Heart Rate Variability Analysis in Neonates

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***Abstract*— Heart rate variability refers to the time intervals between two consecutive heart beats. Heart rate variability is primarily measured using ECG signals as they make distinguishable plots and are easily available to use in all hospitals. In this work the ECG of 5 neonates is studied and time-domain and frequency-domain parameters are calculated to analyze the heart rate variability.**

Keywords—ECG, Heart Rate Variability, Neonates, QRS Complex

I. INTRODUCTION

The physiological phenomenon of variation in the time interval between heartbeats is referred to as heart rate variability[1]. The difference in the beat-to-beat interval is used to calculate it.ECG, blood pressure, ballistocardiography, and the pulse wave signal obtained from a photoplethysmograph (PPG) are some methods used to detect beats . The ECG is preferred because it produces a distinct waveform, making it easier to rule out heartbeats that don't arise from the sinoatrial node. HRV is a non-invasive indicator of autonomic nervous system activity, which is regulated by the autonomic nervous system (ANS) and its sympathetic and parasympathetic branches. HRV can be used to report changes related to specific biological states and pathologies like Myocardial infarction, Diabetic Neuropathy, Liver cirrhosis, Sepsis, Mood and Anxiety Disorders, etc. It is different for adults, children and premature babies[2].

II. METHODOLOGY

A. *Preprocessing*

In this step the signal is filtered using a high pass FIR filter to remove any low frequency wanders present in it. And the output signal is further filtered which performs zero phase digital filtering in both forward and reverse directions to get zero phase distortion.

B. *Defining peaks of the signal*

To find and calculate the parameters needed for calculating heart rate variability it is important we calculate R-R interval or the QRS Complex. There are various algorithms that can be used to find R-peaks of the given ECG Signal. In this work, find peaks is the function used to detect R-peaks in the filtered ECG Signal.

C. *Time-Domain Parameters*

- RR-interval- It is the interval between two consecutive R-R peaks in the ECG signal. It is usually measured in milliseconds.
- NN-interval- NN interval refers to the interval between two normal heart beats. It is measured in milliseconds.
- SDNN-It is the average of all NN intervals' standard deviations. The SDNN describes the variability's median. It is made up of components from both the sympathetic and parasympathetic nervous systems. The SDNN can be described as having an overall variability or total power.
- pNN50- It refers to the percentage of consecutive intervals that differ by greater than 50 ms.
- RMSSD- It is the Root Mean Square value of the standard deviation between consecutive NN intervals.

D. *Frequency-Domain Parameters*

A Fast Fourier transformation (FFT) can be used to decompose pure RR intervals into their frequency constituents. The frequency components in the VLF, LF, and HF spectra are obtained from the signal using this method.

- VLF- It refers to the very low frequency
- LF-low frequency ranges from 0.05-0.2 Hz
- HF- High frequency ranges from 0.5-1.5 Hz.
- LF/HF Ratio- Low to high frequency ratio

III. RESULTS AND DISCUSSIONS

The experiments on the ECG signal obtained from 5 neonates are divided into active and quite parts. The results are as follows:

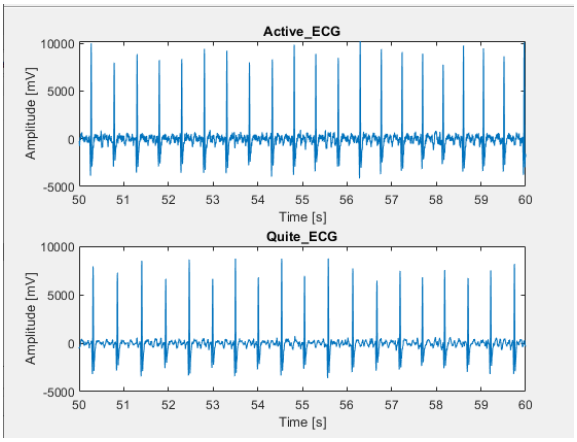

Fig1. Time domain representation of active and quite ECG.

