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Analysis of Phonocardiographic Signals as a Function of Weight

Gurjit Kaur Maan[1], Randhir Singh[2], Jang Bahadur Singh[3], Parveen Lehana[4]
PG Student, S.S.C.E.T., Badhani, Pathankot, Punjab, India[1]
Assistant Professor, S.S.C.E.T Badhani, Pathankot, Punjab, India[2]
Ph.D Scholar, Dept. Physics and Electronics, University of Jammu, J&K, India[3]
Associate Professor, Dept. Physics and Electronics, University of Jammu, J&K, India[4]

Abstract— Physiological process is complex phenomenon and control different actions of human body. These processes consist of number of signals that reflect the activity and nature of process or action performed in human body called biomedical signals. Electrocardiographic signals are produced due to electrical activity of heart and monitor the heart rate. It provides the graphical represent of electrical activities of heart. But there are some defect in their signals and cannot used for low frequency heart sound detection. Any defect or diseases in biological system affect the performance and health of biological system that cause the change in normal physiological processes. Human heart is divided into four chambers, Tow upper chambers called atria and lower chambers are called ventricles. Due to the opening and closer of valves two types of sounds produced during each cardiac cycle called heart sounds. The third heart sound is mainly detected in children but sometime may occur in adults also. The third and fourth sounds are also called gallop sounds. The analysis shows the significant effect of weight on the phonocardiographic signals.

Keywords— Heart sounds, Biomedical signal, Auscultation, Electrocardiogram, Phonocardiographic signal.

I. INTRODUCTION

Human body made up from number of systems such as respiratory, cardiovascular, nervous system etc. These systems are further consists of several subsystem that carry many physiological process in systems. Physiological process is complex phenomenon and control different actions of human body. These processes consist of number of signals that reflect the activity and nature of process or action performed in human body called biomedical signals. Any defect or diseases in biological system affect the performance and health of biological system that cause the change in normal physiological processes. The processes of biological system with disease called pathological processes. These are consisting of signals that are different from the normal signal in some aspects. By observing these signals and comparing with their known terms a disease and disorder can be detected. Physiological and pathological signals can be used to determine the state of biological system and also called as biomedical signal [1]. At present large number of scientific researchers investigated biomedical signals using signal processing, biologists discovered new biology and physician can monitor distinct illness. In human body biological signals are originated from variety of sources i.e. electrical signal in the form of potential and current, mechanical signal in the form of temperature and pressure and biochemical signal in the form of neurotransmitters and hormones, e.g. Electrocardiogram (ECG) Electrogastogram (EGG) Electromyogram (EMG), Phonocardiogram (PCG) etc.

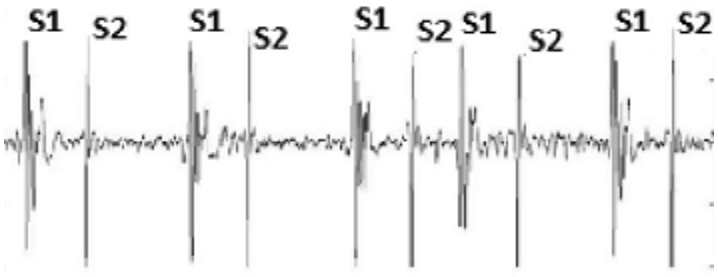

Fig. 1 Waveform of heart sound s1and s2 [10]

Electrocardiogram signals are produced due to electrical activity of heart and monitor the heart rate. It provides the graphical represent of electrical activities of heart. But there are some defect in their signals and cannot used for low frequency heart sound detection. This technique is also expensive and needs expertise therefore its usage is limited [2]. The limitation of electrocardiography can be improved by using phonocardiogram. It concerned with the automatic acoustic recording and processing of heart sounds by using electronic stethoscope [3]. It is the latest diagnostic tool in

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medical science for detecting and analyzing biomedical signals. As the various parameter of human body such as age, gender, weight, height and state of patient can affect the phonocardiogram signals. Paper is based on the analysis of the effect of weight on the phonocardiographic signals. The next section of the paper described the heart sound production technique, methodology use for analysis and result followed by conclusion.

II. HEART SOUND PRODUCTION

Heart sounds are associated with valvular vibrations and short lived bursts of vibration energy having transient characteristic. There are four types of heart sounds occur during the completion of one cardiac cycle [9]. Human heart is divided into four chambers, Tow upper chambers called atria and lower chambers are called ventricles.

