Background: Fetal movements are clinically correlated to fetal wellbeing. Ultrasounds are the most accurate measurements of the fetal movement but expensive and intrusive. To avoid these constraints, Fetal activity is captured through data acquired using low cost and noninvasive accelerometer. Time-frequency distributions (TFDs) are often used to represent the energy, temporal and spectral characteristics of non-stationary signals in the time and frequency plane.

Many quadratic TFDs were proposed in the literature such as Wigner-Ville distribution, Spectrogram, B-Distribution, Choi-Williams, etc. The drawbacks of the majority of these techniques is that only a few parameters can be modified in the kernel, generally the lag and Doppler parameters, so that they cannot be easily adapted to the data.

Objectives: This work aims at designing a new kernel with several parameters that leads to a higher resolution time frequency representation (TFR) of the signal, therefore improving the characteristic of the fetal movement.

Methods: The proposed TFD can be considered as an extension of the Gaussian TFD (also called Choi-Williams distribution). The kernel function of the proposed kernel is given by the sum of the weighted derivative Gaussian TFD (refer to the equation).

Results and Conclusion: The weighted parameters in the above formula can be estimated by maximizing the concentration of the instantaneous frequency. The resulting TFD is compared with other methods and applied to the analysis and classification of the fetal movement data recorded by the accelerometers. The results obtained indicate that the proposed time-frequency methodology allows the detection of fetal movement data recorded by accelerometers.

\[ J_{\text{lag}}(\nu, \tau) = \sum_{i} w_i \frac{\partial^i e^{-\frac{\nu^2 \tau^2}{\sigma}}}{\partial \nu^i} \]

Background: The analysis of Electroencephalography (EEG) signals acquired from epileptic babies shows that seizures can be modeled as piecewise linear frequency modulated (LFM) signals. This fact motivated the use of time-frequency matched filters (TFMFs) for seizure detection in newborn EEG. A TFMF is characterized by a unique test statistic, which is found based on the time-frequency (TF) correlation between the signal under analysis and a template. The test statistic is compared with a threshold to determine the presence or absence of the template in the signal under analysis.

Objectives: We present two seizure detection algorithms based on the general class of TFMFs and an improved algorithm in the ambiguity domain and evaluate their performance using real EEG signals.

Methods: The method includes the following stages:
1. Based on TF analysis of newborn EEG, we create a template set containing M piecewise LFM signals with L pieces and slopes.
2. We define test statistics based on the TF correlation between the EEG signals under analysis; we use the Wigner-Ville distribution (WVD) and other quadratic Time-Frequency Distributions.
3. The test statistics are compared with a predefined threshold.

Results: We evaluated the performance of the proposed method using a database of newborn EEG signals. For each method, we found the area under the receiver operator characteristic curve (AUC) as the performance criteria. All the methods detected seizure accurately with AUC more than 0.9.

Conclusions: This work shows that TFMFs can detect seizures in newborn EEG with a very high accuracy. The optimization of the parameters of the TFDs and the use of fast and memory efficient algorithms for computing TFDs can improve the performance of the methods.