Biosignal Feature Extraction Techniques for IoT Healthcare Platform: ***Survey***

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***Abstract*— In IoT healthcare platform, a variety of biosignals are acquired from its sensors and appropriate feature extraction techniques are crucial in order to make use of the acquired biosignal data and help the healthcare scientist or bio-engineer to reach at optimal decisions. This work reviews the existing biosignal feature extraction and classification methods for different healthcare applications. Due the enormous amount of different biosignals and since most healthcare applications uses electrocardiogram (ECG), electroencephalogram (EEG), electromyogram (EMG), Electrogastrogram (EGG), we focus the review on feature extractions and classification method for these biosignals. The review also includes a summary of Blood Oxygen Saturation determined by Pulse Oximetry (SpO2), Electrooculography and eye movement (EOG), and Respiration (RSP) signals. Its discussion and analysis focuses on advantages, performance and drawbacks of the techniques.**

Keywords*— *Biosignal; feature extraction; feature classifications;

I. Introduction

In the worldwide, significant amount of people lose their life because of health related issue. As the medical facilities are becoming increasingly costly, mostly due to lack of portable devices, patients need to stay in hospitals during the entire period of their treatment and bear the heavy cost of medical facilities. Also it causes very high constraint on the available medical equipment and staffs [1]. So a portable, easily operable, cost effective system is the demand of time, which can be used to monitor patients even if they are stayed in their residences. Such portable systems can be easily operated and cost effective with the progress of sensor technology in terms of better signal acquisition, lower energy consumption and higher integration. Their ability paves the way for a variety of mobile data collection and its analysis for further improving of the treatment options. The invention of the new analysis method of medical instrumentation can help to improve the efficiency and powerful medical applications [2]. Researchers are continually dedicated to improve the functionality of health care devices. Many different categories of technologies are specifically required to address this challenging health monitoring problem. The constant study and monitoring of biomedical signals has been an important tool in the development of new medical technology products. Internet of things (IOT) application in healthcare system enables wearable support and monitoring tools that are often realized as Body Sensor Networks. Different biosignals, like physiological and kinematic data, can be acquired with such networks and pattern recognition methods provide valuable tools for online and offline signal analysis [3]. The Continuous health monitoring using sensor technology on the IOT system and acquiring information is very important from health perspective. The system has different components : Senior that collects the Biomedical signal, microcontroller and microprocessor that process and communicate the data wirelessly with user interface and for secure communication between the gateway and cloud or between the sensor hub and the gateway use secure communication protocols (SSL/TSL).

The bio-medical registered on the sensors which referred to as biosignals are important not only for timeless classical applications concerning medical diagnosis and subsequent therapy , but it can be use in the future in our daily life for so many applications. Goals of signal processing in all these cases usually are noise removal, accurate quantification of signal model and its components through analysis (system identification for modeling and control purposes) [3] . Typical biological applications may involve the use of signal processing algorithms for more than one of these reasons.

The monitored biological signal in most cases is considered as an additive combination of signal and noise [1]. It is obvious that once the signals are measured how to integrate them for a robust [2] and accurate diagnosis becomes a challenging problem.

In this work we present, a review by highlighting the up-to-date detection of most clinically used biomedical signals such as electrocardiogram ECG, EEG, EMG, EEG, SpO2, EOG, and RSP. We will discuss their application, compare and analyses of their feature extraction and classifications techniques within health care systems.

II. Bio Signals

Living organisms are composed of different functional systems, for example, the nervous system, the cardiovascular system, the musculoskeletal system, the digestive system, and the immune system. These systems employ physiological processes such as blood circulation and breathing and more as other functions. Biosignals are signals that quantify the physiological processes. They can be measured as physical quantities such as temperature or pressure, electrical quantities such as currents and voltages and biochemical quantities such as concentrations. The figure below describes the types of biosignals according to their characteristics.

