



Fetal ECG detection

Biomedical Signal Processing (2023-2024)

Carlo Monti (matr. 990990)



REFERENCES

- **Paper:**
 - S. M. M. Martens, C. Rabotti, M. Mischi and R. J. Sluijter - *A robust fetal ECG detection method for abdominal recordings* - Physiological Measurement, 28, 373, 2007
- **Dataset:**
 - Noninvasive Fetal ECG: *The PhysioNet/Computing in Cardiology Challenge 2013*
 - 25 (+ 50) recordings of 4 channel ECGs (1 min each) with annotated FECG

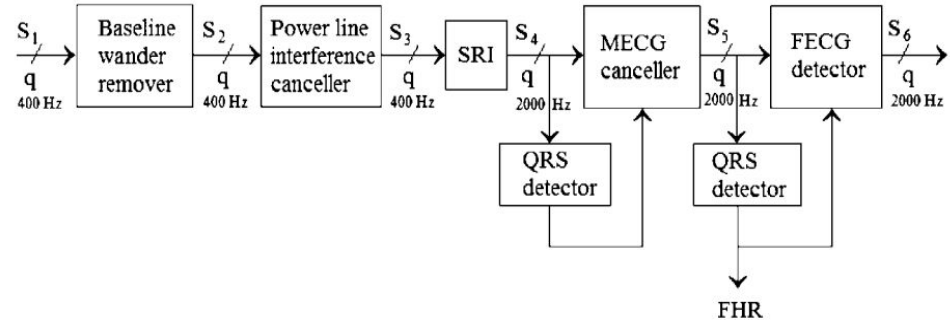


FETAL ECG DETECTION

- Fetal ECG provides information about the fetal well-being:
 - Fetal oxygenation
- Can be obtained by applying an electrode on the fetal scalp:
 - Only during labour
 - Highly invasive!
- Abdominal recordings:
 - During pregnancy and delivery
 - At home monitoring
 - Non-invasive

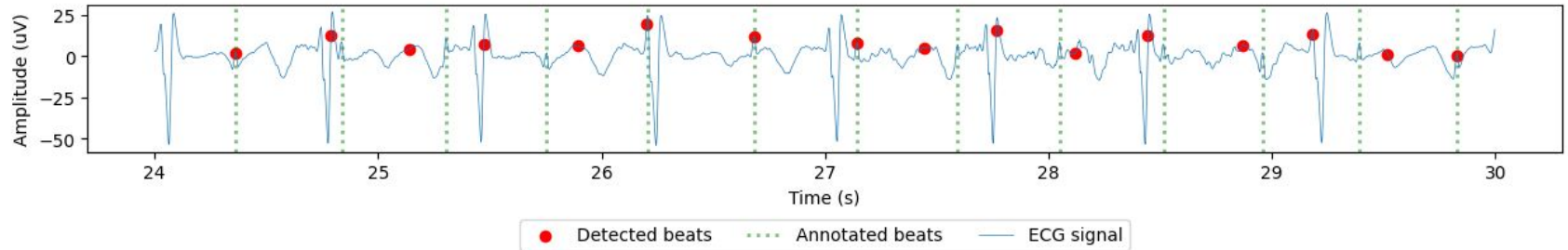
THE ALGORITHM

- Data preprocessing
 - Baseline removal
 - Power line removal
 - Upsampling to 2000Hz
- Mother QRS detection
 - Enhancing using PCA
 - Building QRS template
 - Find peaks with correlation
- Mother QRS removal
 - Averaging and scaling template
 - Template matching
- Fetal QRS detection



EVALUATION

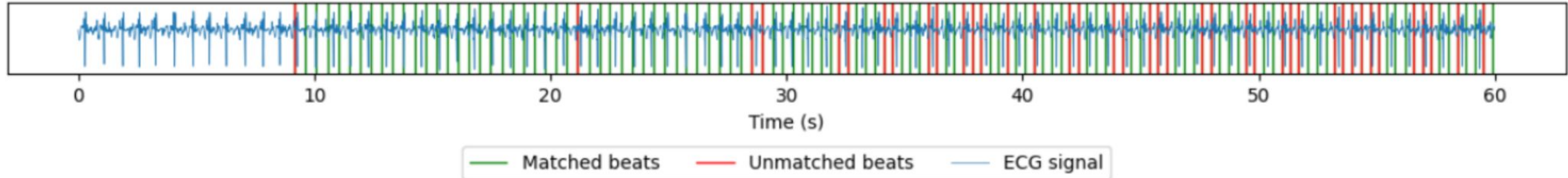
- Beat detection: how many beats are correctly detected?
- FHR trace: how good is the bpm detection?



