A Review on Biomedical Signal Processing

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Abstract-

The aim of this research paper is to extract biochemically or pharmaceutically or clinically the appropriate information in order to enhance and improve the medical diagnosis. All living creatures, from a tiny cell to an organism, transmits signal in biological way. Such signals can be of any form, they can be electrical, mechanical or chemical. All such signals can be of use for diagnosis, for patient monitoring or for research in biomedical. The fundamental and main objective for processing biomedical signals is to filter out the signal of interest from the noisy background and to minimize the redundancy in data stream to only a few, but for relevant parameters. This research paper will cover biomedical signal processing as used in medical diagnosis and the instrumentation.

Keywords-

Signal acquisition; signal processing, medical diagnosis instrumentation, biomedical signals and stochastic signals, sampling and digitization.

I. INTRODUCTION

Biomedical signal processing mainly focuses on the innovative applications of signal processing methods in biomedical signals through numerous creative integration of methods and biomedical knowledge. It's a rapidly expanding field with a wide range of applications. These process ranges from building the artificial limbs and aids for the disabled to the development of highly sophisticated medical monitoring systems that can operate in a manner to give real time views of the workings of the human body. There are numerous medical systems in common use which includes ultrasound, electrocardiography and plythesmography which are used for many purposes.

II. BIO-MEDICAL SIGNAL PROCESSING

The biomedical signals are processed usually in four stages:

1) Measurement i.e. signals acquisition.
2) Reduction and transformation of the signals.
3) Computing signals parameters that are diagnostically significant.
4) Classification of the signals.

The stages of bio-signals processing is shown in figure 1.

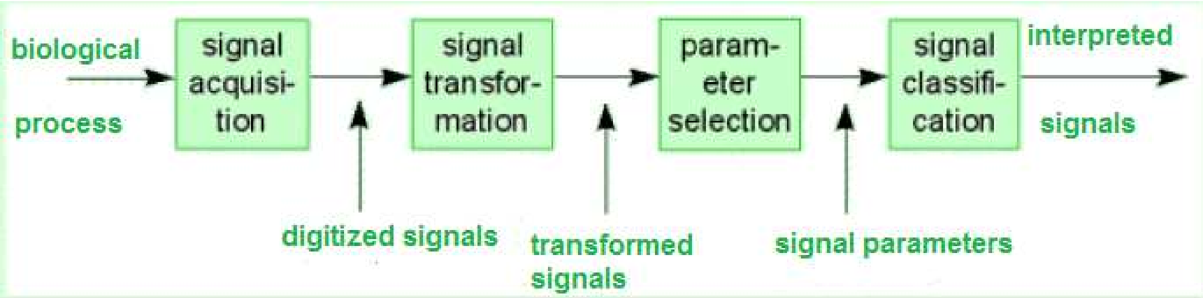

Figure: 1 Bio-Signal Processing Stages

Different types of biological signals are classified into mainly two groups i.e. the deterministic signals and the stochastic signals. Such as the beating heart also generates signals that are repetitive in nature. The deterministic signals are subdivided into mainly three groups which are periodic, quasi-periodic and transient signals. The stochastic signals are subdivided into two groups i.e. stationary and non-stationary signals [1]. Time varying signal wave shapes are shown as in Figure 2.

