Automated Identification of Myocardial Infraction Using Harmonic Phase Distribution Pattern of ECG Data

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***Abstract*- The proposed project consists of the integration of automated ECG analysis techniques for the early detection of myocardial infarction, known as heart attack. It consists of easier and compact way of the detection compared to the already existing models which use complex computations and classifiers to detect MI. The wave sequence consists of P, QRS and T waves which form a complete cardiac cycle. These components are extracted during the analysis of the wave. These components, then, help in distinguishing the heart abnormalities.**

INTRODUCTION

A heart disease effects the ability of the heart to function properly. These diseases cause other problems that effect the body as a whole. These can be arrythmia, prolapsed mitral valve, coronary artery disease, congenital heart disease and many more. These diseases need to be detected in time so that proper treatment can be given on time. These are usually detected using various techniques, both invasive and non-invasive.[1] The most common methods use the electrocardiogram (ECG) signal or the phonocardiogram (PCG) signal. These are a graph of voltage versus time of the heart activity using the electrodes. These electrodes form a cardiac cycle which is a result of the polarization and repolarisation of cardiac muscles. In cases of cardiac abnormalities, the normal ECG pattern change. [2] The electrodes are in the limbs and on the surface of the chest. Ten of these electrodes are placed in the limbs. This a conventional 12- lead ECG. The electrical potential of the heart is measured from twelve different angles called the leads over a period usually 10 seconds.[3] This way, the overall magnitude is measured over a complete cardiac cycle. The ECG consists of the three main components called the P wave, QRS complex and the T wave which represent the atrial and ventricular contractions respectively.[4] The ECG analysis use various tools to analyse the signals. These tools usually use complex algorithms and complexities for differentiating between a normal signal and an abnormal signal with irregularities. These algorithms are integrated with devices for the detection of cardiac abnormalities.[5] In the paper, we will mainly focus on the detection of myocardial infarction, commonly called heart attack. There are already existing systems for the detection of myocardial infarction. This paper proposes a simpler way of detecting myocardial infarction without the various complexities used in the other systems. There are proposals for the development of computerized ECG analysis techniques, but most of them are not suitable for portable device applications due to high memory requirements and complex algorithms.[6] The system proposed in this paper uses easy computations and algorithm which can be easily implemented in portable systems. This system can be used using simple microcontroller-based Arduino board which can be used as an ECG device. It will be used to take the ECG signal using a sensor which will be placed on the limbs. The sensor can be any kind used for the detection the signal. However, in this paper we will only see the software implementation of the project. In this paper we will explore the utility of the harmonic phase distribution pattern of the data obtained from ECG. There are many advantages of the harmonic phase distribution in the ECG signal such as, the use of harmonic phase values as features will eliminate the need for using plane features. Similarly, there are many advantages of the harmonic phase values which reduces the computational complexities compared to the already existing

systems. The proposed system has a very high accuracy of about 94%. This improves the chances of detection of Myocardial infarction.

REQUIREMENTS

The proposed project mainly focuses on the software aspect. The hardware can be added easily to the project. The hardware requirements if wanted to be added would consist of a microcontroller-based Arduino board and sensors which will be used for detecting the signal.

The project mainly consists of two types of databases i.e., training data and testing data. These are used for the differentiating between the normal and the abnormal signals. These are mainly collected databases. The training database consists of already existing data signals which are collected from various sources. The training database is mainly taken from the benchmark PTB diagnostic ECG database available under Physionet. This is used for the development and validation of the proposed technique. These are collected from health control volunteers and patients having hear diseases using digitalized 12- lead ECG. The testing data is the signal which is to be tested. The testing data is compared with the training data which pre-processed.

The software used in this project is MATLAB. MATLAB is a high-performance language for technical computing.[7] It is used for the integration of computation, visualisation and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include, math and computation, algorithm development, modelling and simulation, scientific and engineering graphics. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or FORTRAN. MATLAB can be run on embedded devices. Automatically convert MATLAB algorithms to C/C++, HDL and CUDA code to run on your embedded processor. MATLAB works with Simulink to support Model-Based Design used for multidomain simulation.

MODULES

The module is the essential part of any project. It provides high level description of functional areas, describing the functionality of a module through several processes.

This project consists of six modules namely,

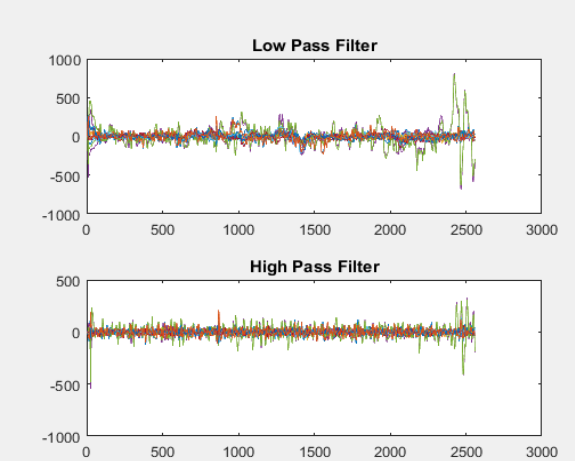
1. Browse
2. Pre-processing
3. Wavelet Transform
4. Features
5. GRNN Neural Network (Training Databases)
6. Classification

