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A Novel Technique for Classification of Wrist Pulse for Health Monitoring using Sparse Classifier

Arathy V R[1], Poornima Indusekhar[2]

PG Scholar, Mohandas College of Engineering and Technology (MCET) [1]

Asst Professor, Dept of Electronics and Communication, MCET [2]

Abstract: A wrist pulse system has been developed that can detect both normal and abnormal conditions in patients based on wrist pulse diagnosis. Pulse diagnosis are mainly done in three steps they are pulse preprocessing, feature extraction and classification. The acquired wrist pulse signal is passed through consecutive stages of denoising, baseline wander removal and period segmentation. The feature extraction is then done to extract time domain, frequency domain and wavelet features. Classification is then done for finding normal and abnormal conditions using SVM (Support Vector Machine) classifier. It is found that by using the SVM classifier, distributed features cannot be efficiently identified, classification accuracy is low and sub-classification cannot be done for abnormal condition as SVM supports only binary data. So SVM classifier is replaced by sparse classifier which has higher accuracy since it supports highly nonlinear data. T test is used in feature selection so that it needs low memory and less time consumption. Sub-classification has been done for the abnormal cases of Anemia, Arrhythmia and Wolff Parkinson White Syndrome.

Keywords: Preprocessing, Feature Extraction, Sparse classifier, T test.

1. INTRODUCTION

Wrist pulse is mainly caused by the cardiac contraction and relaxation. For thousands of years, pulse diagnosis has played an important role in traditional Ayurveda medicine for disease analysis [8]. A practitioner put it three fingers on the wrist of the patient mainly based on the three positions that is can, guan and chi positions. Despite its success in history, pulse diagnosis actually is a subjective skill that needs years of training and practice to master. The pulse signals are passed through three steps they are pulse preprocessing, feature extraction and classification.

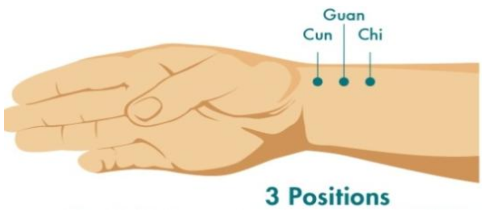

Figure1: Traditional pulse diagnosis

The acquired wrist pulse signal is passed through consecutive stages of denoising, baseline wander removal and period segmentation. To remove noise from the signal denoising is done. While taking reading sometimes the patients may move or some noise occurs, there should be variation in the pulse signals. In order to remove that noise, baseline wander removal is done to minimize the distortion in the pulse signal. Baseline wandering is the process of removing signal below the threshold value. Pulse samples are segmented into a set of single-period signals in pulse segmentation.Then from the segmented pulse , the feature extraction is done on the preprocessed signal to extract time domain, frequency domain and wavelet features.

Time-domain features mainly compute the mean absolute deviation information whereas the frequency features provide cycle stability information existed in the multi period signals. Wavelet features are extracted from the high-level decomposition coefficients of the pulse wavelet transformation .Then classification is done for finding normal and abnormal conditions using SVM classifier.

But it is found that by using SVM Classifier the features cannot be efficiently identified and accuracy is low since it supports for linear data. Also SVM is fundamentally a binary classifier; it has no standardized way for dealing with multiclass problems [4].

To overcome these limitations SVM classifier is replaced by sparse classifier. It has the standardized way for dealing with multiclass problems.

Sub classification can be done for abnormal cases such as Anemia, Arrhythmia [5] and Wolff Parkinson White Syndrome. T Test is used in feature selection to select the first high features so that memory size can be reduced and less time consumption.

2. BIOMEDICAL PROCESSING OF WRIST PULSE

In traditional pulse diagnosis , to analyze the health condition of a patient, a practitioner should put three fingers on the wrist of the patient mainly based on the three positions (i.e., Cun, Guan, and Chi) to adaptively feel the fluctuations in the radial artery. The main sites for pulse assessment are the left and right wrists. For computerized pulse diagnosis, information's from the guan position only can captures since it uses only single channel [3]. By far, a number of sensors and systems have been developed for acquiring pressure pulse signal. The non disturbing measurement of blood pressure signal to design a mechanical electrocardiography system based on the pressure in the electromechanical film and magneto elastic skin curvature sensor[20].

