunisia. Currently he is working as a Lecturer and Quality Centre Manager in the College of Applied Medical Sciences, Majamaah University, Kingdom of Saudi Arabia and pursuing his PhD from Tunis University.

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