FETAL ECG DETECTION METHOD FOR ABDOMINAL RECORDINGS

final project presentation for Biomedical Signal Processing

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SELECTED ARTICLE

IOP PUBLISHING PHYSIOLOGICAL MEASUREMENT

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A robust fetal ECG detection method for abdominal recordings

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DATASET

- 25 recordings of abdominal ECG
- 4 channel ECG
- each 1 minute long
- sampling frequency of 1000Hz

PIPELINE

01 DATA LOADING AND PREPROCESSING

02 QRS DETECTOR

03 MECG CANCELLATION METHOD

04 FECG FEATURE EXTRACTION

05 EVALUATION

06 RESULTS

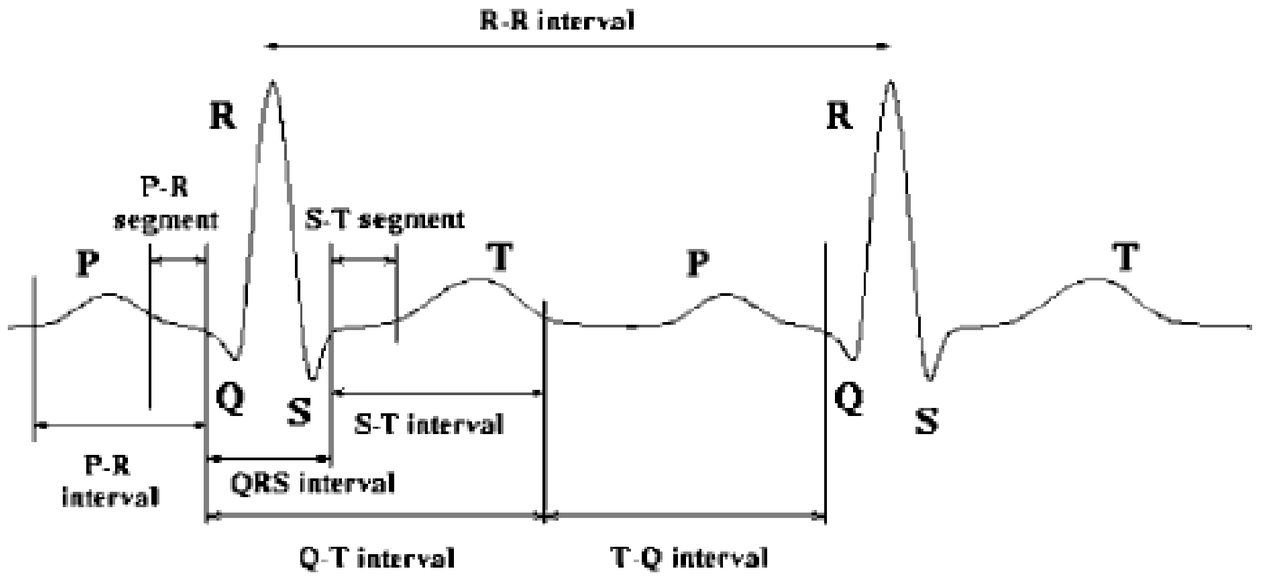


Figure 1. Nomenclature of the electrocardiogram (ECG).

MARTENS SM, RABOTTI C, MISCHI M, SLUIJTER RJ. A ROBUST FETAL ECG DETECTION METHOD FOR ABDOMINAL RECORDINGS. PHYSIOL MEAS. 2007 APR;28(4):373-88.

