Fetal Pulsed-Wave Doppler Atrioventricular Activity Detection by Envelope Extraction and Processing

Pulsed-Wave Doppler (PWD) is a diagnostic ultrasound techniques recommended in presence of suspicious heart cardiac defects, abnormal heart function or rhythm. It is also widely used for fetal heart rate monitoring and has been already investigated to identify the fetal cardiac valves timings, along with fetal ECG. When applied to fetuses, this technique is challenging since, beyond being intrinsically operator-dependent, different issues related to the fetal heart size, the fetal movements and the ultrasound artifacts appear. In long PWD recordings, the signal segments completely meaningful for a morphological analysis, i.e. including a readable atrial and ventricular activity, are then limited in number and duration.

In this work, an approach for the automatic extraction of the fetal PWD envelope from PWD video recordings is presented and evaluated, by comparing the performance with respect to the manual annotation and measurement by expert cardiologists. It consists of the video pre-processing for the extraction of the region of interest from the frames, their analysis and the append to create a single long image representing the Doppler spectrogram of the whole examination, image thresholding, filtering and envelope extraction by edge detection. A dataset including 30 signals from as many pregnant women was adopted, extracting from it multiple segments including different quality readable recordings, artifacts, and unreadable recordings. A supervised classification approach for the detection of the signal segments completely meaningful for a morphological analysis was then applied, revealing an accuracy greater than 85%. On the detected beats, some amplitude and time measurement are automatically performed by the algorithm, whose accuracy is currently being evaluated.