Atria are thin wall chamber which receive blood from veins and ventricles are thick- wall chamber that pumped blood into body. There are four valves are located between upper and lower chambers of heart and ventricles and the major arteris. These valves are open and closed to permit the blood flow in body. Due to the opening and closer of valves two types of sounds produced during each cardiac cycle called heart sounds [10]. Fig. 1 demonstrates S1 and S2 waveform of heart.

The third and fourth sounds are audible which can occur only in an abnormal heart. The third heart sound is mainly detected in children but sometime may occur in adults also. It occurs during the rapid filling period of early diastolic and is produced due to the rush of inflow in ventricular wall which generate the pressure difference between atria and ventricle in a heart. Fig. 2 shows heart sounds with murmur. Fourth heat sound occurs after the diastolic but before the occurrence of first heart sound. It occurs mainly in abnormal heart because it produced due to the vibration occur during expansion of ventricle. The third and fourth sounds are also called gallop sounds [11].

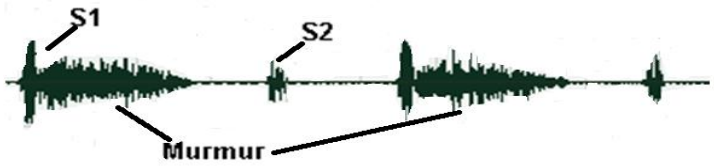

Fig. 2 Heart sounds with Murmurs [4]

Except these four hearts sound an additional sound that is called ‘murmur’ is also produced in heart. It is produced due to the systole or diastole process in heart ventricle and aortic valves. Murmurs are produced due to turbulence flow of blood through atria and ventricular valves. These sounds have a frequency in range 10 Hz to 1500 Hz. Murmur are represented in form of intensity, duration and pitch. There are mainly three types murmur occurs systolic, diastolic and continuous [12].

III. METHODOLOGY

The investigation was carried out in order to analyze the effect of weight on corresponding heart sounds using log spectral distance. The data was collected from 17 subjects having different weights from 7 to 75 Kg. The data was collected using a laptop and phonocardiograph recording system at p1 positions, exactly above heart. The recording of heart sound was done by using an electronic stethoscope which has a capability to record and replay the recorded heart sound with excellent quality and produced a phonocardiogram signal. Fig. 3 shows overall experimental setup of system.

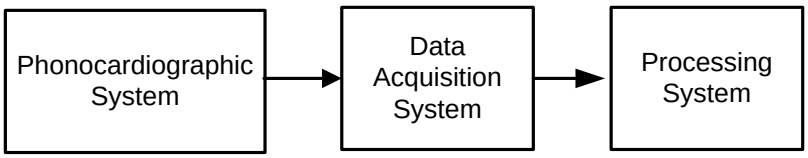

Fig. 3 Experimental setup

These signals were feed into the pre-amplifier for amplification of heart sound to a desired level. The filtering was also done to filter noise component in recorded heart sound. The signals were recorded at sampling frequency 16 KHz. As the heart signals consisted of four heart sound waves. To analyze the effect of weight using log spectral distance the signals were segmented into four sounds. Then the log spectral distance was obtained between corresponding heart sounds of all subjects in increasing order of weight by taking a least weight as reference.

IV. RESULT AND DISCUSSION

The readings taken for subjects of different weights in increasing order at position p1 of heart listed in table 1 and plotted in Fig. 4 to Fig. 7. Here weight is represented along x-axis and log spectral distance is represented along y-axis. Investigation showed that as the weight increases the log spectral distance also increases with different values of standard deviation. Table shows the effect of weight on log spectral distance for four heart sounds S1, S2, S3, and S4. Heart sound

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S1 has maximum significant log spectral distance as compared to other three sounds. The Fig. 4 to Fig. 7 shows that curve which are best fitted for polynomial of degree 5.

Table I shows log spectral distance, mean and standard deviation at position p1 for four sounds of heart as a function of weight.