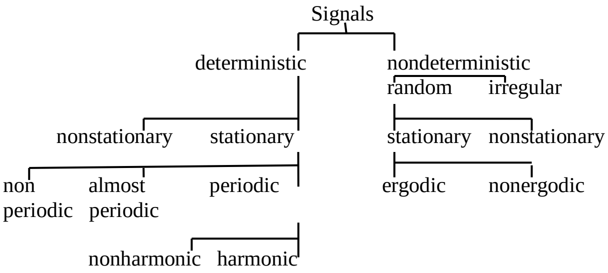

Fig. 1. Types of Biosignals (Characteristics)

The clinical need for the monitoring of biosignals arises from the fact that diseases and dysfunctions in the biological processes cause changes that usually degrade their performance [4]. For example ECG, this provides information on cardiac physiology / pathology [5] and EMG uses for the information on muscle fiber contractions. Most cells of the fiber perform the same electric activity synchronously and a measurable electric voltage [6]. EEG records some other patterns of electric activity and characteristic of different brain diseases e.g., spike-wave complexes in epilepsy [7]. The origin of EEG signals and their systems analysis has been the subject of several studies. EEG represents the brain activity for a subject and gives us an objective mode of recording brain stimulation [8]. An EEG recording is divided into normal and abnormal patterns. One of the best known neurological disorders is epilepsy [9, 10]. Epilepsy is common brain disorder characterized by abnormal neuronal firing in the brain which can lead to seizures. An ECG translates the heart electrical activity into wave line on paper or screen. An electrical impulse initiates the muscle contraction, which results in the heart beating. The spacing between pulses provides a measure of the heart's rhythm, whereas the height of the pulses is an indicator of pumping strength. Comparison of overall ECG waveform pattern and shape enables doctors to identify diseases [11]. Biosignals are produced as electrical signals and can be acquired at the body surface through the use of surface electrodes.

The instrumentation used to acquire most of the biosignals is similar, except for the changes in required amplification and filter settings. The EMG is produced at the body surface due to the electrical activity of contracting muscles immediately beneath the surface. The study of EMG signals is related to the muscle activity obtained in the form of electrical signals [12]. EMG signals is sometimes referred to as myoelectric signals that are obtained by recording the electrical activity of muscle by using electrodes or sensors. The other method to recording EMG signals is come from specific facial muscles. The EEG is produced at the surface of the scalp due to the nerve cell activity in the brain and shows a continuous oscillating electrical activity. EGG is used to register or to measure the vocal fold during voicing without affecting speech production. It also gives as analysis on extraction of gastric slow waves from multichannel sensors. It is important to analyze the methods for date detection, decomposition, processing and classification of EEG, ECG, EGG, EMG and other related biosignals for further comparison study and their application.

III. Signal Analysis

The event ultimate goal of signal analysis is to extract useful information from measured data by performing analysis steps. Biosignals analysis stages described in the next sub sections and as illustrated in Figure 1:

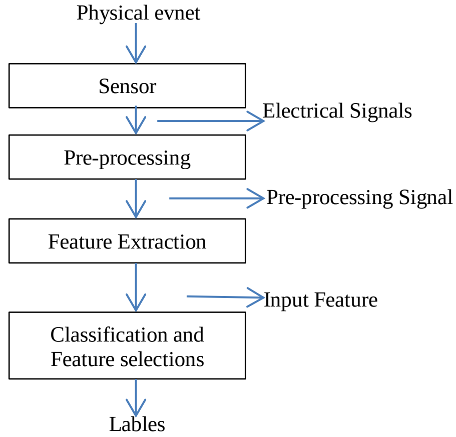

Fig. 2. Stages of Biosignal Analysis

A. *Pre-Processing*

Information in biosignals is often depreciated by a disturbance or noise. The biosignals have to be properly processed using a transformation or filtration to extract the required information. The Biosignal data processing is implemented using a modular architecture (can replace or add any module without affecting the rest of the system, so that different algorithms can be arranged in order depending on the problem intended to be solved. In general, the aim of preprocessing steps to improve the general quality of the biosignals for more accurate analysis and measurement. Noises may disturb the ECG signal due to such an extent that measurements from the original signals are unreliable. The main categories of noise in ECG signal are: low frequency base line wander (BW) caused by respiration and body movements, high frequency random noises caused by mains interference (50or 60Hz) and muscular activity and random shifts of the ECG signal amplitude caused by poor electrode contact and body movements. A number linear and non-linear technique has been developed to eliminate these artifacts. The preprocessing comprises of three steps: removal of base line wander (elimination of very low frequencies) removal of high frequency noise and QRS detection. The analysis of the various waves and the normal vectors of depolarization and repolarization yields is an important diagnostic information and to process and to eliminate the effects of noise and smoothened of the signal. Raw data from EMG offers us valuable information in a particularly useless form. This information is useful only if it can be quantified. Various signal pre-processing methods are applied on raw EMG data to achieve the accurate and actual EMG signal. The first step to process EMG signal is includes data acquisition which involves in analogue to digital conversion, amplification and signal conditioning. It involves the recording of the bioelectric activity, analogue filtering and analogue to digital conversion [13]. Pre-Processing of EGG signals includes the steps of signal identification of infeasibility, identification of redundancy and improving the bounds of the signals accordingly. A signal is recorded and gathered by placing the electrodes or sensors on the skin surface. A sensor converts a physical measurements quantity to electric output. The electrodes also provide an interface between electrical recording device and the biological system. The signal is usually amplified, filtered and converted into a digital signal after being detected by the electrode. During the A/D converter step the input analogue signal is measured, then converted and will be expressed as a numerical depiction of the original signal. In general, the preprocessing methods used in EEG are very dependent on the goal of the applications. Having said that, there are some methods that are used very commonly to improve the quality of Signal to Noise ratio, such as Common Average Referencing (CAR) or filtering. It would be interesting to summarize the effective signal preprocessing methods since they usually can be similar in different applications.

Biosignals signal measurements from the heart (ECG), muscles (EMG), scalp (EEG) and gastric (EGG) are typically very small in amplitude and require amplification at the pre-processing stage of the signal to accurately record, display and analyze the signals. Table 1 shows the amplitude and frequency ranges for ECG, EEG, EOG (Electrooculography, measuring the resting potential of the retina) , EGG, EMG and RSP.

TABLE I. BANDWIDTHS, AMPLITUDE RANGES, AND QUANTIZATION OF SOME FREQUENTLY USED BIOSIGNALS ABLE STYLES

Bio signal	**Frequency and Amplitude**		
	Frequency range (HZ)	***Amplitude Range (Mv)***	***Quantization (bits)***
EGG [14]	0 - 1	0.001 – 0.8	4 - 6
EEG [15]	0.1 - 100	0.001 - 1	4 - 6
EOG [16]	0.1 - 10	0.001 – 0.3	4 - 8
ECG [17]	0.01 – 300	0.05 - 3	10 - 12
EMG [18]	50 - 3000	0.001 - 100	4 - 6
RSP [19]	0.1 - 1	2 – 50breaths/min	8 - 10

B. Feature Extraction

Feature extraction is a key step in most pattern analysis tasks. It is the process of extracting and converting of the input data information into a set of features called feature vector and by using the methods for reducing the data representation of the pattern. It is also the second step of the signal processing in where the actual processing of signal occurs. In this step, processing takes place to extract relevant information from the biosignal.

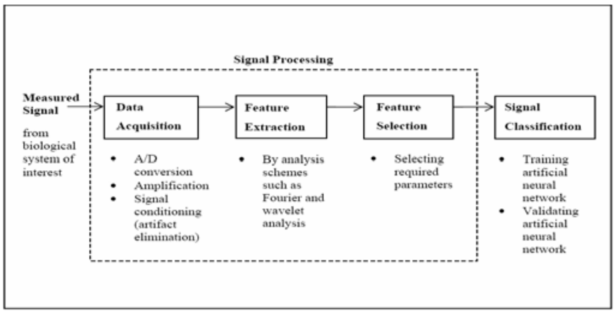

Fig. 3. Schematic of Signal Processing [42].

There are several general guidelines to describe about feature extraction. First its discrimination, features of pattern in different classes should have significantly different values. Second its reliability; features should have similar values for pattern of the same class. Third independent features should not be strongly correlated to each other. Finally its optimal, some redundant features should be deleted. The features set will extract the relevant information from the input data in order to perform the classification task. The feature extraction method for each biosignal depends on the nature, application, source characteristics and type of the signal.