DATA PREPROCESSING

01

LOADING AND SIGNAL INTERPOLATION

02

BASELINE WANDERING REMOVAL

high pass FIR filter
cutoff 3Hz
1001 taps
sampling frequency 1000Hz

03

POWER-LINE INTERFERENCE CANCELLER

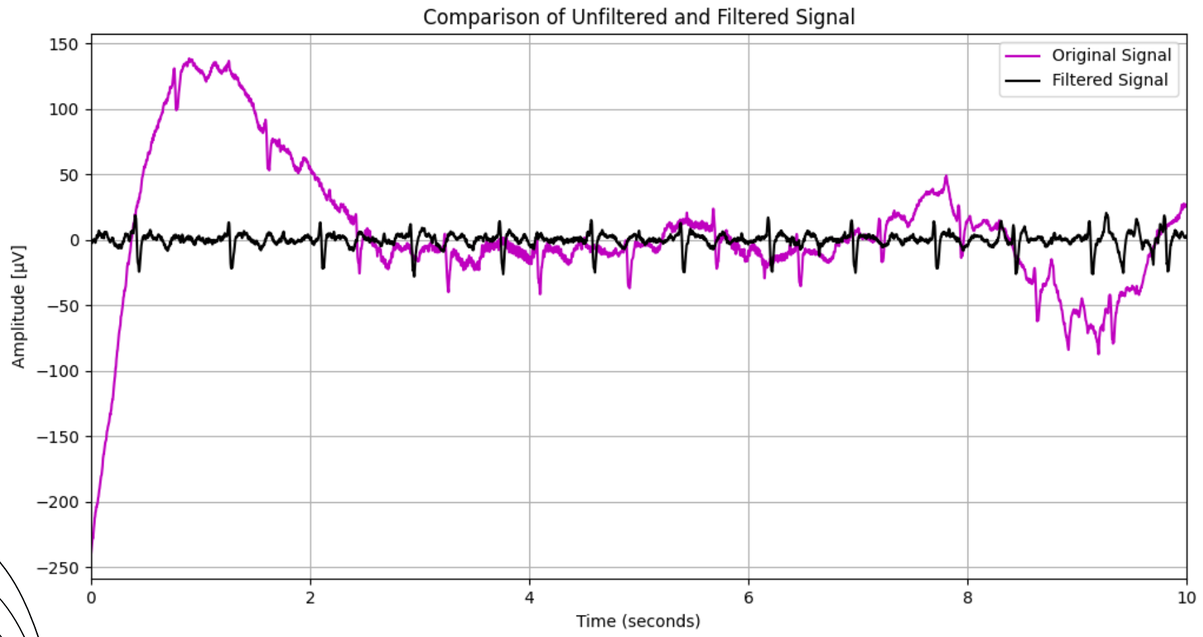
notch filter
cutoff 50Hz
fs 1000Hz

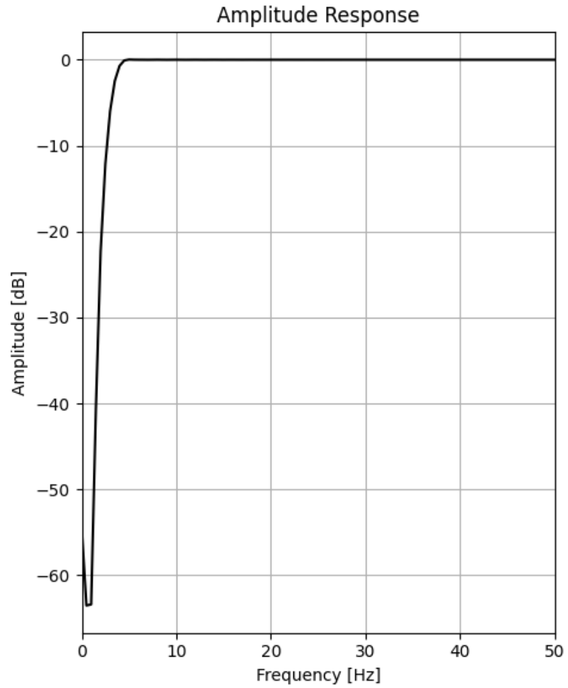
04

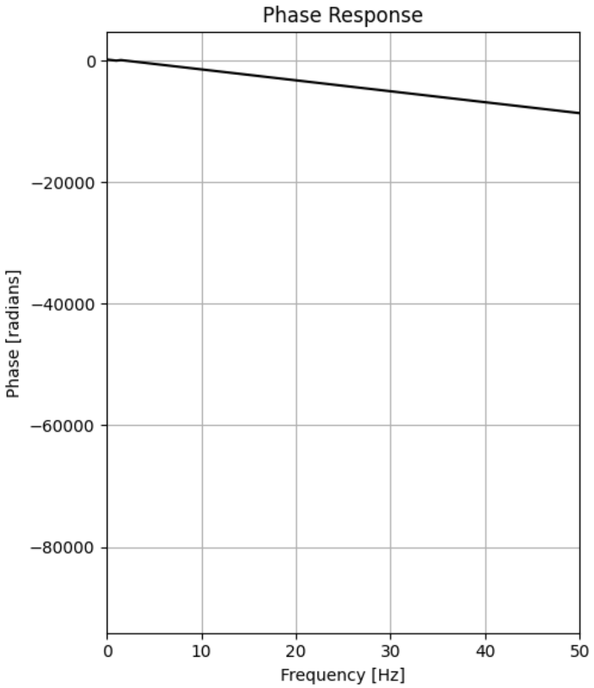
UPSAMPLING OF THE SIGNAL

from 1000 Hz
to 2000 Hz

FILTERING

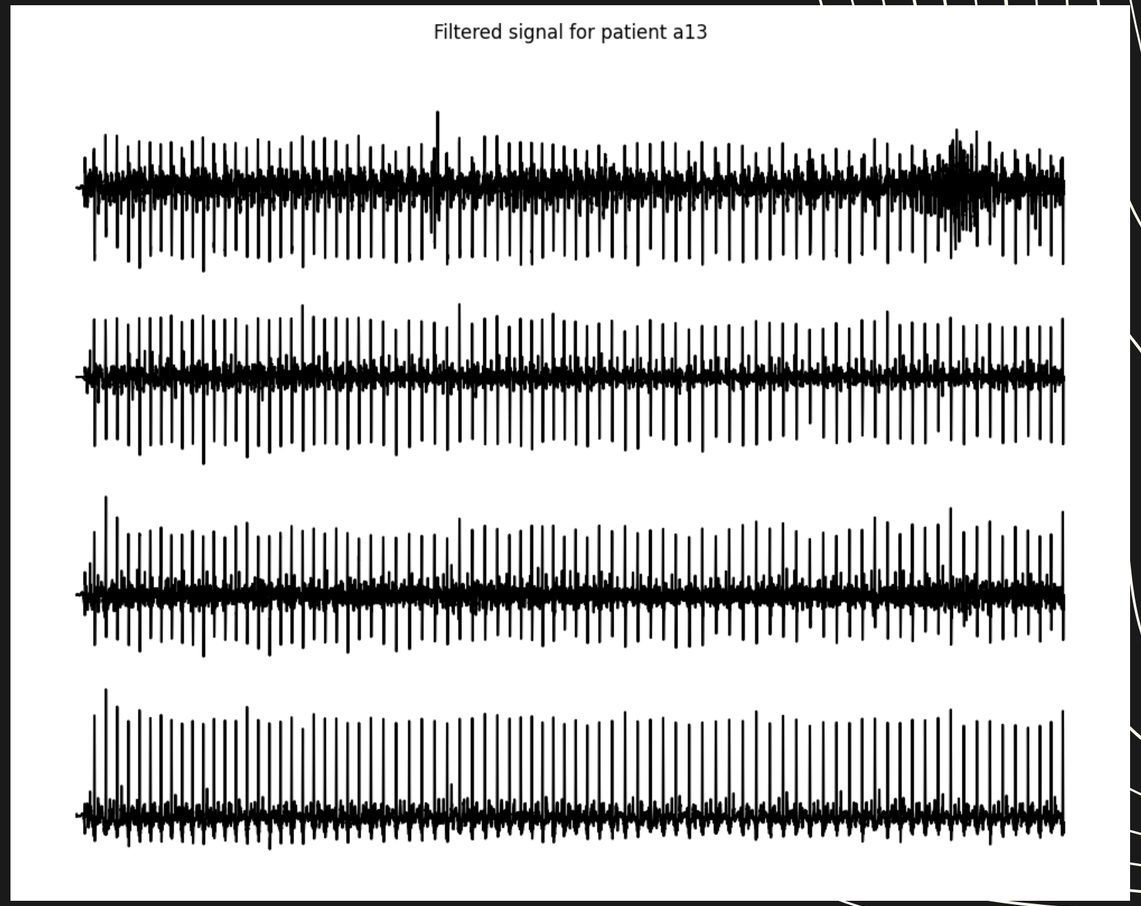






Baseline wander removal. Left plot shows part of one abdominal ECG channel before and after baseline wander removal with the filter. The right plot shows the amplitude (left) and phase (right) of the high-pass filter transfer function.

VISUAL INSPECTION



comparison of the original signal and signal after preprocessing

QRS DETECTOR

ENHANCE THE QRS SIGNAL

optimal combination of the channels is derived by performing a principal component analysis

