Phonocardiograph system to detect the heart valve problem of human body

A thesis submitted toward partial fulfilment of the requirements for the degree of

Master of Engineering

In

Biomedical Engineering

Course affiliated to Faculty of Engineering & Technology

Jadavpur University

Submitted by

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M.E. (Biomedical Engineering) course affiliated to

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Kolkata.

Certificate of Recommendation

We hereby recommend that the thesis entitled "Development of low coast Multifunctional portable Phonocardiograph system to detect the heart valve problem of human body " carried out under my supervision by Jhinuk Sikder may be accepted in partial fulfilment of the requirement for awarding the Degree of Master in Biomedical Engineering of Jadavpur University. The project, in our opinion, is worthy for its acceptance.

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DECLARATION OF ORIGINALITY AND COMPLIANCE OF ACADEMIC ETHICS

I hereby declare that this thesis contains literature survey and original research work by the undersigned candidate, as part of his Master of Engineering in Biomedical Engineering studies during academic session 2017-2018.All information in this document has been obtained and presented in accordance with academic rules and ethical conduct.

I also declare that, as required by this rules and conduct, I have fully cited and referred all material and results that are not original to this work.

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THESIS TITLE**:**

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Development of low coast Multifunctional portable Phonocardiograph system to detect the heart valve problem of human body

Abstract:

The sounds or murmur which is resulted from vibrations formed by closure of the heart valves, there are at least two sounds: the first when the atrio ventricular valves (one is tricuspid and another is mitral) close at the starting of systole and the second when the aortic valve and pulmonary valve (semilunar valves) close at the end of systole. It allows the detection of semi audible sounds and murmurs, and makes an everlasting record of these events. In contrast, the stethoscope cannot always recognize all such sounds or murmurs, and it provides no record of their occurrence. The ability to quantitate the sounds made by the heart gives information not really available from more delicate tests, and it provides vital information about the effects of certain drugs on the heart. It is also an important technique. It provides certain information of the effect of certain drugs in the heart.In Electrocardiography we can record electrical activity of heart or the heart rate but we can not detect any heart valve abnormality.So Ponocardiography is very important diagonostic tool to hear the heart sound and detect heart valve problem by the physician.

CONTENT

Chapter one:INTRODUCTION

HEART AND ITS STRUCTURE HEART VALVE RELATED DISEASE, MEDICINE FOR HEART VALVE RELATED PROBLEM

INTRODUCTION

The heart is a muscular body portion in most of the animals including human beings. In the classification of muscle the heart is an involuntary muscle which has some unique characterstics.That is it never be tired because it had more mitochondria (which is power house of cell) than any other muscle that's why they does not need to stop .Main function of heart is pumping the blood with the help of blood vessel of the circulatory system.Heart is divided into two portion-one is atrium and ventricles. Atrium divided into two portion. At the same time ventricles are the same.There is a node which is called Sino atrial node that is a group of cell .Sino atrial node location is in the wall of right atrium.This group of cell has the ability to create electrical impulse or action potential that travels throughout the heart and cause the conduction. Action potential occurs when the membrane potential of a specific axon quickly rises or falls. It plays crucial roles cell to cell communication system. That helps the heart to contract. IN normal heart SA node continuously produces action potential and settle the rhythm of heart that's why it is called natural pacemaker. Rate of election potential are influenced by the nerve. Under regular conditions, the Sino atrial node initiates an electrical compulsion that spread through the atria to the atrio ventricular node, where a delay time permits ventricular filling before the electrical impulse proceeds through the specialized His-Purkinje conduction system that spreads the electrical signal at speeds of meters per second the ventricles. This electrical impulse which spreads diffusively through the heart and raise the voltage at each cell, producing an action potential, during which a rush in intracellular calcium initiates the mechanical contraction. The normal rhythm is altered when one or more spiral waves of electrical activity appear. These waves are because they act as higher frequency sources and underlie complex cardiac electrical dynamics such as arrhythmia. The main symptom of arrhythmia is low or high heart rate,sweating,chest pain, shortness of breath.