1) Wavelet Transform Analysis: WT is a signal processing algorithms that are used to convert complex signals from time to frequency domains. Even the analysis method is similar to Fourier transforms however in wavelet signals can be localized in both frequency and time space. The WT analysis allows the transformed data to be analyzed simultaneously in both time and frequency domains. WT can be implemented by means of a discrete time filter bank. The other main prpperty of WT is being an efficient mathematical tool for local analysis of non-stationary and fast transient signals. WT filters are the Fourier transforms of the wavelet. Wavelets have been extensively used for processing almost every kind of biosignal with non-stationary characteristics. Wavelet transforms enable arbitrarily good time resolution for high-frequency components. The analysis uses narrow and broad windows for high frequency components and for low frequency components respectively. EMG, ECG, EEG are non-stationary signals and WT represents a very suitable method for the feature extraction of these signals. The WT approach for EEG signal is to extract the spectrum of the signals that contains some characteristic of waveforms that fall from lower to higher range frequency bands. The wavelet transform of the noisy EEG signal generates the wavelet coefficients which denote the correlation coefficients between the noisy signal and the wavelet function. Depending on the choice of mother wavelet function which may resemble the noise component, value of the coefficients generated corresponding to the ocular artifact affected zones will be larger than the value of the coefficients generated in the areas corresponding to the actual EEG. Basically smaller coefficients will be generated in the areas corresponding to the actual EEG by taking the inverse wavelet transform and the de-noised signal is obtained. EMG signals have non stationary and highly complex time-frequency characteristics. .Due to this fact of the signal it is difficult to analyze the signal with a simple method such as Fourier transform. To get optimal solution, Wavelet Transform was used as a feature extraction method and has been widely used in signal analysis [20]. However, many experiments are choosing the best methods for feature extraction use of facial EMG signals between WT and the six methods Integrated (INT), Mean Absolut Value (MAV), Maximum Scatter Difference (MSD), Root Mean Square (RMS), Power Spectrum Density (PSD), Absolute Value (AV), Mean Absolute Deviation (MAD), Standard Deviation (SD) and Variance (VAR). In most cases, WT is chosen the feature extraction of signals as it explained by Rechy-Ramirez and Hu [22]. Upon the ECG signal analysis research, we have different types of feature extraction methods, some of them which have been tested with other researcher are: Discrete Wavelet Transform [21], Optimal Mer Wavelet, Karhunen-Loeve Transform [22], Hermitian Basis [23], and other methods [21] [24]. Wavelet Transform (WT) is used to solve the problem associated with a non-stationary such as EMG, ECG signals. The method is capable of representing signals in different resolutions by dilating and compressing its basis functions. The same way WT is often used for EEG signals extraction by providing very efficient levels of decomposition and different resolution on the signals. Further the method could be used in analyzing physical situations where the signal contains discontinuities and sharp spikes of the EEG signals. The main advantage of the WT is that it has a varying window size, being broad at low frequencies and narrow at high leading to an optimal time frequency resolution in all frequency ranges [39]. WT is one of the efficient analysis of feature extraction method for most biosignal. However, EEG signals have problems on recording multichannel acquisition. This enhances the performance of the signals in finding the quantitatively optimal wavelets to match the EGG signals. Researchers are working towards, WT to be promising feature extraction method for EGG signal processing. There is a variety of approaches to the EEG signal analysis from epilepsy waveform such as feature extraction [23], artificial neural networks (ANN) [22], a Fourier transform [25].

2) Detrended Flunctuation Analysis (DFA): This method is developed by Peng et al. [26]. It is very efficient scaling method commonly used for detecting long range correlations in non-stationary time series signals. It is based on identifying trends in the signal's variance. It is inherently analyzed with different block length. For ECG signals DFA together with spectral analysis of heart rate is used for variability for sleep stage and sleep apnea identification. Researchers have evaluated the significance of Detrended Fluctuation Analysis (DFA) for studying heart rate variability in children with sleep disordered breathing. Complex medical signals in Electrocardiogram (ECG) signal are well performed [24]. The usefulness of DFA in EMG analysis has been started as a beneficial tool for characterizing the similarity of EMG signal and extract the novel feature that has the different pattern with RMS and MAV. Beside the effect of the window size parameter of DFA for EMG feature extractions it is also evaluated by its quality of the three criterions: class separability, robustness, and complexity on the measurements.