CREATE A QRS TEMPLATE

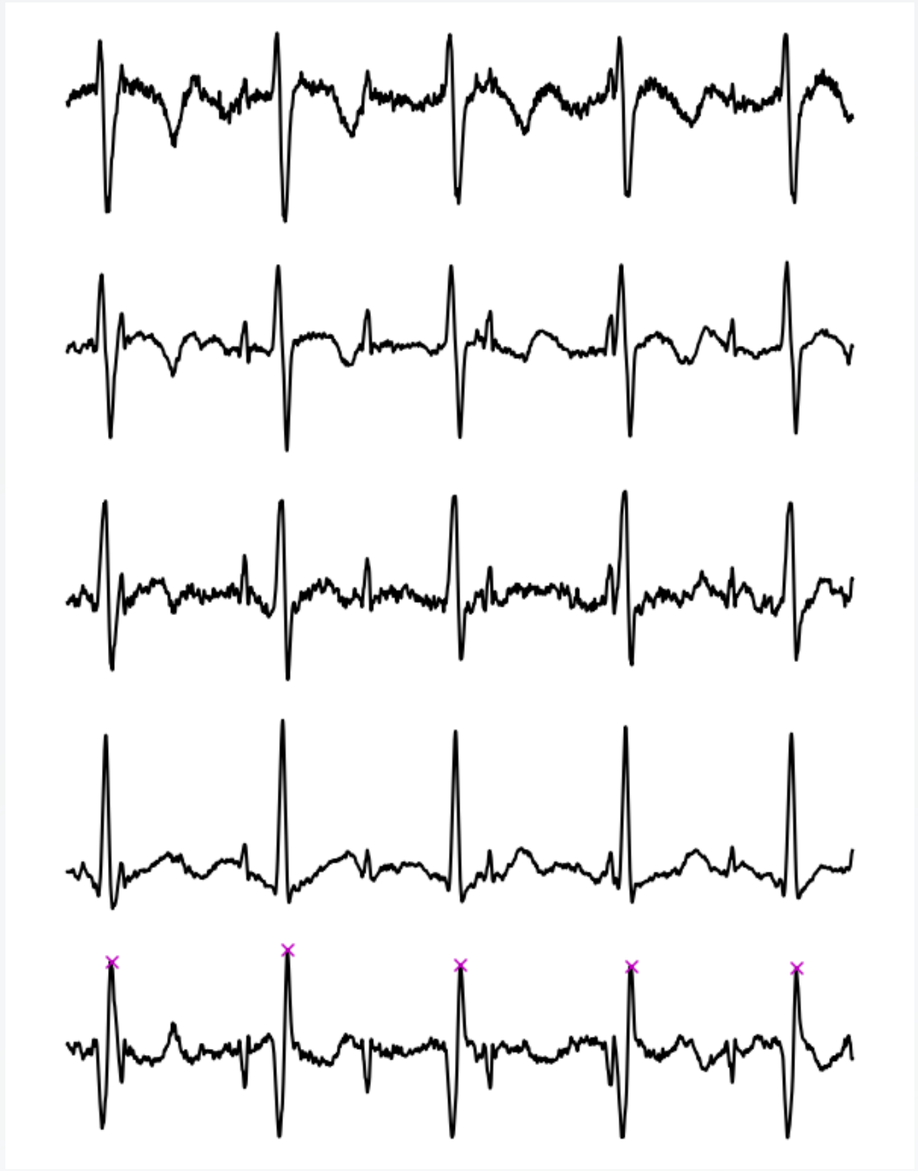
take a bunch of segments of the enhanced signal that contains a QRS complex and take the mean that will serve as a QRS template

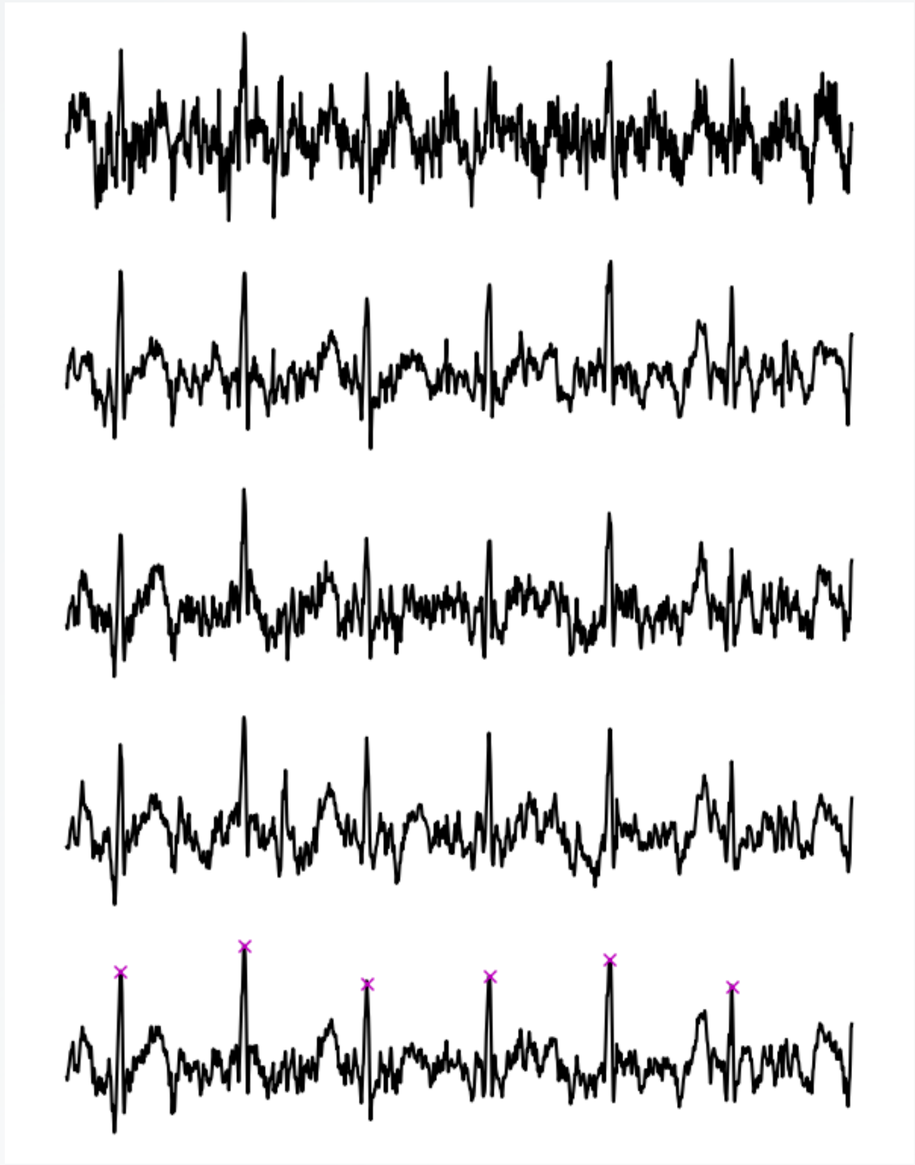
minimal distance between R peaks:

- 0.6s for MECG (HR 100bpm)
- 0.34s for FECG (FHR 175bpm)

DETECT QRS PEAKS

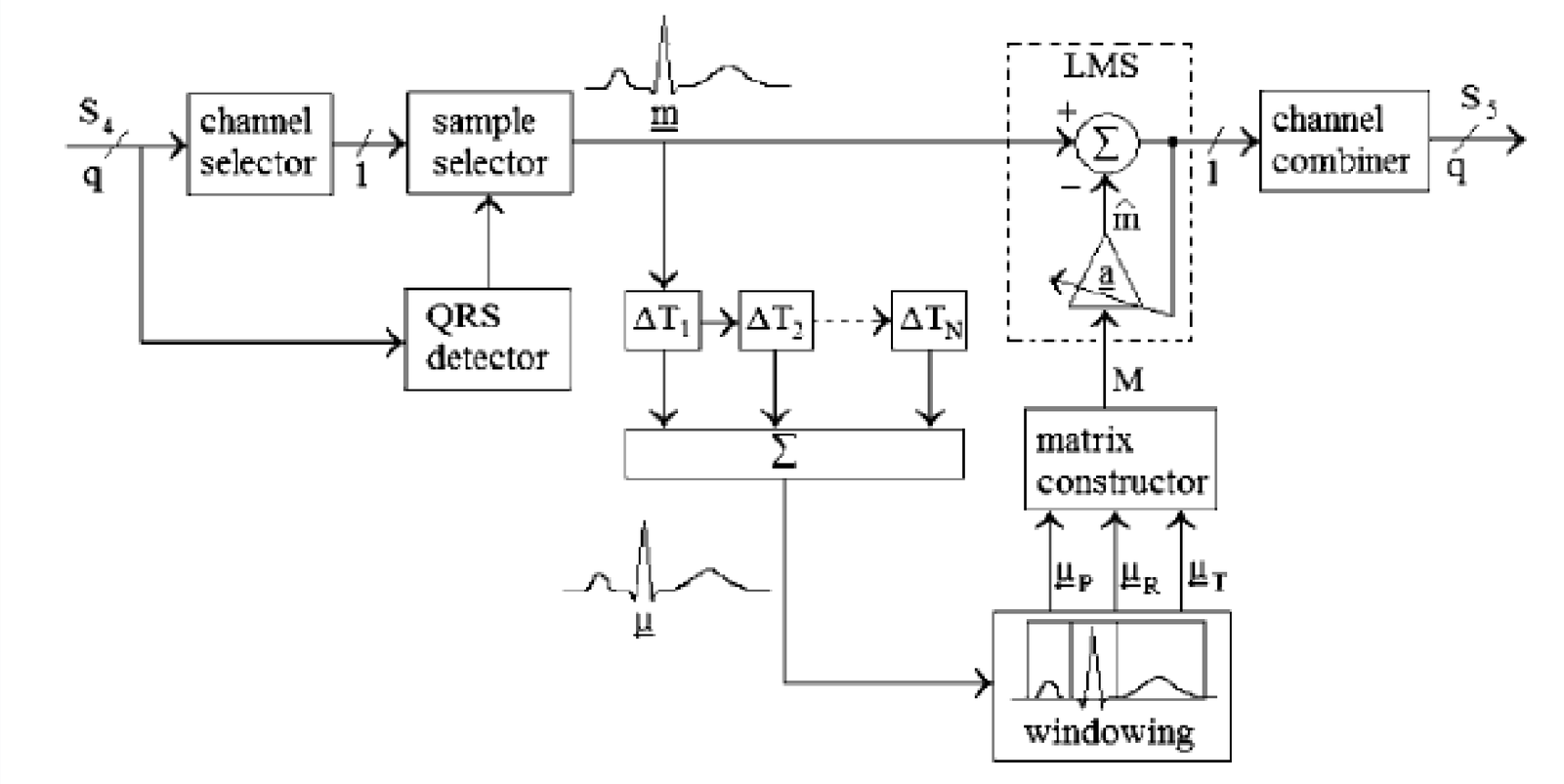
use cross-correlation between the enhanced signal and the QRS template to identify potential QRS complexes





QRS detection for the MECG (left plot) and FECG (right plot). Plots show signals from 4 leads and the signal generated by the multi-channel QRS enhancement method (bottom signal). The detected QRS complexes are indicated by purple x.