S. No	Weight (Kg)	Mean				S.D.			
		S1	S2	S3	S4	S1	S2	S3	S4
1	7.5	10.5	10.0	8.7	8.7	2.9	3.1	1.1	1.3
2	9.5	11.9	11.4	9.8	10.3	5.3	4.2	2.7	2.2
3	12	11.2	11.4	9.5	9.2	4.1	3.6	1.1	1.9
4	16	9.70	10.5	9.2	9.0	2.8	3.7	2.0	1.5
5	24	11.1	10.4	9.0	9.6	3.5	4.1	1.5	1.9
6	27	13.7	11.1	9.9	9.7	6.2	5.0	2.4	2.5
7	29	10.2	10.4	9.5	8.9	3.5	3.8	2.1	1.3
8	34	10.7	10.8	8.8	9.0	3.4	3.6	1.6	1.5
9	36	10.8	9.80	8.8	8.8	3.3	2.4	1.5	1.5
10	37	10.7	9.50	9.2	9.0	4.2	5.0	1.6	1.4
11	42	12.2	12.1	9.4	9.0	6.4	5.3	2.4	1.6
12	43.5	20.9	21.2	19.2	18.4	5.2	2.3	2.2	2.2
13	46.5	20.8	20.8	19.4	18.2	4.5	4.8	2.3	2.1
14	57.6	20.8	20.7	19.9	18.1	4.7	4.9	2.3	2.2
15	59.5	20.4	22.2	19.2	18.7	4.5	5.1	2.4	2.3
16	75	19.9	21.2	19.4	18.2	4.7	4.6	2.5	2.2

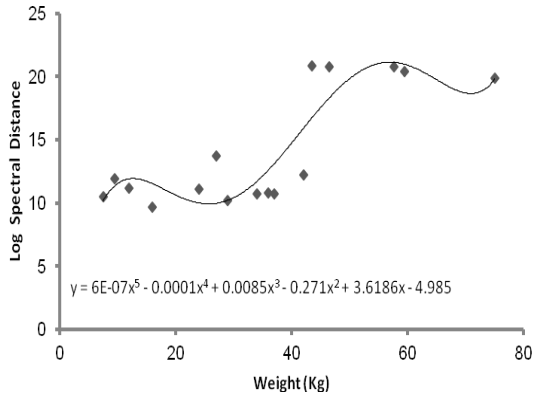

Fig. 4 Log spectral distance of heart sound s1 at position p1 as function of weight

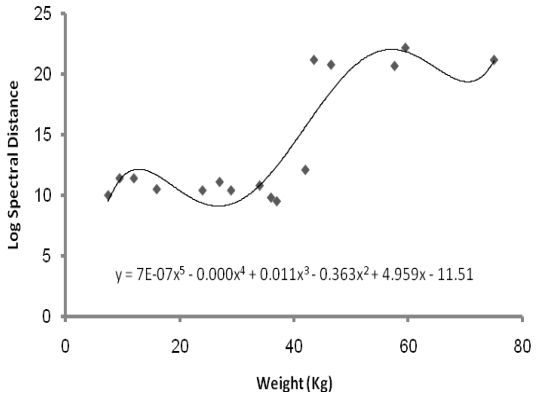

Fig. 5 Log spectral distance of heart sound s2 at position p1 as function of weight

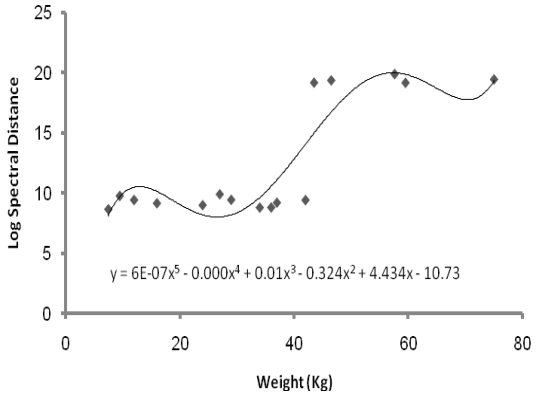

Fig. 6 Log spectral distance of heart sound s3 at position p1 as function of weight

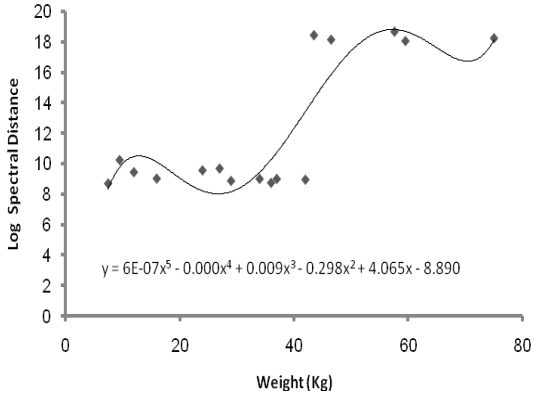

Fig. 7 Log spectral distance of heart sound s4 at position p1 as function of weight

V. CONCLUSION

Data was recorded by using electronic stethoscope. The investigation was carried out on heart sounds, obtained from different individuals. It may be concluded that the log spectral distance of corresponding heart sound is increased as the weight of different individual's increases.

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