3) Fast Fourier Transform (FFT): Most area of study fields such as digital filtering, medical imaging and instrumentation used Fourier transform signal analysis tools. FFT is one of the most common method used for determining the frequency spectrum of the EMG signal [27] map the EMG signal from the time domain to the frequency domain. The frequency spectrum of any signal is clarified and recognized by breaking down the signal into its corresponding sinusoidal of different frequencies. This analysis clearly shows the compression of the spectrum as the muscle is fatigue. FFT analysis to EGG signal produces a similar one to power spectrum of the gastric recordings without losing the real amplitude and frequency of the signal. FFT is one the best-used method for the feature extraction of EGG signal. EMG signals are non-stationary so they have highly complex time-frequency characteristics. Most signal processing tool uses FFT to determine the frequency content of the signal with the mail aspects of feature extraction. Since biosignals are naturally nonstationary signals, understanding the signal characteristics from the obtained frequency content is not sufficient to analyze the signal.

4) Linear Transformation: The method often used for feature extraction or data compression. Kosambi–Karhunen–Loève theorem[43][44] is a representation of a stochastic process as an infinite linear combination of orthogonal functions, analogous to a Fourier series representation of a function on a bounded interval. KLT is used to represent a discrete set of signals in the basis vector which represents important features contained within the pattern data. The method can order optimally in the least squares sense, for estimation of signal patterns in terms of a set of orthonormal basis vectors [21]. An exact representation of the signal is obtained if all basis vectors are used to maximize the rate of decrease of variance and the features are optimally ordered in terms of relative importance. KLT is an effective method for dimensionality reduction, from the perspective of statistical pattern recognition. The Analysis reduces the number of coefficients needed for feature representation by discarding the terms that have small variances and keep only the terms that have large variances. KLT is an attractive and powerful method for feature extraction and shape presentation process of biosignals. The usual and traditional methods of EMG amplitude and spectral analysis are not effective in analyzing the signal impulse, therefore the Histograms and CR values were of the signal is taken for KLT analysis. KLT is applied to ECG signals for noise estimation and retaining the information necessary for accurate analysis. The method rejects noise and artifact from the ECG signals for further feature extraction and classification process of the signal.

5) Hilbert-Huang Transform: The Hilbert-Huang Transform (HHT), is works prperly for nonlinear and non-stationary data analysis in the biomedical processes. The purpose of HHT is to demonstrate an alternative method to present spectral analysis tools for providing the time-frequency-energy description of time series data. Also, the method attempts to describe nonstationary data locally. Hilbert transform was used, rather than a Fourier or wavelet based transform, the in order to compute instantaneous frequencies and amplitudes and describe the signal more locally.

C. Feature Training and Classifications Method

The classification of biosignals lies in the categories as continuous or discrete signals. Another classification of biosignal is as deterministic or random signals as indicated in Figure 1. Explicit mathematical relationship method represents the deterministic signals whereas random signals cannot be exactly expressed. When the signal properties do not change much over time, it is called stationary signals. There are different solutions for Feature classification and training is presented in this review papers that have been proposed during the last decade and some of the method are under evaluation.

1) Neural Networks (NNs): Has become a widely and attracted analysis and classification method due to its good ability, adaptability and nonlinear reparability networks. *Artificial* Neural Networks(ANN) lend themselves to applications involving biosignal processing and recognition. Most recent systems employ artificial neural networks to perform diagnoses since they have demonstrated great consistency in producing accurate results [30]. The ANN has been widely used especially for pattern recognition and for data processing. An artificial network performs in two different modes, which are learning (training) and testing. During the training process, a set of examples will be given and the network will modify the output until it is acceptable. Biosignals such as EMG signal are random and contain numerous non stationary characteristic. Wang and Buchan [30] was introduced neural network method for the modeling of muscle activation dynamics. It was proposed a classification system of EMG signals. In the past studies EMG signal is measured on the controlled prosthetic member by using the neural network method [30]. They developed a neural network method for the muscle activation and compared it with actual EMG signal from the joint moment of arm muscles. The prosthesis is designed in taking in to consideration of the EMG signal can be controlled by surface electrodes attached to the subject's arm. Researchers have proved that the ability of neural networks method is efficient to recognize the EMG patterns. Especially the result is optimal when using this conventional method together with linear separable functions [29]. ECG signal classification using the method of NNs efficiency of classifiers is depends upon a number of factors of the network training. Inputs of the ECG signal models are the training parameters and in the output of the signal should indicate the point where training should stop. Most researchers [34] have proposed a neural network method approach based on a combined genetic algorithm with cascade correlation for the diagnosis of gastric by emptying from the EGG. Good results obtained by using NN classifier in combination with Wavelet-based feature extraction technique to detect epileptic EEG signals using a back propagating artificial neural network classifier [40]. NN classifier for SpO2 measurements can obtaine from pulse oximetry to predict Obstructive Sleep Apnea Syndrome (OSA). The results show that the NN classifier is a useful predictive tool for OSA patients with a high performance and to improve the accuracy [35]. Previous study on EGG has used different types of classification methods such as ANN [28] and Back Propagation [31]. These researchers have chosen this method because of the ability of ANN to learn the functions that describe the output and input mapping in the system. The use ANN method will evaluate the accuracy, specificity and sensitivity with the actual muscle activation from the EMG signal. This approach is based on earlier observations that the EEG spectrum contains some characteristic waveforms that fall primarily within high and low frequency bands. Non-linear dynamics theory opens a new window on understanding the behavior of EEG. ANN also used as a method analyzing the time evolution of the traditional frequency rhythm of an EEG signal and to visualize the frequency band behavior during epileptic seizure. Several seizures are visually selected from the EEG of a patient in [31] the use time-frequency analysis of EEG signals. ANN is the best classification techniques in terms of accuracy, sensitivity and productivity also for ECG

