Chapter 13

Assistive Technology for Heart Monitoring of Elderly People through Speech Analysis

Kavita Thakur
Pt. Ravishankar Shukla University, India

Anjali Deshpande
M. M. College of Technology, India

Arun Shrihari Zadgaonkar
Dr. C.V. Raman University, India

ABSTRACT

Most of the elderly population suffer from some sort of heart disorders, so, continuous monitoring of heart functioning is required to diagnose diseases proactively. Electrocardiogram (ECG) is a tool widely used for identification of various heart diseases, but, it requires patients to visit clinic for checkup by experts. As formant frequencies of speech reflect physiological features of the human body, a correlation exists between ECG cycle and Acoustical Cardiogram (ACG) cycle obtained from formant frequency analysis of speech signal. Various heart parameters like RR-cycle duration, heart beat rate, systole cycle etc. can be determined from acoustical RR-cycle. This chapter introduces a novel non-invasive technique for monitoring of human heart functioning through speech analysis by which patients can monitor their heart functioning themselves. Such kind of assistive technology can be useful for elderly population for monitoring of various physical organs of human body as well through their speech signal analysis.

INTRODUCTION

The elderly population faces lots of problems due to senescence, disability, diseases etc. There are various alternatives available to mitigate those using aging assistive devices, services, technologies. Although, aging assistive devices are already available, still a large problem arises from the mismatch between the person and the assistive technology devices, and inadequate training of the person with the

DOI: 10.4018/978-1-4666-9530-6.ch013
devices, advanced technologies which can not only make life easier for the elderly population who need help to carrying out their daily activities, but, also to improve quality of life, safety and maintain sense of independence in them. The elderly population suffers from various heart, asthmatic, kidney diseases which make them dependent. They may live independently with the help of technology. More than 80% of our elderly population suffers from various physiological disorders. Though this chapter introduces a technology useful for monitoring of human heart functioning and determination of various heart disorders from acoustical analysis of speech signal. The user can easily determine his heart condition with the help of this technology. User can monitor important heart parameters like, Electrocardiogram (ECG) cycle, heart beat rate, blood pressure, pulse pressure, heart rate variability etc. on regular basis with this technique without any clinical support or equipment. Only user has to record his speech signal with help of a microphone and a computer with the required software. The software would provide all the heart parameters, ECG, assessment of various heart diseases, and heart condition of the person. This technique is very advantageous over the traditional one. Since no immediate clinical assistance is required for this, and also the e-copy of Acoustical Cardiogram (ACG) can be sent to the expert for further analysis of heart and get proper advice.

Heart beat rate and rhythm are largely controlled by the autonomic nervous system. There are various heart parameters which help to diagnose and monitor the functioning of human heart. The parameters like RR cycle, blood pressure, pulse pressure, heart beat rate, heart rate variability (HRV) are some of the important parameters for clinical assistance in case of the patients suffering from heart diseases under conditions of acute time pressure, emotional strain and elevated state anxiety. Human speech reflects ones physiological and psychological condition, so, ACG resembles with ECG and various heart parameters can be determined from ACG using formant frequency analysis of human speech signal (Deshpande, Thakur, & Zadgaonkar, 2007; Thakur & Zadgaonkar, 2002).

HEART PHYSIOLOGY

Heart is a hollow, muscular organ having 300 grams mass with four chambers, found in chest between lungs surrounded by membrane called pericardium. Pericardial space is fluid-filled to nourish and protect the heart. The heart is a complex muscular pump that maintains blood pressure and flow through the lungs and the rest of the body. The heart pumps about 100,000 times and moves approx 7200 liters (1900 gallons) of blood every day. The heart has four chambers—two atria act as collecting reservoirs and two ventricles act as pumps. The heart has four valves for pumping action and maintaining unidirectional blood flow (Cromwell, Weibell, & Pfeiffer, 1977; Friedberg, 1966).

In human beings, the function of the right side of the heart is to collect de-oxygenated blood, in right atrium from the body (via superior and inferior vena cavae) and pump it, through the tricuspid valve, via right ventricle into the lungs pulmonary circulation so that carbon dioxide can be dropped off and oxygen can be taken up (exchange of gases). This happens through the passive process of diffusion. The left side heart collects oxygenated blood from the lungs into the left atrium. From the left atrium the blood moves to the left ventricle, through the bicuspid valve (mitral valve), which pumps it out to the body via the aorta. On both sides, the lower ventricles are thicker and stronger than the upper atria. The muscle wall surrounding the left ventricle is thicker than the wall surrounding the right ventricle due to the higher force needed to pump the blood through the systemic circulation.