ECG Diagnosis using Digital Image Processing

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Abstract - Electrocardiogram is a standout amongst the most generally utilized indicative apparatuses for heart maladies these days. By the by, the exact ECG elucidation is basically required with a specific end goal to assess the significant data inner side the ECG signal. The ordinary procedure of sight examination to investigate the ECG signals by specialists or doctors are not viable and tedious. This paper manages the study and investigation of ECG sign handling by method for MATLAB device viably. Investigation of ECG sign incorporates era and recreation of ECG sign, obtaining of continuous ECG information, ECG signal sifting and preparing, highlight extraction, correlation between various ECG signal examination calculations and methods, location of any anomalies in ECG , computing beat rate thus on utilizing the most commonplace and multipurpose MATLAB programming.

Keyword **-** Electrocardiogram; peak detection; QRS detection; RR intervals; signal transmission; system

I. INTRODUCTION

The ECG data is recorded by placing surface electrodes on the chest. It is a record of heart's electrical activity, with an each segment corresponding to depolarization, repolarization of a particular region of the heart muscles. Firstly there is a rapid positive transition from Q wave to the R wave, immediately followed by a negative transition from the R wave to the S wave making up the high frequency spike known as the QRS complex.(As shown in the following figure). ECG is used to diagnose the abnormal rhythms and heart rate. Therefore a fundamental requirement of ECG analysis is computation. Measuring the interval between successive QRS complexes is an easiest way to measure the Heart rate. The ambulatory conditions along with the possibility of shift of the ECG leads provides a lot of scope for introduction of NOISE. Hence a need for Band-Pass filtering arises. The Pan and Tompkins[1] algorithm used in this project is based upon the slope information, consisting of Band Pass filtering, differentiation and squaring to emphasize the high frequency spikes, followed by Moving Window Integration to highlight the upslope and down slope of the QRS complex.

After the successful detection of the position as well as the amplitude of the QRS complex, a rule based approach has been followed to compare the test sample values with the standard values to classify it as a aberrant type. The classification done in this project is for only one category of disease known as Premature Ventricular

Contraction (PVC), in which the gap between two successive Ventricular contraction is abnormally reduced.

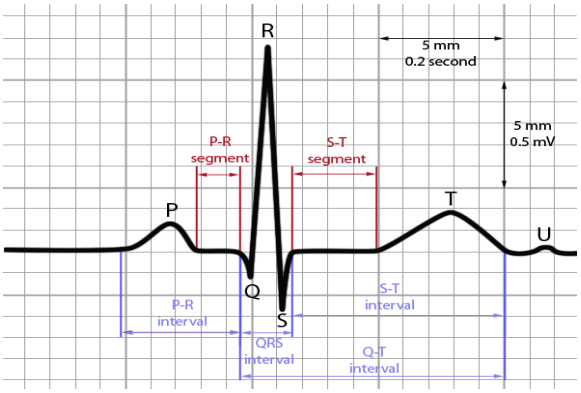


Figure 1: Typical Single Cycle of ECG Signal

Required Tool: Matlab, Turbo C
Area of Research: Digital Image Processing.

II. LITERATURE REVIEW

A. Image Enhancement - Image enhancement is the leading field for doing research work in Digital Image Processing. In any applications namely, military application, home entertainment, medical science and media etc., the image enhancement plays a crucial role. To find out the difference between the two images, the quality of image compared the image with a reference image, typical methods are used[1]. This method of pre-processing was not very efficient. Today importance is being given to improve the quality of images by improving the content of images. Techniques used to do the same are contrast enhancement, histogram equalization etc [2]. Denoising ECG Images is also a greatly studied topic. The major parameter for applying the Pan and Tompkins algorithm is the Signal to Noise ratio (SNR) [3]. It provides a great way to choose the algorithms to apply on such images. The newest method for processing of ECG images is the use of multiresolution image decomposition technique. The input image is taken and it is treated with a host of multiresolution techniques. These techniques improve the pertinent features of the image which help in further processes [4].