2) Neuro-Fuzzy Approach: Neuro-fuzzy is a hybrid of artificial neural networks and fuzzy logic [26]. Fuzzy Neural Network as in the literature [28] incorporates the human-like reasoning style of fuzzy systems through the use of fuzzy sets and a linguistic model consisting of a set of IF-THEN fuzzy rules. The concept is the fuzzy systems which use neural networks theory in order to determine their properties (fuzzy sets and fuzzy rules) by processing data samples. Neuro-fuzzy systems harness the power of the two paradigms: fuzzy logic and neural networks. Utilizing the mathematical properties of neural networks in tuning rule-based fuzzy systems it will approximate the way to process information. The analysis has been used with ECG signals and used to determine the signal property and overall performance.

3) Fuzzy Logic: Although biomedical signals are not always strictly repeatable and many sometimes even the signals can be contradictory; using fuzzy logic systems are advantageous. One of the most prominent features that contradict the data can be tolerated in fuzzy logic system method. In addition to that, by using the trainable fuzzy systems is possible to discover the patterns of the data which are not easily detected by other similar methods as for example neural network. It is possible to integrate this incomplete but valuable knowledge into the fuzzy logic system due to the system's reasoning style as like as human being. This has a significant advantage over the ANN [33].

EMG signals classification problems have been improved by a fuzzy approach and a time- segmented features used by Hudgins et al [32]. ECG signals will be classified by Fuzzy with a good performed and efficiency of the recognition. Its performance is with accuracy of almost 100%. By adopting this method, the arrhythmia is detected more precisely with high contribution to the clinical practice. [41]

4) Linear Discriminant analysis(LDA): Linear Discriminant analysis is a statistical technique to classify objects into mutually exclusive and comprehensive groups based on a set of assessable objects of features. Discriminants Analysis appears with different names for difference fields of study. It is also often called pattern recognition, supervised learning, or supervised classification [36]. EGG has used different types of classification method where the feature should be relevant to the needed task. The use of this classification method for the EGG signal applied to classify objects into mutually exclusive comprehensive groups based on a set of assessable objects of features. Linear Discriminant Analysis is handling the case where the within class frequencies are uneven. Linear Discriminant Analysis is handling the case where the within class frequencies are uneven and their performances have been observed on randomly generated EGG test data. The ratio of between-class variance to the within class variance is maximized in any particular data set in this method ensuring the maximal separability.

D. Feature Selection

Pattern recognition requires representative features, thus features that can be used to discriminate between patterns. If a classifier, using just a couple of features, does not provide accurate classification results, it is common to use more input features in the classifier. This often helps, but the number of input features is limited after this limit the performance of the classifier starts to decrease. The number of training samples must grow exponentially with the number of input features. Thus, it is necessary to select a set of features to be used as inputs to the classifier. For effective classification, it is important to find features that have the optimal discriminative power between the classes [37]. Therefore, different methods have been developed for creating an optimum input feature set for classifiers. For classification, features that maximize the inter class distance and minimize the intra class variability are the best features. Both the prior knowledge and the training data are used for feature selection.