FETAL ECG DETECTION

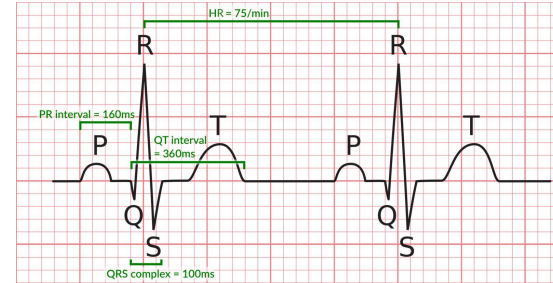
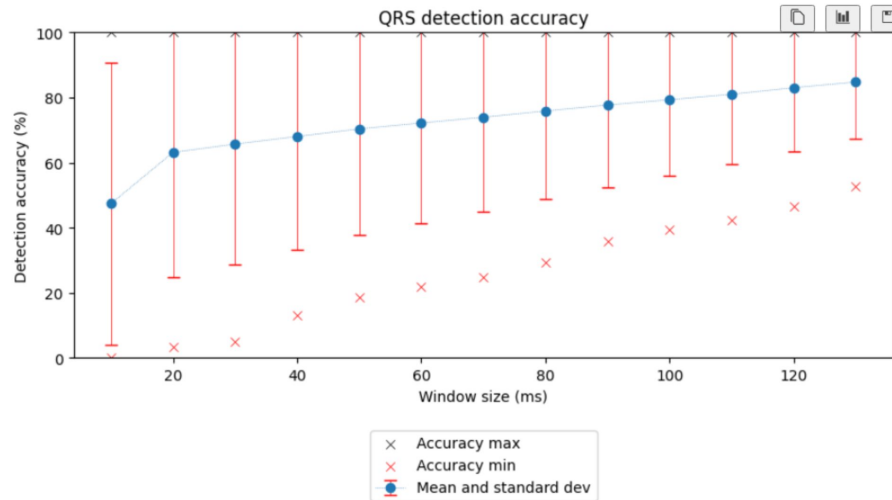
- For every annotated beat we check if there is a detected beat within a window centered on it
 - We check the performance using different window sizes
 - We evaluate: Performance, RMSE, Mean, Std Dev

Sample ID	Window size (ms)	N° of beats	N° of matches	Performance (%)	RMSE	Mean (ms)	Std Dev (ms)
1	130	125	85	68.0	179.45	-143.4	107.88



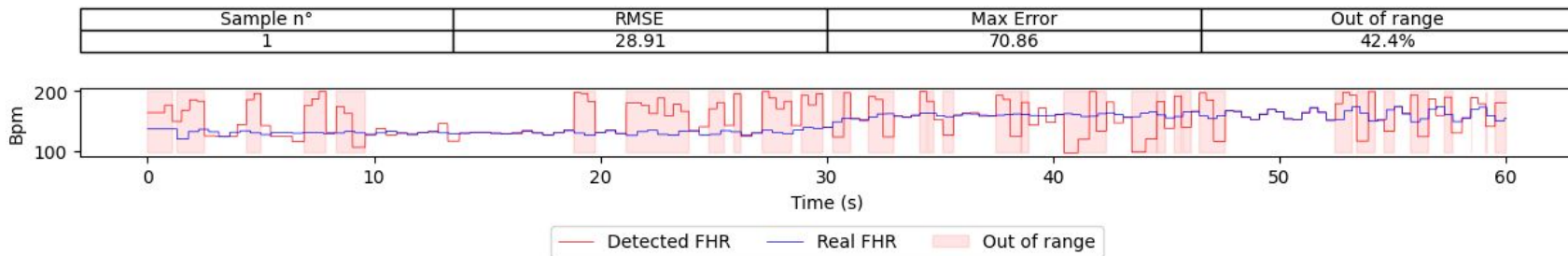
OVERALL ACCURACY

- We evaluate how the overall accuracy change given the detection window size.
- The accuracy grows as the detection window widens but there is still a big variance (and some relevant outliers)!



FHR TRACE

- For each sample, we build the FHR trace and we evaluate how much it deviates from the ground truth.
 - We also check the maximum error and how often it was out of range.
- A little offset in the detection can change the FHR trace a lot!



PEAK DETECTION

- The algorithm performance is highly dependent on the method used to find peaks.
 - We need to find peaks in many places of the procedure (build the QRS average, find correlation, ...)
 - We tried with different values of “distance” (a parameter of `signals.find_peaks` function)

