Characteristics and Analysis of ElectroGastroGram Signal

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Abstract. In this study the various spectral estimation of the Electrogastrogram Signals are discussed. The Main objective of the study is to identify the gastroparesis condition using various signal processing techniques. Gastroparesis is one of the pathetic condition in which the stomach fails to digest. Gastroparesis is also called as stomach paralysis. Due to damage or dysfunction of vagal nerve, kajal cells at stomach lining temporary stomach paralysis happen. The immediate stimulation can make the pacemaker of the stomach to get activated and back to digestion process. In this study the stomach signals are preprocessed and spectral estimation techniques are applied to study about the signal spectrum characteristics. The determination of dominant frequencies and features extracted from frequency domain gives vivid description about the abnormalities of the gastric signal.

Keywords: Gastroparesis · Kajal cells · Spectral Estimation · Pacemaker of Stomach · Dominant Frequency · Electrogastrogram Signals

1 Introduction

Electrogastrography refers to acquisition of Gastric Signals [1, 2]. The Measurement of electrical activity of stomach is called as electrogastrography. Using the Electrogastrography we can able to diagnose many stomach disorders. Tachygastria, bradhygastria, pepsia, ulcer, gastroparesis can be diagnosed. Before going for the imaging or scanning of the stomach/intestine making a EGG signal and observation of Gastric signal will give physician a good clear cut method for diagnosing. The Signal Processing of the Gastric Signals will give vivid description to suggest for scanning of stomach or signals are enough for diagnosing. In this study we taken Electrogastrogram signals from database and applied spectral estimation techniques and targeted to find gastroparesis in the signals.

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2 Methodology

The Main aim of the study is to find the abnormalities of the gastric signals. As mentioned earlier the gastric signals are downloaded from the database. The preprocessing of the signals was done and after preprocessing the signal smoothening, power spectral estimation is done (Fig. 1).

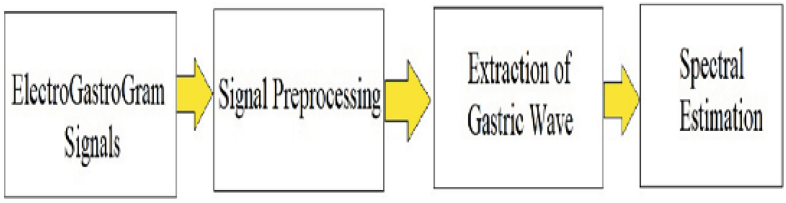

Fig. 1. Block Diagram

3 Preprocessing

The Preprocessing of the signal includes removal of the noise and smoothening of the signal. The removal of noise is the most challenging work in filtering the gastric signals. The gastric signals while acquired from the subjects may consists of many artifacts, sometimes the subjects may give some sudden movements, vibrations, shocks, due to these the signals may get distorted. Another type of noise that is present in the signals are the interferences [4–6]. There may be heavy interference of other dominant signals in the gastric signals while acquiring. Signals like respiratory signals, Electro Cardio Gram signals may present in the gastric signals. It is the top priority to remove the power line interference, other signals interference using suitable algorithm. Most of the study wavelet transforms empirical mode decomposition, discrete cosine transforms and discrete Fourier transforms are used for de noising.

3.1 Filtering

In this study we have applied band pass filter of frequency 0.015 to 0.5 Hz and decimation of new sampling frequency 4 Hz. After the decimation the signals are applied to adaptive filtering. The adaptive filtering is applied for most of the wide sense stationary signals. Most of the recursive type signals & sequences the adaptive filtering is used [8–10]. The most important feature of the adaptive filtering is it can adapt its own performance index and weight. Using the adaptive filtering the gastric signals are clearly extracted without any noise or degradation (Fig. 2).

After the application of adaptive filter, the signals are smoothened. Smoothening is done in two methods, mean average smoothening and median smoothening is done to enhance the signal quality. ECG and Respiratory signals are tested as reference signals for the adaptive filtration. The respiratory signals are best source of reference signals

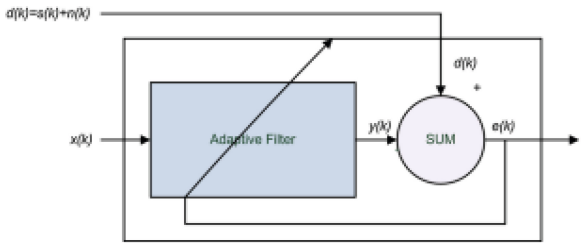

Fig. 2. Adaptive filter

for the adaptive filtration of the gastric signals. The results after adaptive filtering of gastric signals are also promising and quality of the signals are also improved with no degradation (Fig. 3).