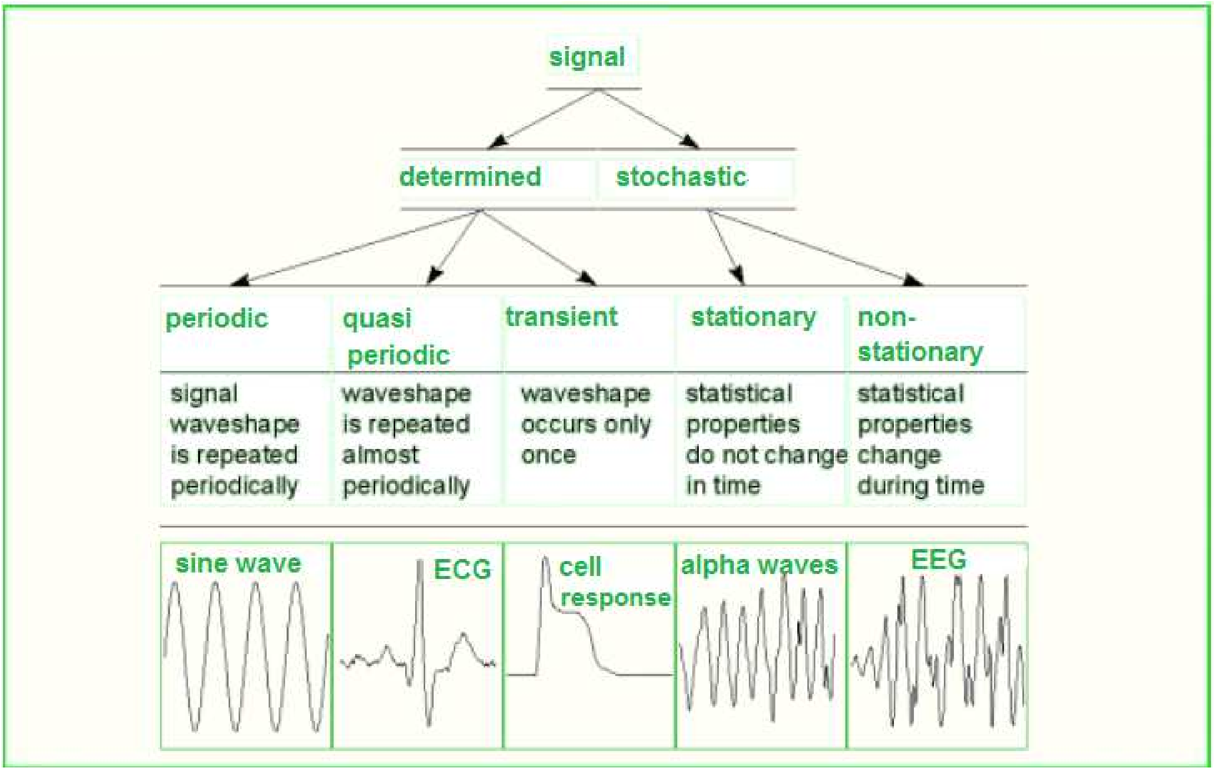

Figure: 2 Signal Wave Shapes

III. ACQUISITION OF BIO-SIGNALS

Real time acquisition of data from source by direct electrical connections from instruments avoids the necessity of people to measure, encode and enter the data manually. Sensors which are attached to the patient convert biological signals, like blood pressure, pulse rate, electrical activity and mechanical movement. The electrical activity, e.g., of heart, brain and muscle, into electrical signals which are transmitted by computer. The signals are periodically sampled and are converted to digital representation for processing. Automated data-acquisition and signal-processing techniques are important in patient monitoring settings [2].

IV. DIGITISATION OF BIO-SIGNALS: SAMPLING AND ACQUISITION

Most naturally occurring signals are analog signals, i.e., signals that are continuous in nature. A digital computer is a computer that stores and processes values in discrete units. Before processing, analog signals must be converted to discrete units. The process of conversion is called analog-to-digital conversion (ADC). ADC (analog to digital conversion) can be thought as sampling and rounding – then the continuous value is observed (*sampled*) at fixed intervals of time and rounded (*quantized*) to the nearest discrete unit. Two parameters determine how closely the digital data match the original analogue signal: the precision with which the signal is recorded and the frequency with which the signal is sampled. Precision describes the degree of accuracy of a sample observation of a signal [3]. It is determined by the number of bits (quantization) used to represent a signal and their correctness; the more bits, the greater the number of levels that can be distinguished. Precision is limited by the accuracy of the instrument that converts and transmits the signal [4].

The need to sample at least twice as frequently as the highest-frequency component needed from a signal. For instance, looking at an ECG, we find that the basic repetition frequency is at most a few per second, but that the QRS complex contains useful frequency components on the order of 150Hz [5]. Thus, the data sampling rate should be at least 300 measurements per second. This rate is called the *Nyquist frequency*.