MECG CANCELLER



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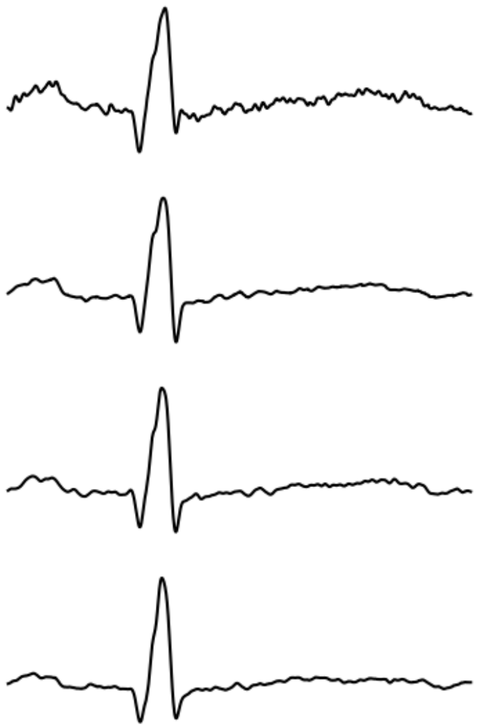
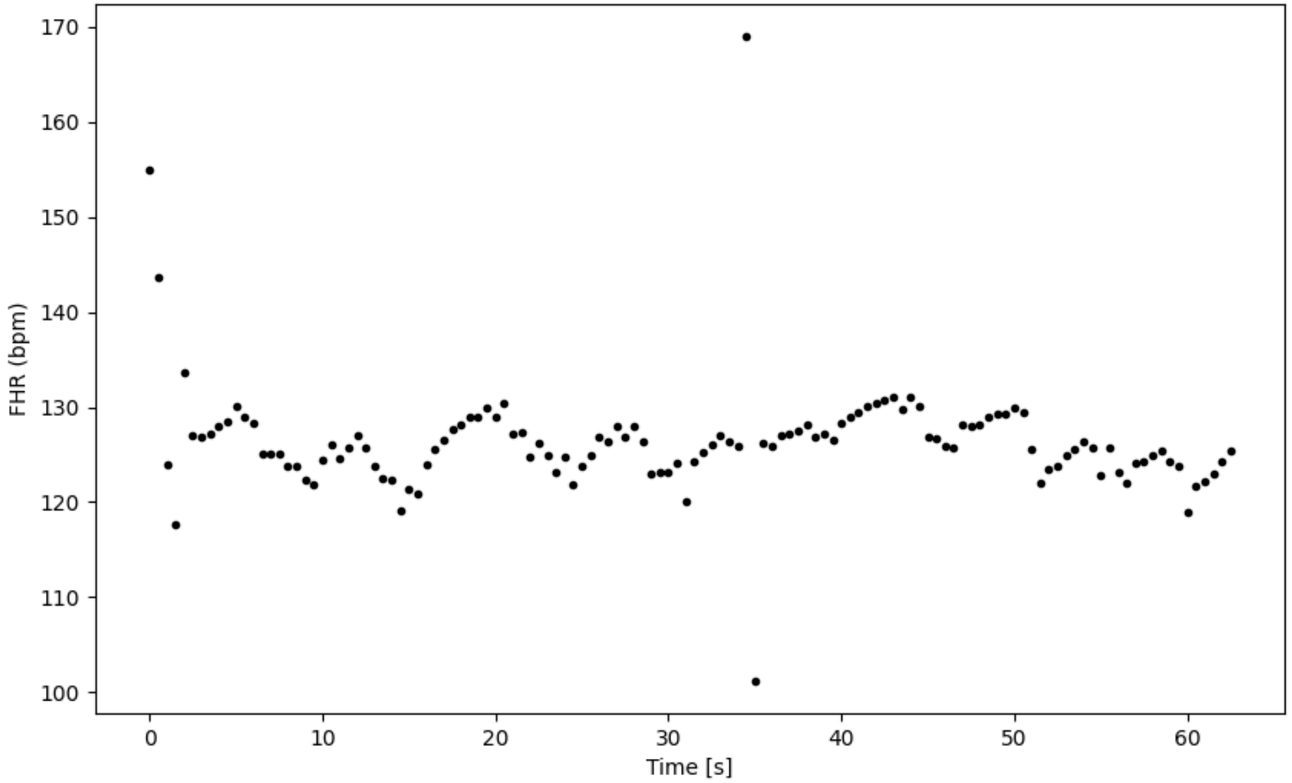
FECG DETECTOR