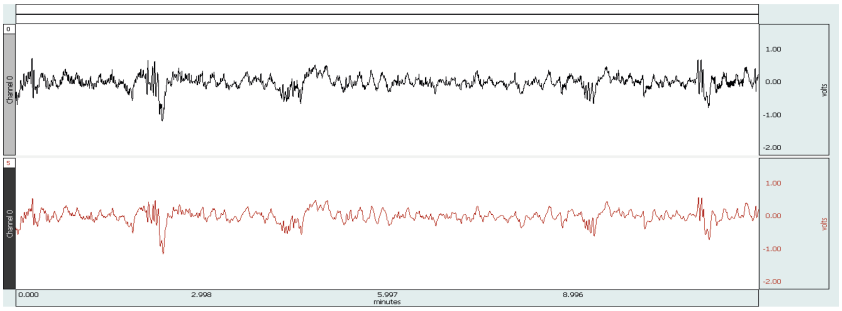

Fig. 3. Filtered Signals after Band Pass filtering

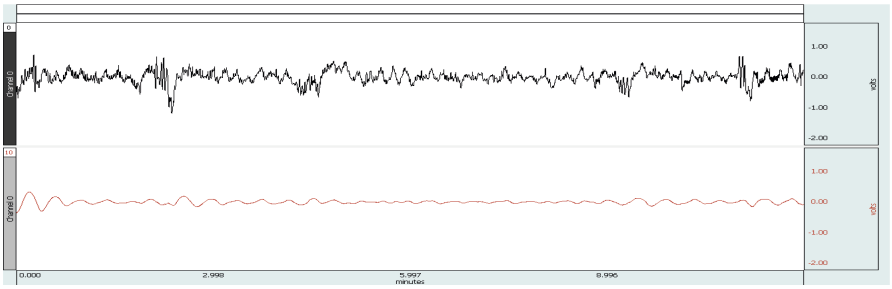

Fig. 4. Adaptive filtered Signal

The above diagram of Fig. 4 illustrates about the adaptive filtered signal, where the mean value of the signals are not removed and its smoothened of order 7 (Fig. 5).

3.2 Spectral Estimation

The Spectral Estimation is defines as classification or distribution of the energy ranges of the signal using parametric methods or non-parametric methods like periodogram. Here

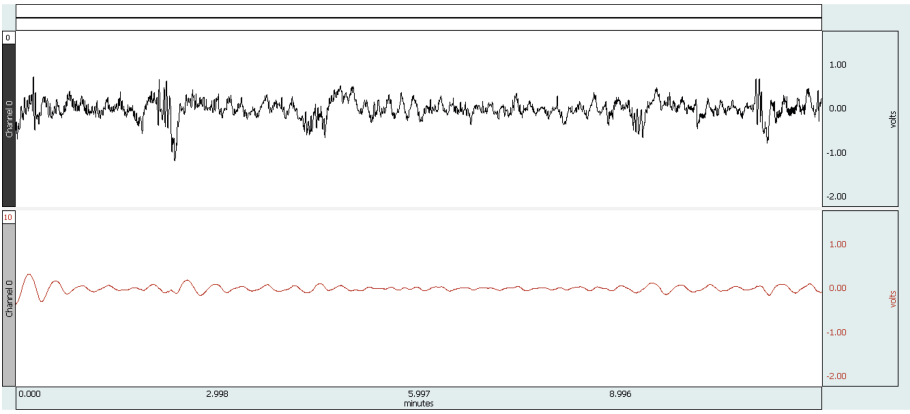

Fig. 5. Smoothened Signal at order 7th - $10e^{-7}$

we applied windowing techniques to estimate the frequency component distribution of the signal. From the spectral estimation we can able to find the most dominant frequency range during digestion of food. The most dominant frequency will be useful to estimate the cycles per minute calculation of the Electrogastrogram signal (Fig. 6).

