Analysis and diagnosis of polycoherence based ECG signal for non-linearity detection .

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***Abstract*— This method gives a new algorithm to detect nonlinearities in ECG signals and to determine the order of non-linearity. The ECG bispectrum is analysed and the bicoherence index is calculated to identify non-linearity. The diagonal slice of the polycoherence index of any order, calculated using the diagonal slice of the polyspectrum of the same order and the power spectrum, is proposed as an estimator. The possibility of higher-order non-linearities in ECG signals is investigated using these slices. Physiological and pathological cases have been studied. The polyspectrum and polycoherence slices indicate the presence of higher-order phase-coupled harmonics, in the physiological cases, which is attributed to higher order non-linearities. Differences between physiological and pathological cases are assessed and a decrease in the non-linearity order could be correlated with pathological conditions.**

***Index Terms*—ECG ,non-linearity detection, IBI, Bispectrum, Polyspectrum.**

I. INTRODUCTION

The ECG signal indicates the electrical activity of the heart. Variations in the amplitude and duration of the ECG signal from a predefined pattern have been used routinely to detect the cardiac abnormality. Because of the difficulty to interpret these variations manually, a computer-aided diagnosis system can help in monitoring the cardiac health status. Because of the nonlinear and nonstationary nature of the ECG signal, nonlinear extraction methods are good candidates for extracting the information in the ECG signal. Cardiac function is analogous to feedback system in which output is non-linear function of the input.ECG is graphical representation of cardiac function and hence predict constant adaptation of heart. ELECTROCARDIOGRAM(ECG) is a diagnostic tool that measure and record electrical activity of heart. An ECG signal consist of P-wave, QRS complex, T-wave. Detection of abnormality and non linearity in ECG signal is necessary. One of the technique is based on Bispectrum, Bi-coherence index , poly-spectrum and polycoherence index. This could be done by various method Bi-spectrum and Bi-coherence index is used to detect non linearity in ECG signal. Second order non-linearity is important for analyzing signal. It can be used as an indicator of the presence of quadratic coupling. Abnormalities in ECG signal were detected by variation in phase contour of the bispectrum.

Diagonal slices of Poly-spectrum and poly-coherence index represent higher order non linearity. The polyspectum and polycoherence slices indicates the presence of higher order phase coupled harmonics , which is attributed to higher order non linearities.

II. FRAMEWORK

Normal ECG data from the MIT/BIH CDROM, the Normal Sinus Rhythm Database (NSR-DB) and ischemic ECG data from the European ST-T database (E-DB) are used. The recorded signal is often contaminated by noise and artifacts that can be within the frequency band of interest and manifest with similar characteristic as the ECG signal itself. In order to extract noisy ECG signals, we need to process the basic ECG signal.

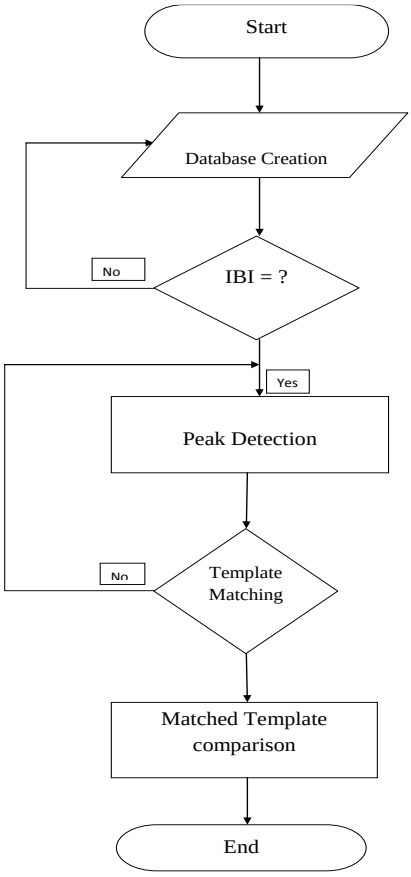
The first phase includes the acquisition of real time ECG data. In the next phase, generation of signals followed by pre-processing. In signal preprocessing stage the ECG signal is high-pass filtered. The pre-processing stage removes or suppresses noise from the raw ECG signal. Pre-processing ECG signals help us remove contaminants from ECG signals. ECG contaminants can be classified into the following categories referred:

1. Power line interference
2. Electrode pop or contact noise
3. Patient-electrode motion artifacts
4. Electromyographic (EMG) noise
5. Baseline wandering

Bispectrum is defined as the two dimensional Fourier Transform of the third order cumulate. It measures the correlation between three spectral peaks at the frequencies w1, w2 and (w1+w2) and hence estimates the phase coupling between them.