- In fig 1 the ECG signal is divided and plotted as active and quite in time domain
- In fig 2 the ECG signal is represented in the frequency domain.

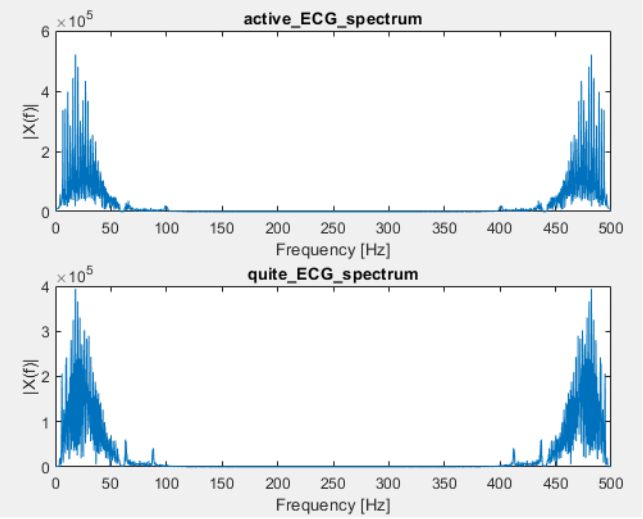

Fig 2 Frequency domain representation of active and quite ECG

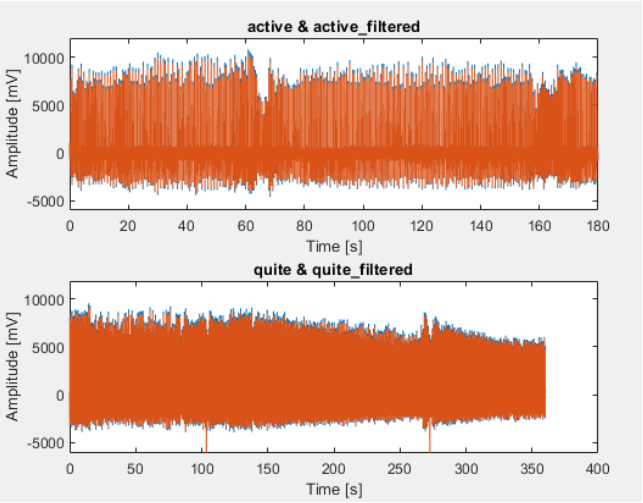

Fig 3 Filtered ECG Signal

- In fig 3 the signal is filtered using a high pass filter to eliminate any low frequency components.

