CHAPTER 1

INTRODUCTION

1.1 GENERAL

Heart disease is the leading cause of death in India as well as all over the world. So, making efforts for early detection of these issues is a priority research in biomedicine. One person dies in every 33 seconds owing to a heart attack in India, says a top cardiologist. He also adds that the deadly condition is making Indians its victim 10 years ahead of the people in the West.

Though the cardiac arrhythmias are not a fatal disease in all its forms, they can indicate more serious problems and can even lead to death.

1.2 THE HEART AND CARDIAC ARRHYTHMIAS

The heart is an organ of extreme importance for the proper functioning of the human body. It is an organ of extreme importance for the proper functioning of the human body. It is responsible for pumping the oxygenated blood from the lungs through the whole organism and redirecting it to them again to be re-oxygenated.
The heart consists of three types of muscle, following are the list:

- The atrial muscle
- The ventricular muscle
- The specialized excitatory
- Conductive fibers.

The atrial and ventricular types of muscles are responsible for the movement of blood, having a valve shape. The structure of the heart and the directions of the blood flow through the valves are seen in cameras is shown in Figure 1.1 The excitatory and conductive fibers present automatic rhythmic electric discharges and are responsible for the control of the heart beats.

Figure 1.1 Structure of the heart blood flow of the chambers and heart valves

Cardiac arrhythmias are a pathology of the heart characterized by an abnormal rhythm of heart beats. The following disorders are usually
caused by combinations of the rhythmicity-heart conduction system abnormalities:

- Abnormal pacemaker rhythm.
- Changing the pacemaker of the sinus node to another point of the heart.
- Blockages, at different points, of the propagation of the impulse in the heart.
- Abnormal pathways of transmission of heart impulses.
- Spontaneous generation of false impulses in almost any part of the heart.

There are several types of arrhythmias, some are difficult to see and others are easily detected. Some are asymptomatic and others may lead to instant death.

1.3 ELECTROCARDIOGRAM

The electrocardiogram (ECG) was designed by Augustus Desire Waller in 1887 as a device responsible for recording the electrical currents that originated in the heart. This technique is modernized and improved, and becoming essential for the diagnosis of cardiac pathologies. The ECG is the main tool used for the detection of cardiac arrhythmias, both by specialists and automatic methods. So understanding the morphology of the curve is essential to allow the correct classification of the beats. A curved ECG of the normal pressure is composed of P-wave, QRS complex, and T-wave.

Another important aspect of ECG is lack of differential electrocardiographic findings that are differentiated by the points where the electrodes are placed in the patient.
1.4 DETECTION OF ARRHYTHMIAS

A disturbance in heart rhythm by irregularity such as abnormally fast heartbeat or abnormally slow heart rates is defined as cardiac arrhythmias. Although arrhythmias are not usually fatal cardiac disease, they may indicate a series of heart and circulatory system problems that may result in cardiac death. Therefore, the sooner the cardiac arrhythmias are detected in the patient, the more effective will be their treatment or the diagnosis of other diseases.

Analyzing ECG records by a specialist is costly and time-consuming task, since arrhythmias can occur with very low frequency and are difficult to detect, requiring an analysis of many hours of recording to find arrhythmic beats. The automatic detection of arrhythmias tries to optimize this process, increasing the efficiency in the clinical analyzes and serves as an aid tool for the physician who needs immediate attention.

There are several studies that targets the development of systems and classification of heart beats, which are divided into pre-processing and extraction of characteristics. Despite being a problem well studied in the literature, high accuracy has not yet been obtained for implantation in the clinical setting.

1.5 BACKGROUND OF THE WORK

Patients affected by arrhythmia can suffer from pain, but in many cases patients can’t feel the occurrence of arrhythmia. This type of situation is so lethal, and can even cause death to a person. Hence, automatic detection of arrhythmia is the focus for researchers in recent days. There are two types of cardiac arrhythmias, such as arrhythmia morphological and rhythmic arrhythmia which can be identified by different ECG patterns. Morphological
arrhythmias are caused by single irregular beat in ECG signal. Rhythmic arrhythmias are caused by a group of irregular heartbeats. The classification of normal and abnormal heartbeat is the main area of interest in this survey.

The heart, functions with the help of electrical signals that are produced from the sinus nodes present in the wall of heart. Based on the electrical pulses in the sinus nodes, contraction or release of heart muscles may happen. Cells in the sinus node produce electrical pulses based on command from nervous system (Weisser-Thomas et al. 2014). Nervous system regulates the electrical pulse based on the emotion or physical activity of a patient. There are two types of control signals from neurons: Parasympathetic simulation and sympathetic stimulation. Parasympathetic simulation controls the sinus node in normal phase in resting stage and at normal activities. Whereas, sympathetic simulation rises heart rate during exercise or any emotions. Therefore, by analyzing the electrical activity of the heart can be identified the emotions or abnormality in patients.