IV. DISCUSSTION

One of the most important aspects of the biosignals classification systems is reliable analysis, which enables significant values to be identified on the measured signal. It is noted that the wide variety of techniques used for feature extraction presents two problems: which techniques should be used and how to select from among the features that each extraction technique generates. Selected features are best only by some standard; therefore, techniques for generation of features tend not to be very portable from one pattern processing problem to another. Many types of standard feature extraction and classification methods are used for different biosignals. A set of features or parameters are used to characterize each object in the classification method, where these features should be relevant to the task. Many techniques do not generate independent features; therefore, there is redundancy in the data, which potentially affects both efficiency and accuracy in pattern recognition. We also need to consider the complexity of biological tissue, which makes the feature extraction modelling very hard and difficulties linked to a standard reference measurement of biosignals which is dependent on the signals of many unknown factors. For researchers during their test time finding the optimal solution for the feature extraction and classification method can be difficult due to regulations that cannot get sample data from a real patient any time as wanted. This means that, not being able to find consistent samples for finding a suitable method and do the analysis of the biosignals difficult, since the samples are working with is inconsistent at best. The other reason what makes the biomedical signal analysis difficult is the fact that the signals are very weak (in mVolts) including the noise and common mode signals (ranges from -5 to +5V) [38]. So, it needs high common mode rejection ratio amplification. Also, picking a signal from the body surface is actually picking all the biosignals and hence it needs good filtration before analyses the signal for feature extraction and classification of different methods. A number of digital signal processing methods for analysis are applied to each biosignals like Fast Fourier Transform (FFT), Discrete Wavelet Transform (DWT) and Discrete Wavelet Packet Transform (DWPT). Brief theories of specific techniques selected and discussed here which include Neural Networks, Wavelets Transform (WT), Fast Fourier Transform (FFT), Fuzzy Logic and Support Vector Machine. Wavelet transform is the best method for feature extraction since it could be used in analyzing physical situations where the signal contains discontinuities and sharp spikes. WT more specifically the detection of attribute values achieves a sufficiently high level of reliability for ECG/ EMG analysis. The adaptive spectral analysis and exponential distribution method are the most accurate method of extracting the real signal from EGG signals than the rest ones. It attributes in few steps also is important from the point of view of the time requirement for processing. The extracted values are then used as input values for a classification system. The EEG signal is more complex, and thus it requires more steps of pre-processing.

The table below summarizes the most suitable feature extraction and classification method used for Biosignals:

TABLE II. SUMMARY OF THE BEST APPROACH OF BIOSIGNALS FEATURE EXTRACTION AND CLSSIFICATION METHODS

Bio signal	Methods		
	Feature Extraction)	***Classification***	***Disease***
ECG	Karhunen Lo`eve Transform (KLT), Wavelet Transform	Neuro Fuzzy, Artificial Neutral Networks	Heart Disease, Coronary Syndrome,
EEG	Wavelet Transform	Artificial Neutral Network, Fuzzy	epileptiform brain sleep disorders
EGG	Wavelet Transform, FFT	Artificial Neutral Network, LDA	Gastric abnormalities
EMG	Detrended Fluctuation Analysis, Wavelets	Neural Networks, Fuzzy Logic, Support Vector Machine Learning	Muscle response, Nerve Injury
SpO2	Neural Networks,	Neural Networks,	Obstructive sleep apnea (OSA)
RSP	autoregressive modeling (AR)	LDA, Neural Network	OSA Body activity
EOG	autoregressive modeling Wavelets, ICA	Linear filter	Eye movement or blink

V. CONCLUSION

One of the main aims of a biosignal extraction and classification system is to help healthcare professionals to interpret biosignals measurements correctly, and then to propose the most appropriate treatment. Further applications of these systems can be useful educating new researchers and doctors, in evaluating biosignal records. There are a number of algorithms and methods that be employed to classify or to extract biosignals. Proper selection of attributes plays a very important role and significantly influences on the success rate of processing, extracting and classification of the biosignal. Various techniques and scientific research have been proposed for biosignals feature extraction and classification methods. This survey paper provides an overview of s feature extraction and classification techniques for frequent used biosignals. In our work, we summarize the approach for a common biosignal feature extraction and classification techniques in which scientist and researchers with in the area can adapt to their work easily. The future works mainly concentrate on developing an algorithm for accurate and fast feature extraction of the biosignals.

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