B. Image Segmentation - Image Segmentation is concerned about segmenting the image into various segments using different techniques. In early days a semi automatic approach was being used to detect the exact boundaries of the ECG Diagnosis. A slice with ECG is selected from the image and then the chosen slice was segmented using Fuzzy C-means method [5]. However, Human induced errors and time consumption made semi automatic methods unsuccessful. A much better application of ECG Diagnosis was made using Markov Random Fields method which was a fully automated method. It had a three

step segmentation process to segment the ECG [6]. Fuzzy C-means (FCM) clustering algorithm has been widely used in many medical image segmentations. But the drawback of Fuzzy C-means is that it is highly susceptible to noise. Hence a modified Fuzzy C-mean method was also employed [7]. The majority of research in medical image segmentation concerns ECG Graph. Pictures from the distinctive division strategies were contrasted and each other and investigated by expert radiologists to discover the division method which is the most precise. Trial results demonstrate that the Otsu's thresholding technique is the most reasonable picture division strategy [8].

Computer aided methods which combine two separate algorithms for ECG Diagnosis have also been tested. These methods have a greater accuracy and take less time [9].An enhanced version of K-means method for ECG detection has also been developed. It is considered to be an efficient method for ECG detection [10]. The latest trend for detecting ECG Diagnosis is the use of Neural Networks.

C. Morphological Analysis - Morphological Analysis forms an integral part of Image Processing. Binary Morphological analysis works only on a set value and does not consider the gray level value r intensity of pixels. Fuzzy mathematical morphology (FMM) is a traditional and robust method of image morphological analysis. The only concern is to decide the shape of the structuring element that is to be used with the input image [12]. If image has salt and pepper or Gaussian noise, Multi scale morphology is used. The image is classified into two regions as background and foreground [13]. Mathematical morphology because it uses inbuilt set functions, has a clear advantage for image processing. Morphological framework is considered very important not because it performs various tasks but because it can perform operations on almost all the images in all fields of image Processing [14]. Computer Aided Design (CAD) systems also help the radiologists with ECG detection. CAD systems usually don't make use of morphological operators, but use techniques such as histogram equalization etc [15]. The combination of morphological operator allows the locally segmented image to be processed using the most suitable morphological operator and hence extract the qrs from it. It is a very useful tool for ECG Diagnosis

Applications - There is still a lot of room for improvement in this project according to us. More specifically we would like to index at three particular aspects.

Firstly, all the classification done is solely based on the RHYTHM pattern observed. This method of classification can be improved by taking into consideration the previously observed patterns and thereby making the classification more reliable.

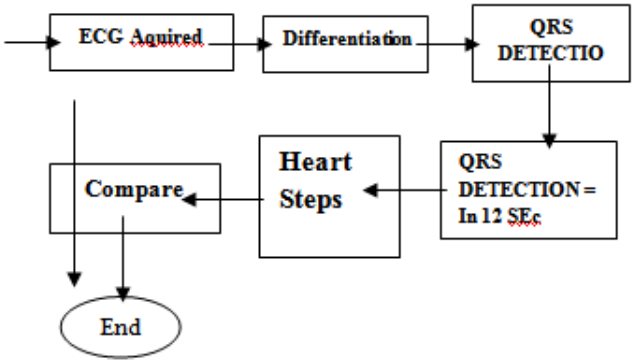
Secondly, even though we use low and high pass filters to filter out the noise due to the ambulatory and other real-life disturbances there is still scope for bettering this filtering process and hence ameliorating the classification.

And finally the adaptiveness of this project to different types of beats in a person, or many different persons can be taken into account by using Neural Networks.

In the coming time we would like to work on these aspects to enhance the functionability and efficiency of this Classifier.

III. RESEARCH METHODLOGY

- The methodology to be adopted during the development of the system is:
- Take an input as a gray scale ECG Graph.
- Perform Pre-Processing on the image.
- Segment the image using suitable segmentation method.
- Apply Morphological operators on the segmented image.
- Calculate the accuracy of the results.
- Show the QRS extracted from the input image



IV. PROBLEM FORMULATION

A. Design -

i). Existing System - The existing system of ECG Diagnosis in mainly based on locating the manually from the ECG Graph of the patient. Experts have a detailed look at the ECG Graph and then try to locate and detect the heart rate. This approach is not very accurate and is also considered to be very time consuming. Due to the lack of fully developed and sophisticated automated systems, there is no option but to rely on the manual approach as of now.

ii). Proposed System - The proposed system of ECG Diagnosis is fully automated system and is based on the MATLAB platform. It does not require any human intervention at all. The ECG Graph of the patient is taken as the input and the final output is the image of the heart beat. The proposed system is seen to be less time consuming, more efficient, accurate, and more reliable than the current approach.