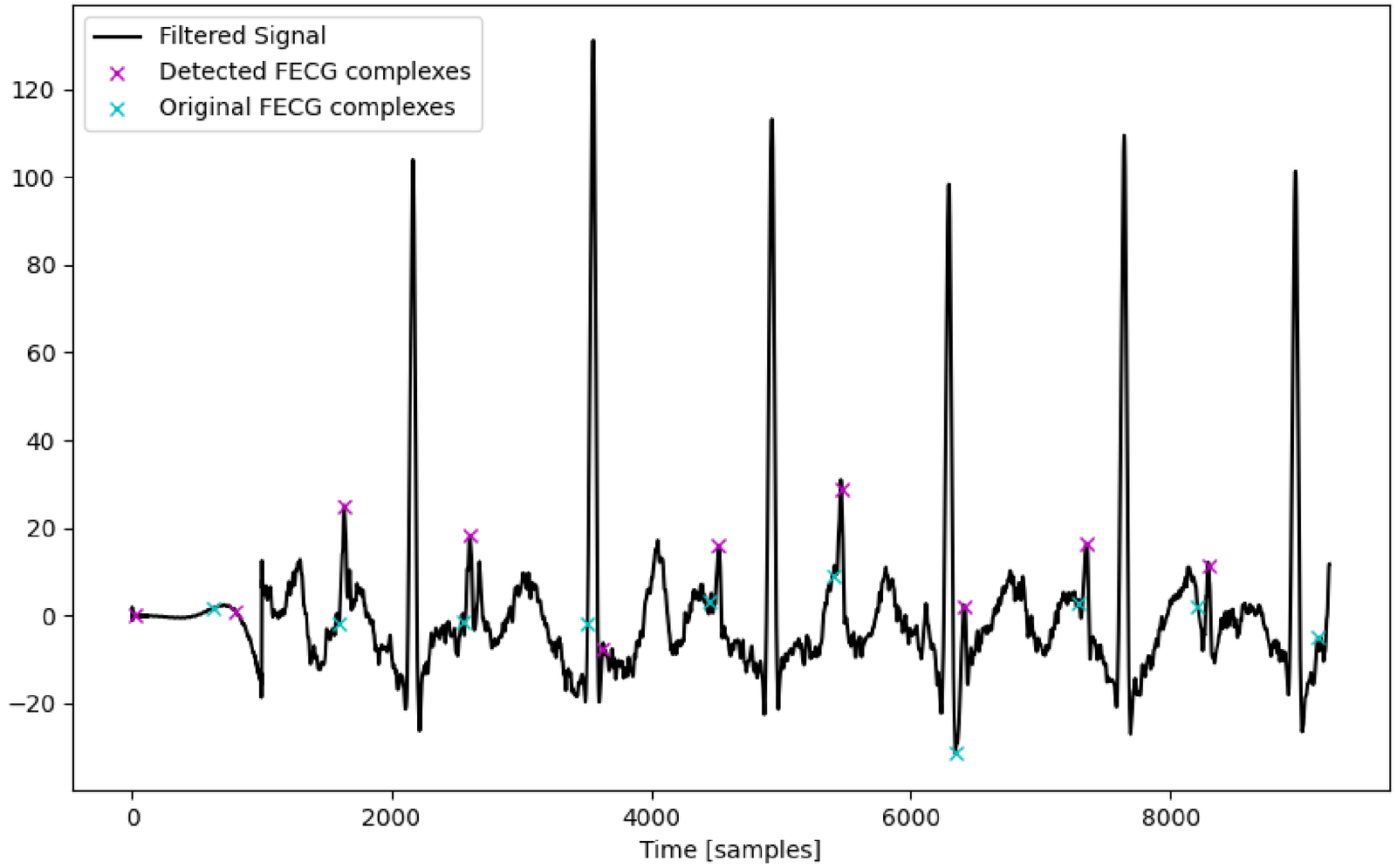
averages FECG complexes synchronized on the fetal QRS complex