There are many methods to extract ECG of patient: conventional method of extraction is by placing 12 electrodes in surface of the body and analyzing the signal. But due to advancement in technology, people are going for wearable type of ECG extraction devices; they want to know the status of their heart instantaneously. They don’t have time to go for health care centers to check their heart status. To solve this problem, many researchers are focusing on wearable ECG monitoring devices (Athavale & Krishnan 2017). To improve health monitoring in wearable system effectively requires perfect design and novel placement of sensors. Previous methods of ECG extraction use sensors based on two accelerometers are located to extract the PPG signal and this signal is then approximated to find the heart function (Gjoreski et al. 2014). This type of heart monitoring with the help of PPG signal is more dangerous as they can even lead to false triggering. Some of the sensors uses
acoustic signals (Sound of the heart) to extract the ECG signals. This type of sensors is then combined with filters to obtain the required signals (Shi & Chiao 2016). Noises in the ECG signal are due to Power Line Interference (PLI), baseline wandering relaxation and contraction of muscles etc. Power line interference is the most common noise affecting the ECG signal. There are two types of PLI signals: stationary and non-stationary PLI. Stationary PLI signals can be removed with the help of non-adaptive filters and non-stationary signals can be removed with the help of adaptive filters (Guleria & Kaur 2016).

Adaptive filters are linear type of filters with a transfer function obtained from an optimization procedure defined by the user. Whereas non-adaptive filters are controlled by constant parameters given as input initially. Types of linear filters are kalman filter, wiener filter, kernel adaptive filter etc. Baseline wandering is due to motion artefacts from the surface of body. They can be eliminated by applying non-linear filters to the signal (Zou et al. 2017).

To analyze the signal and determine the presence of abnormality, features in the ECG signal needs to be extracted. The features in the ECG includes peak points and wave function of the signal. There are different kinds of feature extraction techniques such as decomposition, heuristic based extraction and machine learning based extraction to extract the ECG signal. These features in the signal determine the amplitude and interval of PQRST segment and gives an understanding about the functioning of human heart. However, due to non-static nature of ECG signal visual analysis of signal becomes very difficult and this analysis can be done with the help of soft computing based techniques such as Fuzzy Logic Methods, Artificial Neural Networks (ANN), Genetic Algorithm (GA), Support Vector Machines (SVM), and other Signal Analysis techniques (Vincent & Sreekumar 2017).
The two types of feature analysis methods that are available frequency based methods and time domain based analysis methods. Both of this approach should be used for analysis because time domain method cannot be adequate for all the features in signal. Therefore, combination of both time domain and frequency domain of the signals are used for analysis.

The classification algorithms are used to differentiate the normal signal from affected signals. The abnormality of each type has different pattern in the ECG signal. By analyzing the present pattern of ECG signal and comparing it with the predefined pattern of the abnormal signal and finding the relation between the signals is the main function of a classifier. Classifier also has methods like heuristic and machine learning based algorithms for classification as same as feature extraction, but the working of this algorithms is different for these two approaches. In this survey, various approaches are focused to classify cardia abnormalities of a patient.

1.6 OBJECTIVES OF THIS WORK

- To review the existing techniques that classifies the abnormalities in patients.

- To propose a new technique that accurately classifies abnormality and emotion of patients using wearable technology devices with improved accuracy than existing algorithms.

- To classify the abnormalities using automatic detection algorithms.

- To implement an effective classification method to detect different types of arrhythmia in patients using ECG signal and
helps algorithm suitable for wearable technology devices to
detect the emotion of a person.

- To classify emotion and cardiac abnormality of patient
  simultaneously by fusing both ECG and respiratory signals
  using effective classification algorithm.

- To validate and perform the proposed algorithm and
  comparing it with the existing algorithm by using
  conventional methods to get output.

1.7 METHODOLOGY ADOPTED FOR THE WORK

The overall flow graph for the proposed method is illustrated using
Figure 1.2. First, ECG data is acquired from MIT-BIH data base. Then, the
acquired ECG data is subjected to denoising using various techniques. Later
features such as P, Q, R, S and T peak values etc. are extracted using the
denoised ECG signals. Now, these features are given as input to the proposed
algorithms in order to classify if the given ECG signals are normal (or)
abnormal.
Figure 1.2 Shows the flow graph classify abnormalities
1.8 SCOPE OF THE WORK

The focus of the work is to develop an automatic arrhythmia and emotion detection technique with the help of ECG signal which gives better understanding about the health of a person. By monitoring ECG determines the health of an individual and also helps in finding the below:

- Physical health of a patient
- Emotional state of an individual
- Physical activity monitoring
- Arrhythmia detection
- Wearable health monitoring system
- Lie Detection devices used to find out the correct outcome
- Sleep detection device for drivers
- Detect health of sports persons

1.9 THESIS ORGANIZATION

This thesis is organized as follows:

Chapter 1 deals with the introduction about the work undertaken and also the background of the study to define the objectives, methodology adopted and scope of the work.

Chapter 2 presents the literature survey of the most relevant works in the areas of pre-processing (or) denoising, feature extraction, classification and detection methods used in wearable devices. It is followed by identifying the research gaps.

Chapter 3 proposes a novel ECG signal classification system based on MML-NN technique that efficiently removes noise in the system and
accurately identifies and classifies the abnormality in patients. The performance analysis is also done by incorporating the statistical analysis with the existing scheme.

Chapter 4 describes the fuzzy based multi-objective algorithm using FFT for achieving better efficiency in terms of signal noise ratio and mean square error. The simulation results are compared and contrasted in detail.

Chapter 5 provides a neonatal emotion detection scheme based on probability based gravitational search algorithm. It mainly focuses on the reduction of the computation time and power consumption which is obviously achieved successfully. It also illustrated reduced cost.

Chapter 6 presents an effective and automatic detection mechanism in finding the abnormality in heart using wearable device by identifying the physical and emotional state of a person.

Chapter 7 that summarizes the conclusion of the thesis comparison and contrast of all the above mentioned techniques for the detection and classification of cardiovascular abnormalities. Suggestions for future work is followed by references.