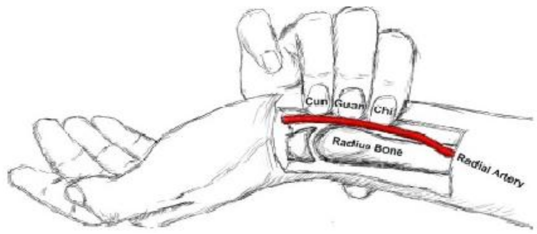

Figure2: Principle of Pulse Diagnosis.

Conventional acquisition system has several limitations ie the user will manually place the probe to the appropriate position based on the user's experience. Thus, the wrist pulse signals actually are the combination of acquisition device and manual probe positioning, and the objectiveness of the acquired pulse signal would be difficult to guarantee. The pulse signal acquisition systems only use a single pressure sensor to capture pulse signal, and thus cannot simultaneously acquire multichannel signals for comprehensive pulse signal analysis.

2.1 .Pulse Pre-processing

The pulse signals collected by sensors are done in three steps pulse preprocessing which includes denoising baseline wander removal and period segmentation, then feature extractionie extracting time domain , frequency domain and wavelet features and classifying it in to normal and abnormal categories. The acquired wrist pulse signal is passed through consecutive stages of denoising, baseline wander removal and period segmentation. To remove the noise denoising is done.By using the low pass filter the high frequency noise pulse are removed. Baseline wandering is the process of removing signal below the threshold value. Pulse samples are segmented into a set of single-period signals in pulse segmentation.Then from the segmented pulse wave ,feature extraction is done on the preprocessed signal to extract time domain, frequency domain and wavelet features. Time-domain features mainly compute mean absolute deviation of the pulse signal, whereas the frequency features provide cycle stability information existed in the multi period signals. Wavelet features are extracted from the high-level decomposition coefficients of the pulse wavelet transformation. Then classification is done for finding normal and abnormal conditions using Sparse Classifier.

Signal denoising is done in order to remove the noise existed in the pulse signal. By using low pass filter the high frequency noise signal are removed. The frequency above 100 hertz are removed by using the low pass filter.

Baseline wander removal is required in order to ST segment are analysed for the diagnosis of anemia, arrhythmia, tuberculosis and wolffparkinson white syndrome. The frequency content of baseline wander is usually in the range below 0.5 Hz.

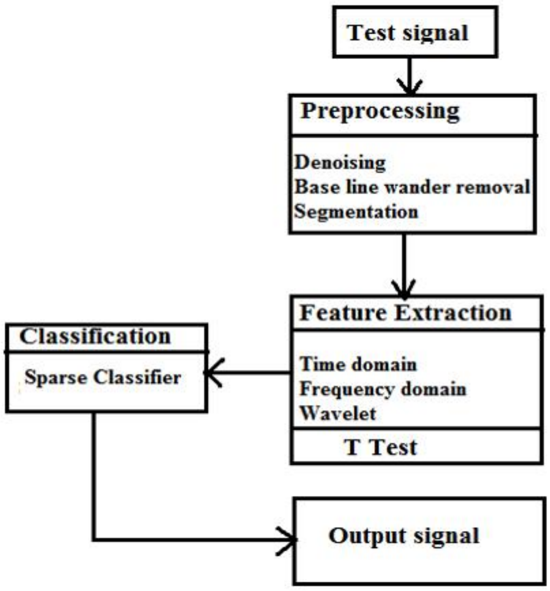

Figure 3: Block Diagram of Proposed Method

Period segmentation is done after baseline wander removal. Here the pulse samples are segmented in to a set of single period pulse. To find the peak of each wave, segment out the left and right region.