Polycoherence indices are useful in detection of non-linearity and separating linear process from non-linear ones. The diagonal slices of the polyspectrum and polycoherence index constitute important features to discriminate between physiological and pathological condition of heart.Also higher order non-linearity is detected using polyspectrum and polycoherence index.

Flow chart:



Data source is MIT BIH, European data base. Here we take recorded E-DB from internet. Data base is used for further processing. For IBI (Inter Bit Interval) beats are detected. This bits i.e. b1 and b2 are useful for indicating start and end of IBI window respectively. In this IBI we may sure that this start does not occur before sample 1 and also end does not occur beyond last sample. If any ECG beat value occurs beyond threshold value then it is true outlier.

Peak detection method detects peak within input signal. A double threshold is applied to input signal. It switches the output to high state when the input passes upward to high threshold value. It then prevent switching back to low state until the input passes down through a low threshold value. Pre allocation of memory is necessary for the purpose that starting peak occur at sample 1before that there is free space In this we skip next peak if necessary .This is useful if more than one successive small peaks exists that didn't drop below the second threshold. Finding and removing of empty peak is also done in this method window with the template . In Template Matching method there are two terms are used threshold primary and threshold secondary. Threshold primary for high threshold value and Threshold secondary for low threshold value. If the correlation between template and window exceeds the primary then a QRS complex is detected. A double threshold is applied to input signal.

The Matched Template comparison states the comparison between the IBI and input applied to GUI. The input waveform shows that the linear and non-linear waves. When the peaks are empty then it is a non-linear process. When they are filled then it is a linear process