returns FECG complex template and FHR trace

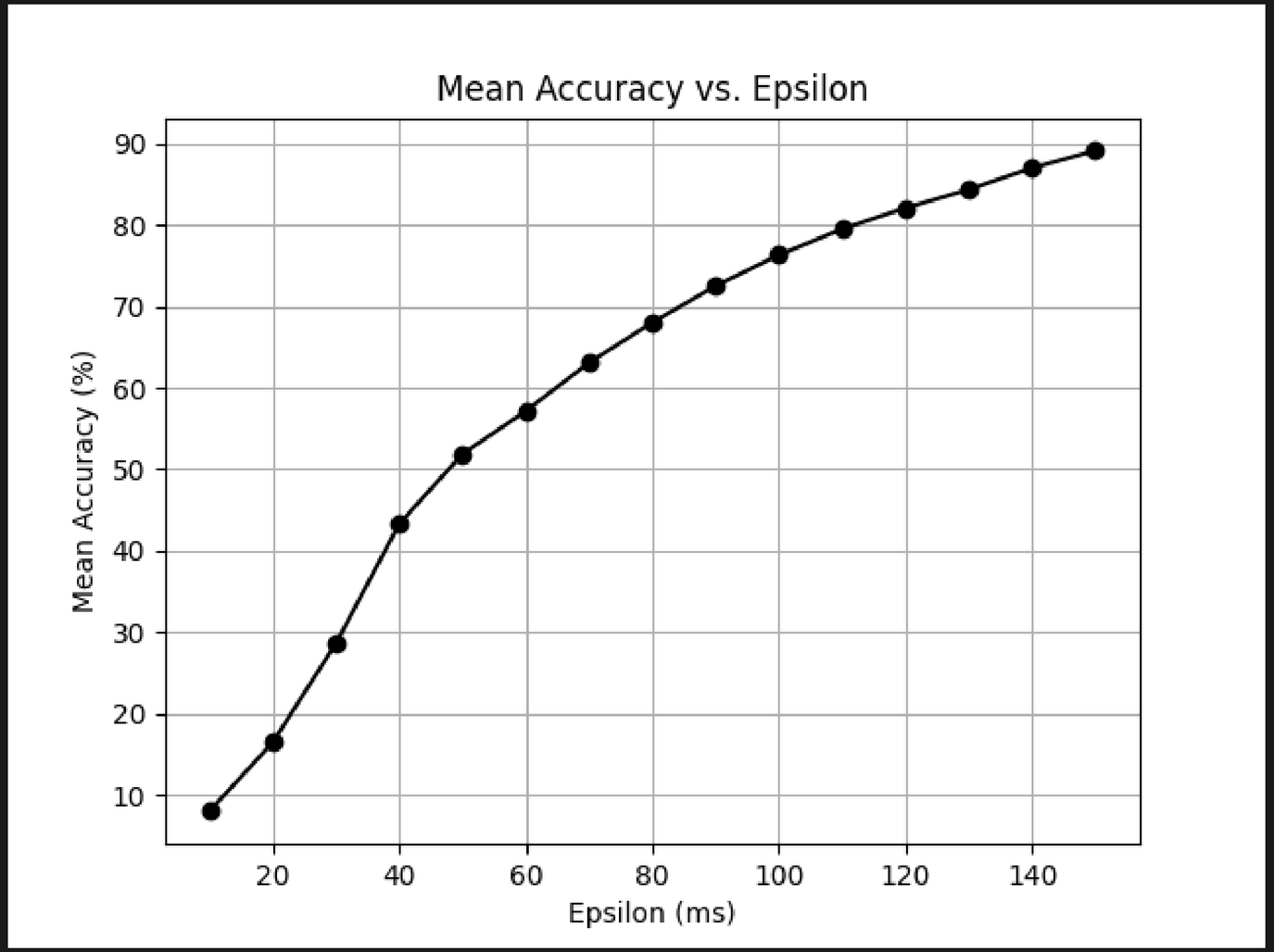




EVALUATION


Filtered Signal
Detected FECG complexes
Original FECG complexes
120
100
80
60
40
20
0
−20
0
2000
4000
6000
8000
Time [samples]

RESULTS




```
Accuracy for patient 1: 56.72%
Accuracy for patient 2: 50.77%
Accuracy for patient 3: 82.81%
Accuracy for patient 4: 95.45%
Accuracy for patient 5: 100.00%
Accuracy for patient 6: 49.21%
Accuracy for patient 7: 56.35%
Accuracy for patient 8: 97.66%
Accuracy for patient 9: 54.47%
Accuracy for patient 10: 56.91%
Accuracy for patient 11: 58.73%
Accuracy for patient 12: 84.78%
Accuracy for patient 13: 99.21%
Accuracy for patient 14: 80.31%
Accuracy for patient 15: 75.37%
Accuracy for patient 16: 49.12%
Accuracy for patient 17: 96.97%
Accuracy for patient 18: 50.00%
Accuracy for patient 19: 94.49%
Accuracy for patient 20: 95.45%
Accuracy for patient 21: 66.91%
Accuracy for patient 22: 60.28%
Accuracy for patient 23: 98.43%
Accuracy for patient 24: 99.19%
Accuracy for patient 25: 98.40%
Mean accuracy: 76.32%
```