V. PRECISION AND ACCURACY

Precision refers to the fidelity of the measurement; if the measurement is repeated on the same subject, the same result will be obtained. Accuracy refers to the tendency of measured values to be symmetrically grouped around the variable's true value. Variability of medical data can arise from intra- and inter- instrumental and observer variations (analytical or metrological variability) or intra- and inter-individual variations (biological variability); the total is the combination of these.

VI. APPLICATION AREA

It is a known fact that a fetal ECG (FECG) signal is obtained from the abdominal ECG (AECG) of a pregnant woman that has the potential of being an effective diagnostic tool for determining the overall condition of the fetus during the delivery, as well as for the detection of pathological phenomena. The fetal contribution to the AECG is minor; therefore, it is not uncommon to record a much corrupt signal from which even the fetal heart rate can hardly be monitored [7]. The detection of the FECG is yet a difficult task even when the maternal component of the signal has been reduced. In order to observe the FECG, some technique should be applied for improving the signal to noise ratio (SNR) and eliminating the maternal contribution to the signal.

Several methods have been proposed for detecting fetal heart rate (FHR) by extracting the FECG signal from AECG signal. Two fundamental methods can be considered: a peak detection method and a transform method [8]. Using the peak detection method, a small segment of the FECG is observed at a time and searched for the fetal R wave. Mainly, the result of the search depends on the algorithm used, and on the local SNR in the above mentioned data segment. Due to the unpredictable nature of the AECG signal, the local SNR value fluctuates about the SNR value of the entire signal and might sometimes be much smaller

FHR and maternal heart rate (MHR) sample traces recorded by signal processing system are displayed in Figure 3. The measurement of the maternal heart rates was successful in most cases. The performance of the system in determining the FHR depends upon the FECG signal, which is obtained by subtracting the average maternal ECG (MECG) from the AECG signal [8].

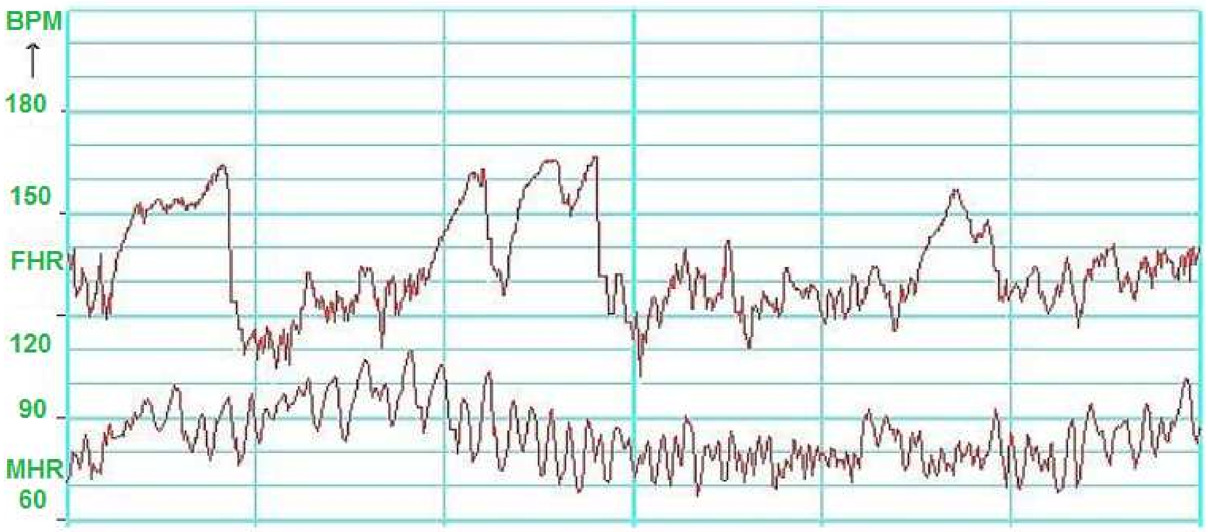

Figure: 3 FHR (upper) and MHR (lower) traces using the signal processing system

FUTURE CONSIDERATION

The field of biomedical signal processing is seems to hold a very promising and bright future. This field is still in its early stages and continuous research is being held in many institutions around the world. Physiological modeling using the advanced knowledge on the observed physiological system is required to achieve significant progress in the area of biomedical signal processing. Hence, inter disciplinary work groups are required to reach this goal.

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