Linear and Non-Linear Features for Intrapartum Cardiotocography Evaluation

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Cardiotocography (CTG), consisting of fetal heart rate (fHR) and tocographic (TOCO) measurements, is used to evaluate fetal well-being during the delivery. It provides real-time information of fetal status and allows clinicians to detect ongoing hypoxia.

In this work we tried to confront new (from the obstetricians point of view) descriptive features with day-to-day clinical praxis.

In the data preprocessing phase 20-minute segments preceding the deliveries were selected. Artifacts were removed and the fHR signal was interpolated to equidistant 4Hz sampling frequency.

Final data set consisted of 476 recordings each annotated by three expert obstetricians into FIGO-like categories: normal; suspect and pathological.

Then linear and nonlinear features were computed. Many of these features are known in the field of HRV processing, but completely unknown in obstetrics and their benefits there has yet to be proven. The linear features computed were: description of the fHR baseline using mean, median and SD measures, SDNN, RMSSD, mean of RR interval, and NN50 from the time domain. The non-linear features computed were: Fractal dimension of attractor, fractal dimension of waveform, entropy, and complexity. The particular methods used to compute the features were: correlation method for estimation of attractor dimension; Higuchi's, variance, and box counting method for estimation of waveform fractal dimension; approximate and sample method for estimation of entropy and the Lempel Ziv Complexity.

Two fold evaluation of the features was employed. All features were investigated for their informational gain and feature selection was performed resulting into several sets of features. These feature sets were used for data classification using decision tree algorithm.

Promising new features were identifyied: baseline standard deviation; sample entropy and Higuchi's fractal dimension. Features useful for everyday use in the obstetrician wards since our classification mehtod outperformed the FIGO guidelines classifier while matching expert panel interobserver variability.