2.2 Feature extraction

The aim of feature extraction is to find a low dimensional subspace that preserves most of the pulse information in the original time series and removes the redundancy. Extracting the pulse features from three aspects they are time-domain features, frequency features and wavelet features.

Time-domain features mainly compute the mean absolute deviation. First find the mean of recorded samples. Then take the difference between each recorded data and mean. Then take the absolute value. A time-domain graph shows the mean absolute deviation of each pulse wave.

Frequency domain features shows how the signal are distributed in the different bands of frequency. By using spectrogram different bands of frequency are distributed are shown. Here each colour represents each bands of frequency.

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Wavelet features are used to find the energy, variance, entropy and waveform length of wrist pulse. First , the wavelet reconstruction is done on the pulse signal and find the energy, variance, entropy and waveform length and the wavelet reconstruction is done. Energy is nothing but the pulse power ,it is found by taking the product of amplitude and time value. Variance is the square root of change in deviation from original value. Entropy is the speed of the wave in unit time.

After extracting the features from time domain ,frequency domain and wavelet, T test is done in feature extraction to select the first high features so that it requires less memory and time consumption. Paired-sample T-test is used here because the if two sets of data are significantly different from each other. First there are reference data and recorded data, then calculate the mean of both reference and recorded data.If the mean of recorded data is similar to reference data then that value can be taken so that redundant datas can be removed.

2.3Classification

At first classification can be done by using SVM classifier to categorizing it in to normal and abnormal conditions. By taking wavelet transform the features having high values are on one side and low values on other side .If an imaginary line is drawn between these higher and lower values. Marginis defined as the width of the boundary could be increased before hitting the data point. Support vectors are chosen based on the vectors that hit the boundary. By using this SVM classifier the features cannot be efficiently identified and also sub-classification cannot be done since SVM supports only binary data.

Hence for classification Sparse classifier is used to classify normal and abnormal conditions in patients. Sub classification can be done for abnormal cases such as Anemia[1], Arrhythmia and Wolff Parkinson White Syndrome. Sparse classifier[7]is populated primarily with zeros.

They are stored using special data structures, which allow to store only nonzero elements so that itsaves a lot of memory and CPU time. The main advantage of using this sparse classifier is that distributed features can be efficiently identified. Accuracy is high since it supports for highly nonlinear data.Sparse classifier will reduce calculation time by eliminating zero elements.

Sub classification [11] can be done by using sparse classifier for abnormal cases such as Anemia, Arrhythmia and Wolff Parkinson White Syndrome.Anemia is the decrease in the amount of RBCs or hemoglobin in the blood. An irregular heartbeat is an arrhythmia. Heart rates can also be irregular.Wolff Parkinson White Syndrome is one of several disorders of the electrical system of the heart that are commonly referred to as pre-excitation syndromes.

3. RESULTS AND DISCUSSION

Biomedical processing of wrist pulse that can detect both normal and abnormal conditions like Anemia, Arrhythmia, Tuberculosis and Wolff Parkinson White Syndrome has done by using Sparse Classifier. By using Sparse classifier , distributed features can be efficiently identified and accuracy is high compared with SVM Classifier. T test in used in feature selection to select the first high features.Pulse preprocessing, feature extraction and classification has been simulated using MATLABR2013a 8.1.0.604 Simulation results for wrist pulse to detect normal and abnormal conditions like Anemia, Arrhythmiaand Wolff Parkinson White Syndrome.

