Chapter 7
A Computer Based System for ECG Arrhythmia Classification

S. R. Nirmala
Gauhati University, India

Pratiksha Sarma
Girijananda Chowdhury Institute of Management and Technology, India

ABSTRACT

Biological signals can be classified according to its various characteristics like waveform shape, statistical structure and temporal properties. Among various bioelectric signals, one of the most familiar signal is the ECG. It is a signal derived from the electrical activity of the heart. The heart is an important organ which supplies body with oxygen. ECG is widely used in monitoring the health condition of the human. Cardiac arrhythmias can affect electrical system of the heart muscles and cause abnormal heart rhythms that can lead to insufficient pumping of blood and death risks. An important step towards identifying an arrhythmia is the classification of heartbeats. Modern analysis of electrical activity of the heart uses simple as well as sophisticated algorithms of digital signal processing. With the advent of technology, automatic classification of electrocardiogram signals through human-computer interactive systems has received great attention. This chapter discusses some computer assisted classification techniques based on statistical features extracted from ECG signal.

INTRODUCTION

(This section gives a brief overview of the importance of biosignal ECG and its processing in medical field. It also discusses the motivation of processing the biosignal ECG with computer assisted methods followed by a brief literature review on such works performed by various researchers.)

The discovery of association of electricity with medical science dates back to 18th century which formed the basis of the study of the action of living tissues in terms of bioelectric potentials. Bioelectric phenomena are associated with the distribution of ions or charged molecules in a biologic structure and the changes in this distribution resulting from specific processes (Khandpur 2006). These signals give

DOI: 10.4018/978-1-4666-8493-5.ch007

pathological significance of a specific organ of human body. Biological Signals can be classified according to various characteristics of the signal including the waveform shape, statistical structure and temporal properties (Enderle et al. 2006).

Among various bioelectric signals, one of the most important signal under diagnosis is the electrocardiogram (ECG). ECG is a non-invasive clinical signal that records the electrical activity of the heart at the surface of the body. The heart is one of the most important organs in the body. It supplies the body with oxygen. The heart generates an electrochemical impulse, initiated by a group of nerve cells called the sinoatrial (SA) node. This result in a process called depolarization which propagates from cell to cell across the entire heart. The wave of depolarization causes the cells of the heart to contract and relax in a timely order and makes the heartbeat. As this action represents flow of electricity, it can be measured on the surface of the body by skin electrodes, placed at designated locations. The record of the propagation of this bio-signal is called as ECG (Enamet 2009).

The ECG was originally observed by Waller in 1899. W. Einthoven, in the year 1903, introduced the electrophysiology concept that includes the labels of the waves and it is still used today. ECG aims at extracting significant information of the cardiovascular system for diagnosing various condition of the heart such as conduction through the heart, disturbances in cardiac rhythm due to cardiac ischemia and infarction (Adams and Choi 2012).The diagnosis is possible as the pattern of electrical propagation of ECG is not random. It spreads over the structure of the heart in a coordinated pattern. Therefore, in order to better analyze the heart's activity, the morphology of ECG needs great attention. Any deviation in the ECG waveform, from the normal form, is an indication to abnormality or possible disease occurring in the heart. This is popularly known as arrhythmia. Cardiac arrhythmias are frequent reason of death around the world. Early detection of this cardiac arrhythmia would enable mankind to enhance better quality of life through effective treatments (Chazal et al. 2004).

An important step towards identifying an arrhythmia is the classification of heartbeats. The rhythm of the ECG signal can be determined by analyzing two consecutive heartbeats in the signal. However, the ECG signals being non-stationary in nature, it is very difficult to analyze them visually. Some heart disorders or arrhythmias might appear infrequently and such problems might require monitoring of ECG activity up to a week or so to successfully capture them. Many arrhythmias manifest as sequences of heartbeats with unusual timing or ECG morphology. The work of the cardiologist becomes tedious while tracking down such abnormalities. Also daily clinical practice generates large amount of signals during monitoring of patients and for diagnostics purpose. As a follow up to such possibilities, system for automatic classification of cardiac arrhythmias has become necessary and important for diagnosis of cardiac abnormalities. New computer assisted methods can simplify and speed up the processing of large volume of data. Among the available literature, some of the published works describing computer assisted methods are discussed below briefly.

Emanet et.al.(2009) presented an algorithm named Random Forest to classify five types of ECG beats using the ECG signals obtained from the MIT/BIH database were used to classify the five heartbeat classes (N, L,R, V, P). Feature extraction from the ECG signals for classification of ECG beats was performed by using discrete wavelet transform (DWT) with a classification accuracy of 99.8%. Wang et al. (2011) describes an effective electrocardiogram (ECG) arrhythmia classification scheme consisting of a feature reduction method combining principal component analysis (PCA) with linear discriminant analysis (LDA), and a probabilistic neural network (PNN) classifier to discriminate eight different types of arrhythmia from ECG beats. Their average classification accuracy was 99.71%. Hosseini et al. (2001)