VLSI IMPLEMENTATION FOR EXTRACTION OF FETAL ELECTRO CARDIOGRAM FROM ABDOMEN ELECTRO CARDIOGRAM

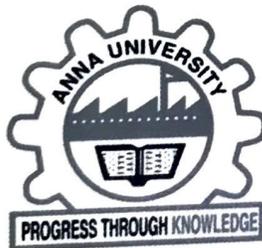**A THESIS**

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ABSTRACT

Fetal electro cardiogram detection plays a significant role in fetal abnormality detection during labor rather than a heartbeat and heart sound using pinard horn. The detection of electrical activity of the fetus heart helps in the reduction of fetal still birth. Fetal distress is observed by predicting fetal heart rate variation indirectly during pregnancy and labor. Maternal and fetal Heart Rate Variability (HRV) cycle is constructed from the detected QRS wave and the Fetal Heart Rate (FHR) parameters are quantify the fetal status well-being. So, the fetal status is observed noninvasively. Placing of electrode is important to acquire the ECG signal with high quality from the pregnant mother. So the basic knowledge is required for placing the electrodes in the abdomen. Abdomen ECG is the mixture of fetal and maternal ECG, muscular noise and power line interference. Maternal ECG amplitude is five times stronger than the amplitude of fetal ECG and the signal is overlapped in time domain and frequency domain. Hence, maternal electro cardiogram removal and extraction of fetal ECG is the major challenge in the signal processing technique.

Initially, a portable device is designed for the acquisition of abdomen ECG. The adaptive noise cancellation and wavelet transformation techniques are applied for the extraction of fetal ECG. The mean value of the extracted fetal heart rate is nine times of mother's ECG in adaptive noise cancellation technique and two times greater in wavelet transformation technique. Simulator data, physionet data and real time data are used to test the performances of both the techniques by determining the parameters such

as sensitivity, accuracy and positive predictive value. In adaptive method, the parameters are 96.83, 89.87 and 92.55 and in wavelet the values are 95.97, 88.5 and 92 respectively. In addition, heart rate variability of mother and fetus are analyzed for continuous monitoring.

Next, for continuous monitoring of the pregnant mother and fetus, wearable fetal monitoring front end system is designed to full fill the requirement of VLSI design like size, low power and cost. Front end system is designed with conventional instrumentation amplifier, filters and multiplexer. The system is implemented in cadence tool and Common Mode Rejection Ratio (CMRR), gain and power consumption with Power Supply Rejection Ratio (PSRR) of 82 dB is measured. The values are 170 dB, 80 dB and 300 µW respectively.

Finally, current balancing instrumentation amplifier is designed using tanner tool for achieving less power consumption, high common mode rejection ratio and good noise rejection. The measured parameters of conventional and current balance approach are compared to evaluate the performance of the Analog Front End (AFE) system. Current balance front end amplifier produces better result than conventional since the gain of the amplifier is not varied by the mismatch of resistors.

In future, the designed circuit is fabricated for continuous and long term monitoring of fetus and pregnant woman. Also, the maternal ECG signal elimination can be done by using adaptive noise cancellation with neural network. In addition, instead of acquiring mothers signal from thorax Adaptive Neuro Fuzzy Interference System (ANFIS) is designed to predict maternal component from the abdomen ECG.