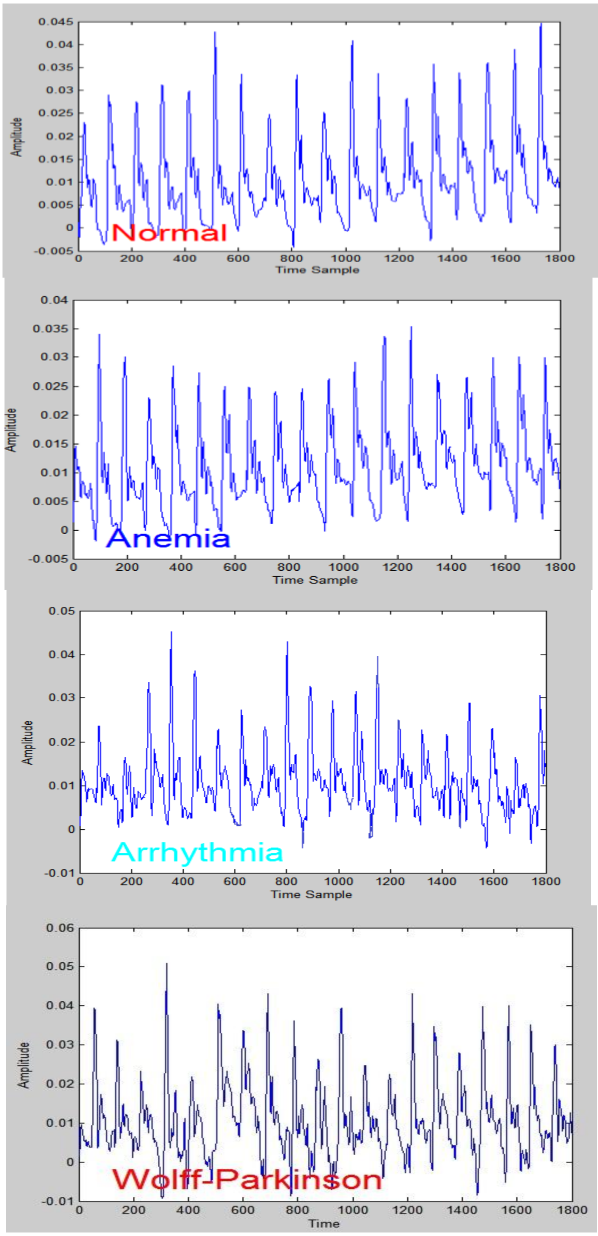

Fig3.1 Classification for normal and abnormal conditions like Anemia, Arrhythmia and Wolff Parkinson White Syndrome

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4. PERFORMANCE ANALYSIS

By comparing with SVM classifier for diagnosing normal and abnormal categories, the proposed method ie by using sparse classifier has several advantages. The main advantage of sparse classifier is higher accuracy. By using the SVM classifier the accuracy is 90%,but by using sparse classifier the accuracy is 96.7%.T test is used in feature selection so that it needs less time consumption. When the data size increases the time consumption also increases, but compared to the existing method time consumption decreases in the proposed method.

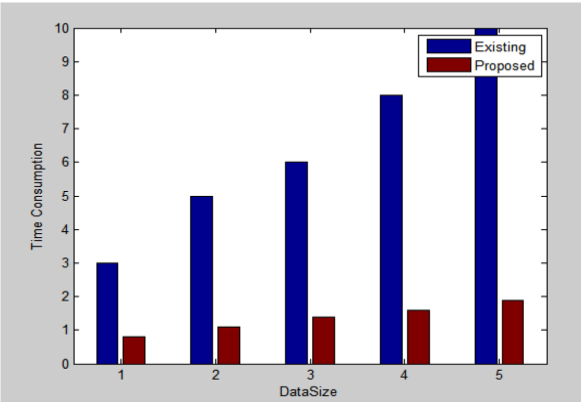

Fig 4.1 Performance analysis for time consumption

5. CONCLUSION

Wrist pulse that can detect both normal and abnormal conditions can be done by using sparse classifier. The pulse signal is passed through the consecutive stages of pulse preprocessing, feature extraction and classification. T test is used in feature selection to select the high features so that it uses less memory and less time consumption. Sparse classifier is used in classification to detect normal and abnormal conditions in patients. The main advantages of sparse classifier is distributed features can be efficiently identified, achieve high classification accuracy. Also it needs low training sample. Sub classification can be done for abnormal cases such as Arrhythmia, Anemia and Wolff Parkinson White Syndrome.

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