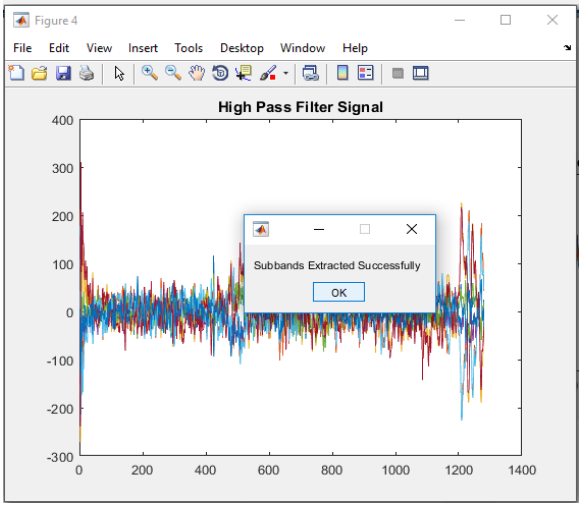
Browse: The browsing module helps to select signals from training database. This project consists of twenty database signals. On clicking the browse button, you can select any signal from the database. This signal undergoes pre-processing which helps to compare with the already existing database.

Pre-processing: This operation is performed on images at lowest level of abstraction.[8] The goal of pre-processing is to improve the image data by supressing unwanted distortions or enhancing important image features. Image restoration is used to obtain a clean original image by removing various noises and corrupt data. Motion blur, noise and camera misfocus are various forms of corruption. The noises are removed using median filter. A median filter is applied to smooth a noisy image. It is applied with a 3X3 pixel window i.e. The value of every pixel in the noisy image is recorded along with nearest eight neighbours. All these nine numbers are then ordered according to size and the median is selected as the value of the pixel in the new image. As the 3X3 window is moved one pixel at a time across the noisy image, the filtered image is formed. Therefore, by clicking on this button a filtered signal is obtained. The filtered signal makes it easy for wavelet transformation in the next step.

Wavelet Transform:[9] Wavelet transforms are mathematical means for performing signal frequency varies over time. It provides precise information about the signal data compared to other signal analysis technique. The wavelet transform uses exponential scale with base equal to the power two. It provides sparse representation for many signals i.e.; important features of signal are captured by DWT

coefficients subsets which is much smaller than the original signal and compresses the signal. The output is always the same number of coefficients as the original signals but the value maybe close to zero. As a result, many of the coefficients can be thrown away and we can still maintain a high-quality signal approximation. There are equivalent to discrete filter banks. It is specifically a tree structured discrete filter bank where the signal is first filters by a low pass and a high pass filter to obtain low pass and high pass sub-bands. Upon, inversion, the wavelet transforms provide perfect reconstruction i.e.; you can take the discrete wavelet transform of a signal and use the coefficients to obtain an exact reproduction of the signal to numerical precision.





Features:This is used to extraction different parameters of the signal. These help in analysing the signal properly. The various parameters extracted are:

1. Skewness
2.Kurtosis
3.Entropy
4. Standard deviation

Skewness The skewness is a measure of the asymmetrical spread of a signal about its mean value. For a random variable with a Normal distribution the skewness is zero. It is used in making judgement of the image surfaces. Darker and Glosser surfaces tend to be more positively skewed than lighter and matte surfaces. Kurtosis The kurtosis is a measure of the average fourth power of the deviation of a signal from its mean value divided by the fourth power of the standard deviation. Therefore, it is dimensionless. For a random variable with a Normal distribution the kurtosis has a value of 3. Entropy The entropy of a signal is a measure of its spectral power distribution. 4. Standard Deviation It is a measure of how far the signal fluctuates from the mean. The variants the power of this fluctuation.

General Regression Neural Network

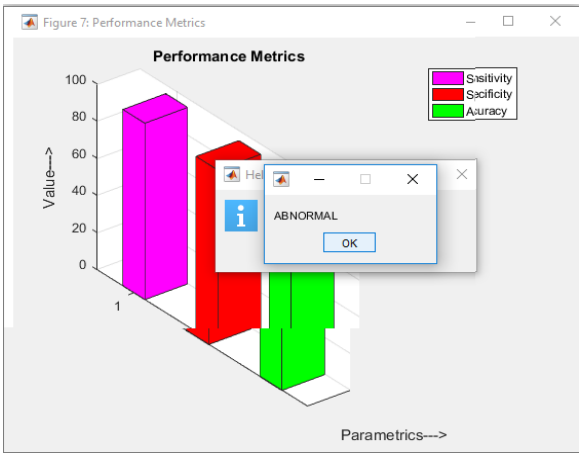
Neural networks are predictive models that are based on action of biological neurons. [10]Neural network is a tool used for recognition and discrimination between different signals to get best results. Learning algorithm and suitable architectures should be selected to obtain good results using neural network.

Types of neural networks are:

a. Artificial Neural Network
b. Probabilistic Neural Network
c. General Regression Neural Network

Neural networks and General Regression Neural Networks have similar architectures, but there is a fundamental difference: networks perform classification where the target variable is categorical, where is General Regression Neural Network perform regression where the target variable is continuous. It is basically a one pass learning algorithm with a parallel structure. In any problem where an assumption of linearity is not defined, this algorithm form can used. Neural Network is a set of algorithms designed to recognise patterns. It helps us cluster and classify. They help group unlabelled data according to similarities among example inputs and classify data when they have a labelled dataset to train on.

Classification: It is used to classify between normal and abnormal signal. It uses different parameters to form a performance metrics. It shows various performance values such as sensitivity, specificity and accuracy.



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