UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF GRADUATE STUDIES AND ACADEMIC ADVANCEMENT

Analysis of ECG Signal for the Detection of Abnormalities Using MATLAB

By

Osman Hashim Khalaf Allah Mergani

A Thesis

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Supervisor

Dr. Zeinab Adam Mustafa

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Abstract

ECG signal shows the electrical activity of the hearts. These signals are non-stationary; they display a fractal like self-similarity. It is one of the most important physiological parameter, which is being extensively used for knowing the state of cardiac patients. They may contain indicators of heart disease, or even warnings about impending diseases. The indicators may be present at all times or may occur at random. Soft-Computing approach is an important tool in which two or more successive ECG recordings are compared in order to find disorders in cardiac. This thesis classifies the ECG signal into two classes, Normal and Abnormal ECG waveform is detected and analyzed using wavelet transform and the neural network was applied to obtain the accuracy of the network in MATLAB.

ECG signal and heart rate are used the parameter for detection diseases, most of the data comes from Physio Data Net and MIT-BIH data base. This research is focused on to find out best neural network structure which classifies the abnormalities of heart diseases. This technique also identifies the normal region for classification of abnormalities; because of ECG waveform is varying from person to person at different condition.

The ANN classifier in this case was observed to be correct in approximately 99% of the test cases.

1.1 Introduction

The ECG is nothing but the recording of the heart's electrical activity. The deviations in the normal electrical patterns indicate various cardiac disorders. Cardiac cells, in the normal state are electrically polarized. Their inner sides are negatively charged relative to their outer sides. These cardiac cells can lose their normal negativity in a process called depolarization, which is the fundamental electrical activity of the heart. This depolarization is propagated from cell to cell, producing a wave of depolarization that can be transmitted across the entire heart. This wave of depolarization produces a flow of electric current and it can be detected by keeping the electrodes on the surface of the body. Once the depolarization is complete, the cardiac cells are able to restore their normal polarity by a process called re-polarization. This is also sensed by the electrodes. The earlier method of ECG signal analysis was based on time domain method. But this is not always sufficient to study all the features of ECG signals. So, the frequency representation of a signal is required. To accomplish this, FFT (Fast Fourier Transform) technique is applied. But the unavoidable limitation of this FFT is that the technique failed to provide the information regarding the exact location of frequency components in time. As the frequency content of the ECG varies in time, the need for an accurate description of the ECG frequency contents according to their location in time is essential. This justifies the use of time frequency representation in quantitative electro cardiology. The immediate tool available for this purpose is the Short Term Fourier Transform (STFT). But the major draw-back of this STFT is that its time frequency precision is not optimal. Hence we opt a more suitable technique to overcome this drawback. Among the various time frequency transformations the wavelet transformation is found to be simple and more valuable.

The wavelet transformation is based on a set of analyzing wavelets allowing the decomposition of ECG signal in a set of coefficients. Each analyzing wavelet has its own time duration, time location and frequency band. The wavelet coefficient resulting from the wavelet transformation corresponds to a measurement of the ECG components in this time segment and frequency band.

This project deals with the study and analysis of ECG signal processing by means of MATLAB tool.

Study of ECG signal includes generation & simulation of ECG signal, acquisition of real time ECG data, ECG signal filtering & processing, feature extraction, comparison between different ECG signal analysis using Wavelet transform, detection of any abnormalities in ECG, The proper utilization of MATLAB functions, toolbox and SIMULINK can lead us to work with ECG signals for processing and analysis both in real time and by simulation with great accuracy and convenience.

1.2 Problem statement

The heart is composed of muscle tissue that contracts and relaxes in a coordinated manner when an electrical stimulus is applied. The heart's function is to pump blood around the body, through the arterial system to enable the transport of vital nutrients and oxygen. Like all other muscles, the heart receives its oxygen and nutrients from arteries, which are the coronary arteries in this case. A blockage of these vessels often leads to a heart attack (the cessation of the beating of the heart). In fact, coronary heart disease has been shown to be the leading cause of death in developed countries. Myocardial Infarction (MI), heart failure, angina, and sudden death can all occur from the blockages which occur in the coronary arteries. Following an MI, the conventional treatment is to inject a 'clot-busting' decoagulation agent, in order to remove the blockage. However, often the heart has already suffered much damage and muscle-tissue loss, leading to an increased likelihood of re-infarction.

1.3 Objective

1.3.1 General

The aim of this study ECG Signal Analysis for the detection of abnormalities using MATLAB, The development of ECG signal analysis would considerably improve the quality of life for heart disease patients, facilitate their compliance for heart rate monitoring, and reduce complications and mortality associated with this heart diseases.

1.3.2 Specific

The aim of this project:

- Obtaining database of ECG signals to be used for the purpose of QRS detection.
- Detection of QRS complex using wavelet transforms.
- Developing an algorithm to analysis and classification ECG signal.

1.4 Thesis layout

This thesis is divided into six chapters. The first chapter consists of the introduction, problem statement, objective and the thesis layout. The second chapter explains an introduction and background on ECG signal. The third chapter reviews literature that refers different ECG signal classification techniques. The fourth chapter contains the methodology that explains the data collection and the fifth chapter consists of results and discussions. The final chapter of this thesis contains the conclusion and recommendations.