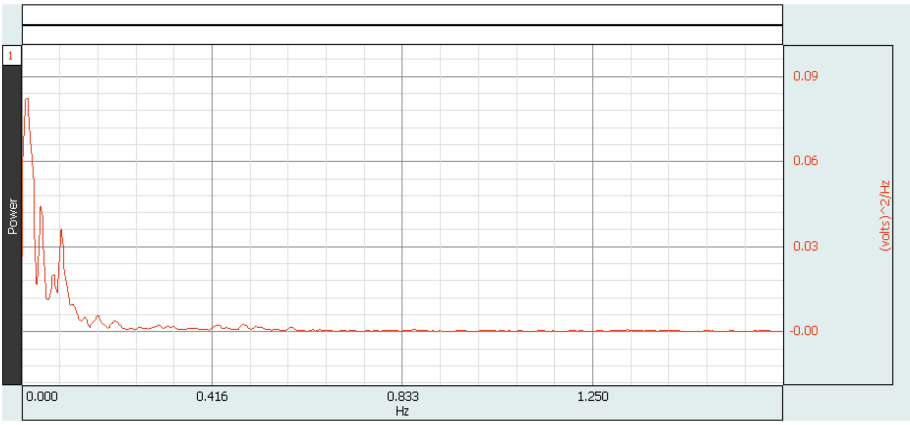

Fig. 6. PSD of Hamming Window

Feature extractions are the useful component for comparison and evaluation of the data. In our study feature exaction are used for comparison of the gastric signal attributes. After converting the signal into frequency domain by using Fast Fourier Transform, various spectral estimation techniques are applied to study about the distribution of the spectrum in various level. FFT windowing is applied to the signals. Windows like Kaiser, Blackmann, Hanning, Hamming are applied to check the different FFT range of the gastric signals to estimate the spectral range and dominant frequency range. The CPM values are also estimated using the spectral estimation. After spectral estimation

feature extraction is done. Features like Mean, Median, Skewness, Kurtosis are done to compare the each windowing function (Fig. 7).

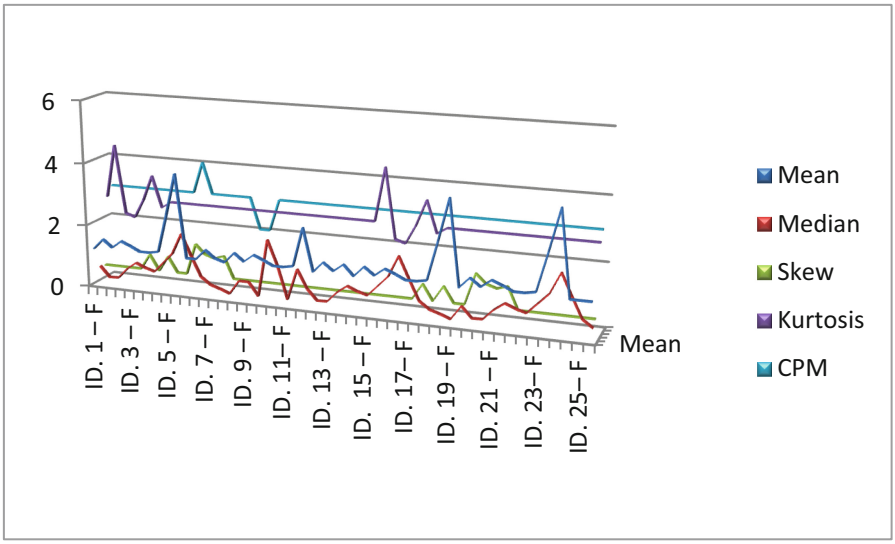

Fig. 7. Gastric Signal Attributes

4 Result

The Gastric Signals are used to measure the activities of food digestion and its process. In our study we have targeted to study in detail about detection of the particular pathological disorder called gastroparesis. We aim to diagnose the gastroparesis which is also referred as stomach paralysis by spectral estimation of the gastric signals. The spectral estimation of the gastric signals provides valuable information about distribution of the power and energy of the signals in every cycles. A normal person (adult) has 3 to 4 cycles per minute as it's a food grinding cycle in the stomach/intestine. For the person who is diagnosed to be in gastroparesis condition has low spectral range as below 3 cycles per minute and very low frequency distribution. On observing the dominant frequency of the gastric signals and comparing the feature extracted values some subjects exhibits the low spectrum and suspects gastroparesis condition. But the accuracy of prediction can be done only after signal classification with suitable signal classifiers. Using spectral estimation we cannot conclude or diagnose the gastroparesis in the subjects but can suspect the disorder, only after signal classification and evaluation we can conclude the disorders in the subjects.

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