Separating uterine EMG records using sample entropy

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Abstract

Uterine electromyogram (EMG), also termed electrohysterogram (EHG), represents electrical activity of uterus. The EHG signals contain also intervals with increased electrical activity of uterus. The increased electrical activity is visible in the EHG signals as short bursts with higher signal amplitude. These intervals usually coincide with contractions.

I. Introduction

The frequency contents of the EHG signals changes during contractions, but the studies have also shown, that the frequency contents of the EHG signals as well as frequency contents of individual contractions within a signal, changes as the labour approaches. Our task was to analyse 4 different records and their sample entropies:

- PE - pre-term labour, recorded before 26th week.
- PL - pre-term labour, recorded during or after 26th week.
- TE - term labour, recorded before 26th week.
- TL - term labour, recorded during or after 26th week.

II. Methods

In the assignment we used Matlab on web. We used Term-Preterm EHG Database.

- We wrote a MATLAB program which opens 4 records and calculates sample entropy for the signal 3 of each record.
- We also calculate one second signal, we calculated for pre-term labour, recorded before 26th week.
- Before calculating sample entropy, each signal was digitally filtered using 4 - pole digital Butterworth filter with a doublepass filtering scheme.
- The band-pass cut-off frequency was from 0.3Hz to 4Hz. We took one record from each group.
- The program calculates sample entropy using the pattern length of m=3 and pattern match margin of r=0.15.

Sample entropy is a measure of regularity, finite length time series and estimates the extent to which the data did not arise from a random process. Less predictable time series exhibit a higher sample entropy.

When the labour is aproaching, the power spectrum is moving to lower frequencies which makes the signal more predictable. Therefore, the sample entropy is lower because of higher predictability.

The Butterworth filter is a type of signal processing filter designed to have as flat a frequency response as possible in the passband. It has a smooth frequency response and is computationally non intensive. Filter can be high-pass, low-pass or band-pass.

We used band-pass filter with bandpass be-

tween 0.3 - 4 Hz, we can see comparisions of linear filters on figure 1.

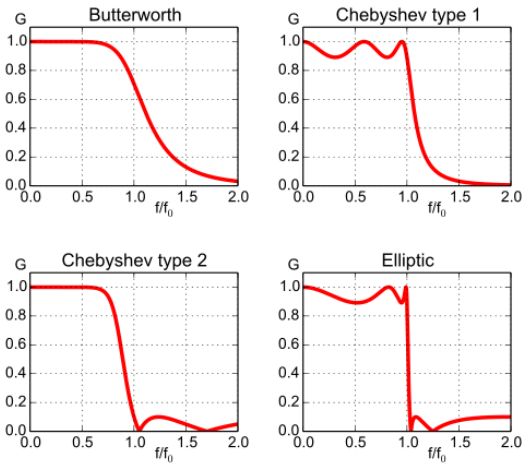

Figure 1: *Comparision with other linear filters.*

III. Results

On graph 2, we can see Signal of early pre-term labour.

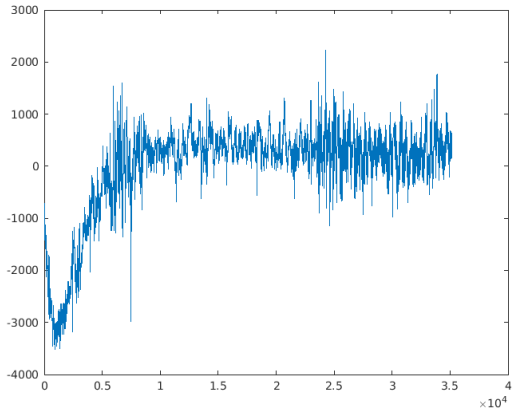

Figure 2: *Pre-term labour before* 26*th week*

On graph 3, we can see signal after 26th week of pre-term labour.

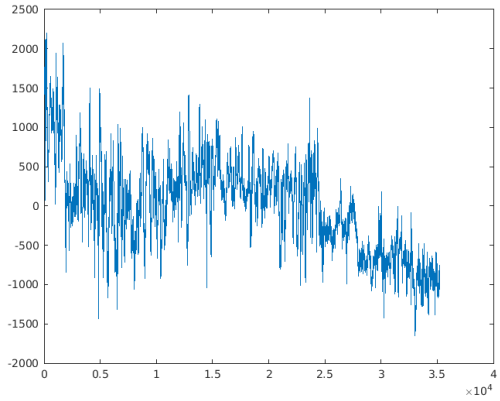

Figure 3: *Pre-term labou after* 26*th weekr*

On graph 4, we can see early signal of term labour.

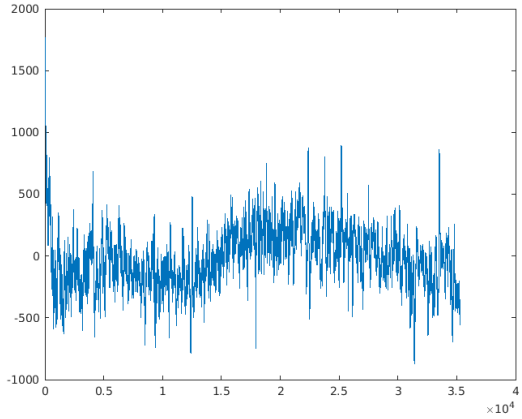

Figure 4: *Term labour before* 26*th week*

Finally on graph 5 we can see signal of term labour after 26th week.

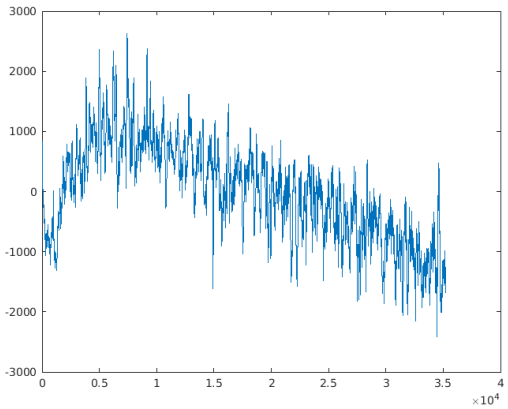

Figure 5: *Term labour after* 26*th week*

- Sample entropy of PE (3.signal): 1.5805
- Sample entropy of PE (2.signal): 1.0367
- Sample entropy of PL (3.signal): 1.2150
- Sample entropy of TE (3.signal): 1.9926
- Sample entropy of TL (3.signal): 1.6447

IV. Conclusion

Sample entropy of pre-term labour, recorded before 26th week is higher than sample entropy of pre-term labour recorded after 26th week. This was expected, because when the labour is close, contractions are more regular and predictability of the signal is higher.

Sample entropy of term labour recorded before 26th week is higher than sample entropy of term labour recorded after 26th week. Both values are higher than from pre-term labour, which is expected, because predictability of pre-eterm record must be higher, because the power spectrum already moved to lower frequencies which corresponds to higher predictability and consequently lower sample entropy values.

We tried calculating second signal, but we got much lower values, which means that the predictability of second signal is much higher than third.

References

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