III. RESULT

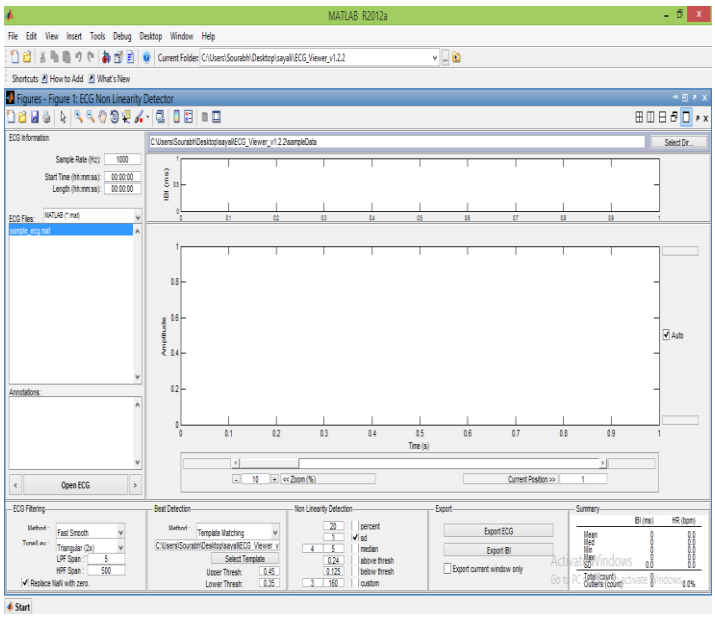


Fig1. GUI created image

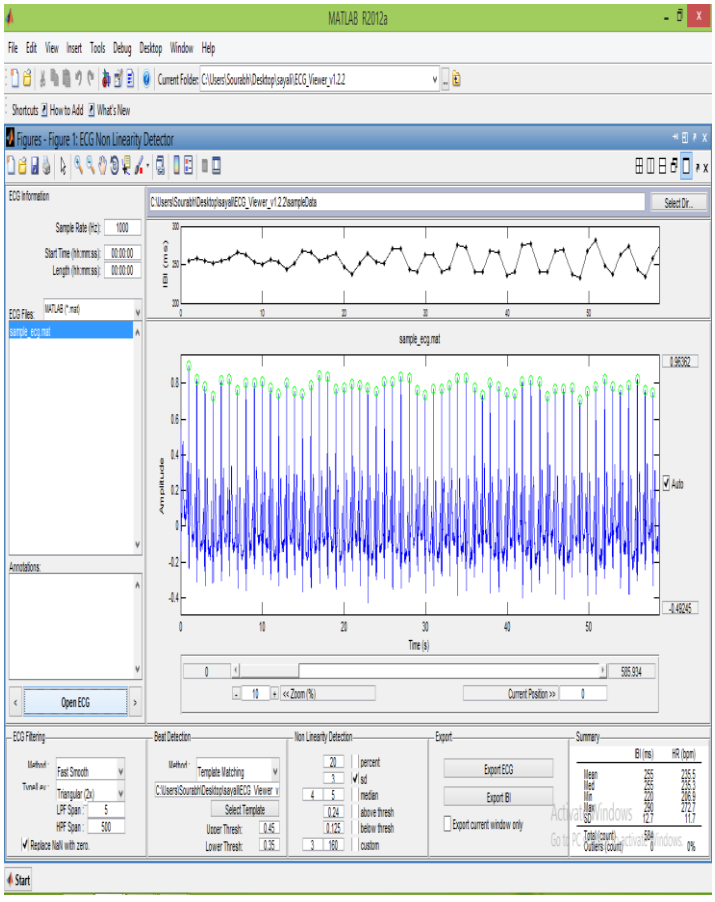


Fig2 . GUI when input is detected

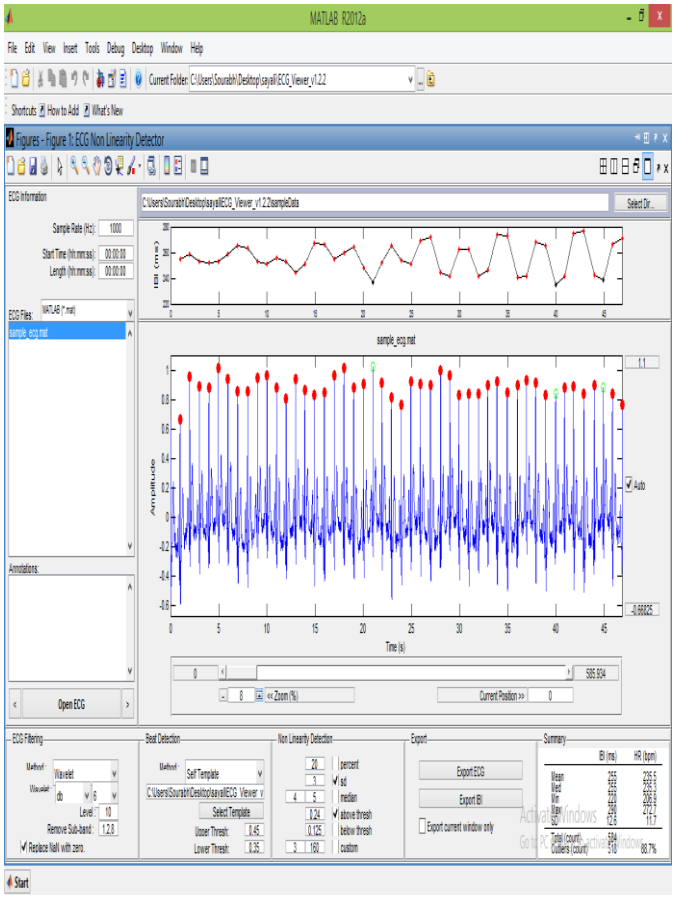


Fig3. GUI when output is detected

The above fig 1 shows that it is an GUI created image, before applying input to that. Here, first block shows a sampled frequency signal and second block shows IBI (Inter Bit Interval)plot. Above Fig 2 shows that ,the input is applied to the GUI. Fig 3This waveform is for non-linearity detection. That shows there is a linearity and non-linearity in the waveform. The blank holes (green holes) are represent there is a non-linearity in ECG signal and filled holes are represent the linearity in signal. for that we first set the ECG filtering data. The next waveform shows a IBI signal Which shows a maximum peaks present in ECG signal for that set all basic ECG filtering information.

IV. Conclusion

A It is useful to extract features from frequency domain to classify arrhythmias. After observing two waveforms of ECG signal we conclude that blank holes describe non-linearity in ECG signal. Filled holes represent linearity in the ECG signal. IBI plot describes the polycoherence method. Fast smoothening method is used to detect various type of smoothening ,which is helpful to determine the edges in IBI plot. With the help of peak detection method we can detect the peaks in ECG signal that are useful to determine non-linearity. Templates are made which are used to detect QRS complex by sliding the window across the input signal.

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