B. Implementations - The proposed system is implemented on the MATLAB platform. The system is divided into the following modules:

i). Image Pre-processing: This module involves applying basic pre-processing operations such as filtering, contrast enhancement etc on the image to obtain a better resultant image than the original image. The system applies the following operation on the image:

- High Pass Filter: It was found from experimentation that high pass filter works best to remove the noise from the image. A high pass filter also enhances the features of a image in the best possible way.
- Contrast Enhancement: Contrast enhancement is also done on the image to enhance the region which is darker.
- Brightness Adjustment: Image Brightness is also adjusted so that the users have no problem in viewing the image properly.

ii). Image Segmentation: After pre-processing, Image is segmented by applying various segmentation techniques. The QRS can be distinguished from the healthy tissue ob basis of many parameters like shape, size etc. Different Segmentation techniques applied are:

- K-Means Segmentation: K-means is an effective segmentation method which aims to divide the image into a fixed number of clusters. The number of clusters is called as k. Initially the user selects the number of clusters he wants to divide his image into. After that the algorithm assigns points randomly to various pixels in the image present in the clusters. During the time the algorithm runs, an objective function is calculated.
- Otsu's Thresholding: Otsu's thresholding divides the image into two regions namely foreground and background. The pixels are divided in the two regions using a threshold value set by the user. The main aim is to have the class sum of foreground and background regions as minimum.
- Fuzzy C-Means Clustering: Fuzzy C-means implements fuzzy logic to segment the image. The Fuzzy logic assigns a membership value to each of the pixels. The value is in between the range of 0 to 1. The main advantage of fuzzy clustering is that the member of one class can also be a member of the other class.
- Image Thresholding: Image Thresholding is the simplest method of image segmentation. Image thresholding is usually used to create a binary image from a grey level image. Thresholding usually works by defining a threshold and then testing various pixels of an image against the threshold.

iii). Morphological Analysis: Morphological Analysis of the segmented image takes place after segmentation. Morphological analysis is defined as the analysis of shapes and boundaries of an object. Morphological Analysis is of great use to extract QRS from the segmented image. The system uses two morphological operators namely:

- Erosion: The erosion operator removes pixel from boundaries of the objects. The pixels to be removed are determined by the size and shape of the structuring element that is used to process the image.
- Dilation: The Dilation operator adds pixel to the boundary of the object.. The pixels to be added are determined by the size and shape of the structuring element that is used to process the image.
- Open: The open operator performs erosion followed by a dilation operation. Both erosion and dilation use the same structuring elements.
- Close: The close operator performs dilation followed by erosion. Both erosions and dilation use the same structuring element.

iv). Accuracy Of Results: The accuracy of the results shown by the system is measured using the following expression:

$$\textbf{Accuracy (\%)} = \frac{\textbf{Total area of the pixels in the final image}}{\textbf{Total area of the pixels in Ground Truth}} \times 1000 \quad (6)$$

Where Ground Truth is the exact position of qrs value in image. The above expression is used to find out the accuracy of all the segmentation methods and then chose the best method accordingly.

v). Final Output: Finally the output of the system consisting of the QRS detection only is shown to the user. The user can verify the accuracy of the output and can also use different segmentation methods if the results are not satisfactory.

V. OBJECTIVE & FUTURE PROSPECTS

Objectives - ECG analysis functions of beat detection and classification are implemented as C functions. The beat detector functions are independent of the beat classification functions and may be used alone in applications that do not require beat classification.

VI. CONCLUSION AND FUTURE PROSPECTS

The developed system will able to meet its objective which were stated when the project was started. The main objective of this is to develop a system which can detect rate of heart beat from brain ECG Graph. This will presents a fast, automatic and accurate method for segmenting QRS. It will also found out that of all the segmentation algorithms, which algorithms will present the best experimental results.
In future, with more time and with more comprehensive research the developed system can be made more accurate. Also new ECG Diagnosis algorithms can be added so as to give the doctor a wider variety of options to choose from.

VII. REFEREENCES

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