AIN SHAMS UNIVERSITY
Faculty of Computer and Information Sciences
Computer Sciences Department

Automatic Diagnosis OF Heart Diseases Based ON ECG Analysis

A Thesis Submitted to the Department of Computer Science, Faculty of Computer and Information Sciences, Ain Shams University, in partial fulfillment of the requirements for the degree of Master in Computer Sciences

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Cairo 2010

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Abstract

An electrocardiogram (ECG) is a signal, which records the heart's electrical activity versus time. It is an important diagnostic tool and efficient way to diagnose different kinds of cardiac diseases including arrhythmia.

There are different efforts for automatic diagnose system of arrhythmia based on ECG analysis, by different techniques the accuracy of them was between 90-96 %. The goal of this work is to develop a system for more accuracy and facilitates.

There are many types of arrhythmia, six of them were selected for ECG analysis. Our diagnose system consists the following phases, in the features extraction phase the Independent Component Analysis (ICA), power spectrum together with Pan-Tompkins technique were implemented. In the classification phase three techniques were used for comparison, namely, Artificial Neural Network (ANN), Fuzzy Inference Systems (FIS) and a hybrid approach of an Adaptive Neuro-Fuzzy Inference System (ANFIS). A large sets of standard data (420 cases) were used for training and testing which obtained from the (MIT-BIH) arrhythmia database,

The results which were obtained by using ANFIS were the highest efficiency 97.1%, while performance of the other methods ANN and FIS, were 94.3%, 95.7% respectively, which means the ANFIS technique is the best one.

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Table of contents

List of Tables

List of Figures

List of Figures

1.1 Introduction

Bio-signals on the surface of the human reflect the internal status and the electric activity, thus providing information on internal organs with measurement such as ECG. Abnormal heart rhythms known as arrhythmias are the cause of millions of deaths and hospitalizations every year and there is a great need for advancements in the field of cardiac electrophysiology. The surface ECG is a useful diagnostic technique. Since the development of medical science many systems have been developed which are improving people's health.

Generally, the ECG is one of the oldest and the most popular instrument-bound measurements in medical applications.

The analysis of the Electrocardiogram (ECG) has been widely used for diagnosing many cardiac diseases in many systems. The features extraction methods provide most of the clinically useful information in the ECG signal which is, in its characteristic, wave peaks and time intervals [1].

Automated ECG analysis consists of a series of procedures that can be utilized in order to produce useful information to help the physician to reach a diagnosis of the patient's heart faster and safer. ECG analysis consists of four stages: (a) signal acquisition, (b) processing, (c) feature extraction and (d) diagnosis [2].

For several years, the automatic classification of ECG signals has received great attention from the biomedical engineering community, this is mainly due to the fact that ECG provides cardiologists with useful information about the rhythm and functioning of the heart. Therefore, its analysis represents an efficient way to detect and to treat different kinds of cardiac diseases.

Several researchers have addressed the problem of automatic detection and classification of cardiac rhythms, as Follows:

Different techniques were used to extract features from ECG signal, which are Largest Lyapunov Exponent and Spectral Entropy [3]. An Adaptive Neuro-Fuzzy Inference System (ANFIS) was presented for classification of the ECG signals (extracted features as ANFIS inputs). The R-peaks (the peak with the highest amplitude in QRS complex) of ECG were detected by using Tompkins's algorithm, eight classes were chosen; which are Normal Sinus Rhythm (NSR), Left Bundle Branch Block (LBBB), Pre-Ventricular Contraction (PVC), Atrial Fibrillation (AF), Ventricular Fibrillation (VF), Complete Heart Block (CHB), Ischemic Dilated Cardiomyopathy (ISCH), Sick Sinus Syndrome

(SSS), Paced Rhythm (PR) and Congestive Heart Failure (CHF). The results indicate a high efficiency level of tools, used with an accuracy level of more than 94 %.

Another approach based on Adaptive Neuro-Fuzzy Inference System (ANFIS) was presented for classification of the ECG signals [4], It used Lyapunov exponents for ECG feature extraction (extracted features as ANFIS inputs). The presented ANFIS model combined the Neural Network adaptive capabilities and the Fuzzy Logic qualitative approach. The ANFIS classifiers were trained with the Backpropagation gradient descent method in combination with the Least Squares method, it is classified in four types of ECG beats NSR, CHF, VT and AF the total classification accuracy of the ANFIS model was 96.39 %.

On other hand there three different techniques were used to extract features from ECG signal [5], which are Fast Fourier Transform, Autoregressive Modeling and Principal Component Analysis. The features were classified by using three different classifiers which are ANN and two types of statistical classifiers; which are Minimum Distance Classifier, Bayes Minimum Distance Classifier. The results accuracy was 92.7 %.

Also the Blind Source Separation techniques were used for feature extraction [6]. Five different types, including NSR, Ventricular Couplet (VC), VT, Ventricular Bigeminy (VB) and VF. The features were classified by using three different classifiers, which are Minimum Distance classifier, Bayes Minimum Error classifier and K-Nearest Neighbour classifier. The results accuracy was 85.04 %.

In [7] the Wavelet Transform was used for ECG feature extraction. The Fuzzy classifier, was presented for classification eight types of ECG beats NSR, PVC, LBBB, AF, VF, CHB, ISCH and SSS. The results accuracy was 93.13%.

Another study was used Fuzzy Hybrid Neural Network which composed of two subnetworks connected [8]. The Fuzzy Self-Organizing layer, performing the preclassification task and the following Multilayer Perceptron (MLP), working as the final classifier. The Fuzzy Self-Organizing layer is responsible for the analysis of the distribution of data, grouping them into clusters with different membership values. The transformed data points were formed into the feature vectors inputted to the Neural Network classifier, the number of input nodes of MLP is equal to the number of Self-Organizing neurons. six types of arrhythmia have been taken into account in the investigations: PVC, LBBB, Right Bundle Branch Block beat (RBBB), the Atrial Premature contraction (APC), Ventricular Flatter wave (VF) and the Ventricular Escape beat (VE). The results accuracy was 96 %.