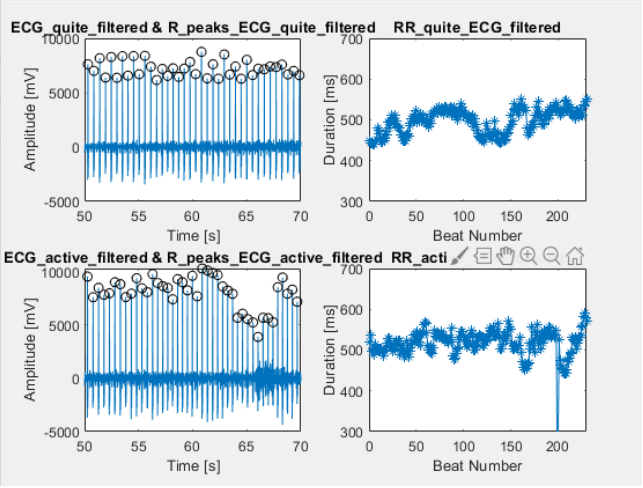

Fig 4 R-peaks in the quite and active ECG Signal

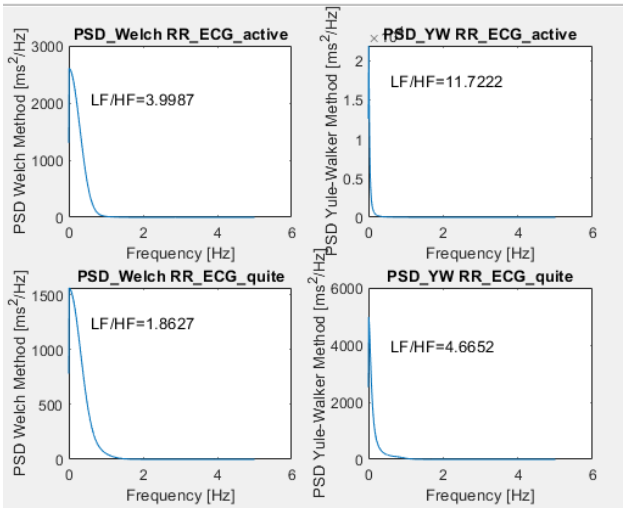

Fig 5 Frequency domain parameters

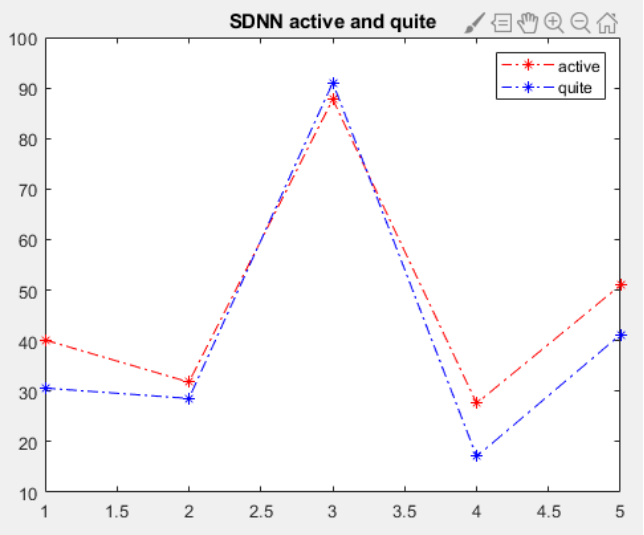

Fig 6 Time domain Parameter- SDNN

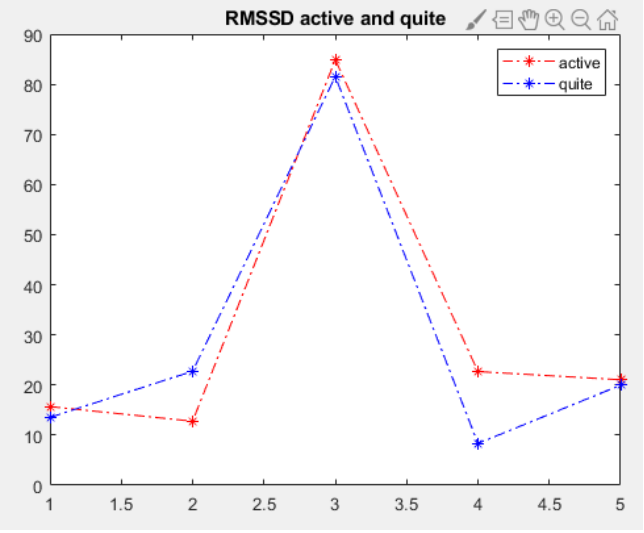

Fig 7 Time domain parameter -RMSSD

IV. Conclusions and Future scope

The Heart rate Variability of all the neonates was different. This can also be calculated by employing Non-linear parameters and by employing other algorithms to find R-Peak of the ECG Signal.

References

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[3] Heart rate variability Standards of measurement, physiological interpretation, and clinical use Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology (Membership of the Task Force listed in the Appendix)

[4] https://www.firstbeat.com/en/blog/what-is-heart-rate-variability-hrv/ What is Heart rate variability (HRV) & why does it matter?

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[6]