CHAPTER ONE: OVERVIEW OF HEART:

HEART:

Human heart is roughly size of a large fist. Approximate weight of a heart is 280 to 300 gm. Human heart is a four chamber heart –right atrium, left atrium, right ventricles and left ventricles.Heart is a pumping system that pumps blood all through the body which is a messenger of food and nutrients to the tissues and removing carbon di oxide and other waste. 100,000 times per day are beated by the human heart. During that time, 4,300 gallons blood is pumped all through the entire body by heart.

Different portion of the heart:

Atrium:

Atria is the upper most portion of the heart. There is two atrium in different position one is left which is connected to the lung and right atrium which is connected to the venous circulation. Right atrium receive and retain deoxygenated blood from superior vena cava, anterior vena cava, smallest cardiac veins and coronary sinus. Then it send to the right ventricles.Tricuspid valve open then. Deoxygenated blood goes to the pulmonary artery then to the lungs for the pulmonary circulation. Left atrium receives oxygenated blood from pulmonary veins. It pumps to the left ventricles by the bicuspid or mitral valve.

Nodes in the atrium:

SA NODE:

Sino atrial node is located posterior wall of right atrium. This is the group of cell continuous depolarizes. The objective of depolarization to create action potential. Action potentials pass through one cardiac cell to another through holes known as gap junctions. These gap junctions are consists of proteins called connexions. There are fewer gap junctions within the SA node and they are smaller in size. This is again important in insulating the SA node from the surrounding atrial cells.

AV NODE:

Atria ventricular node is significant part of heart conduction system. This is the node which connect the atria and ventricles that co-ordinates the top of the heart.AV node created lower back of coronary sinus normal electrical impulse.It is associated with dominance coronary artery solution.

Ventricles:

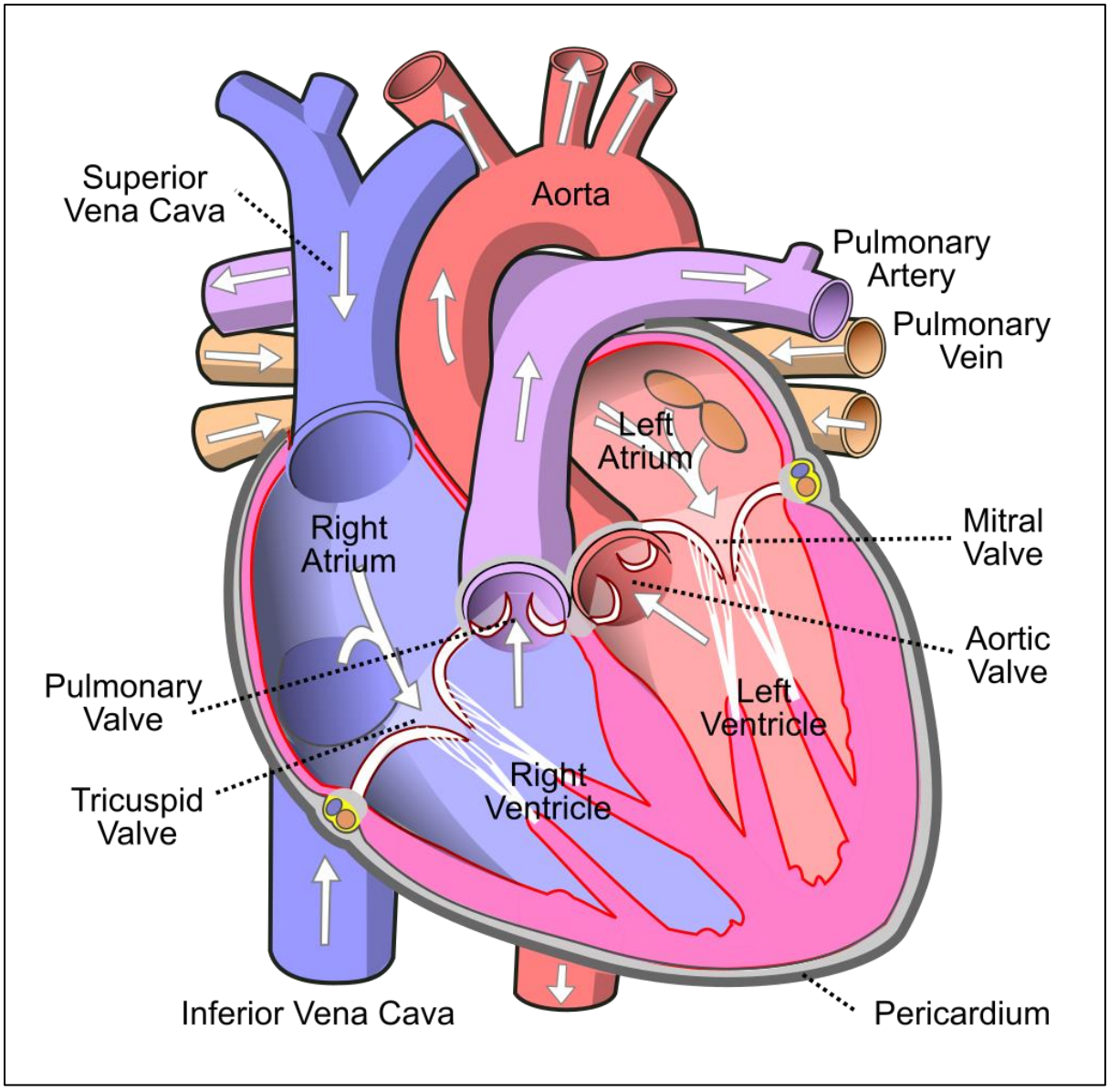
Ventricles situated lower chamber of the heart. Two ventricles are there one is left atrium and one is right atrium. During normal cardiac cycle left ventricles get oxygenated valve through the mitral valve or bicuspid valve. Through tricuspid valve right ventricles get deoxygenated and impure blood. After transferring the blood both tricuspid and bicuspid valve is closed.Right ventricles pump the blood into the pulmonary circulation into the lungs and left ventricles pump the blood systemic circulation through the aorta.It has thicker wall to produce higher pressure.The physiological load by ventricles to pump the blood all through the body and lung is much greater than the pressure generate by atria when it pump the blood to ventricles. At the time of systole ventricles contract and at the time of diastole it relaxes. The left ventricle gets oxygenated and pure blood from the left atrium through mitral valve or bicuspid valve and pumps it to the aorta with the help of aortic valve, into the systemic circulation. The left ventricular muscle have to relax and contract quickly and be able to increase or lower its pumping capacity under the control of the nervous system. In the diastolic phase, it has to relax very quickly after each contraction so as to quickly fill with the oxygenated blood flowing from the pulmonary veins. Likewise in the systolic phase, the left ventricle must contract rapidly and forcibly to pump this blood into the aorta, overcoming the much higher aortic pressure. The extra pressure applied is also needed to elasticity the aorta and other arteries have to provide accommodations the increase in blood volume.

PUMPING VOLUME BY THE HEART:

The typical healthy and normal adult heart pumping volume is approx 5 liters/min, on the resting mode. Maximum capacity pumping volume extends from approx. 25 liters/min for non-athletes to as high as approx. 45 liters/min for international level players or athlets.

STRUCTURE OF HEARTTHIS IS THE PICTURE OF NORMAL AND HEALTHY HEART

We can see superior vena cava, inferior vena cava, tricuspid



valve, pulmonary valve, aorta, pulmonary artery, pulmonary vein, mitral valve, pulmonary vein and pulmonary artery

Aorta.It is the largest and main artery in human body system. The origin of aorta is left ventricles.The aorta carries pure and oxygenated blood from the left ventricle to the various parts of the body as the left ventricle contracts except lungs. Because of the large pressure produced by the left ventricle, the aorta is the largest single blood vessel in the body and is approximately the diameter of the thumb. The aorta proceeds from the left ventricle of the heart through the chest and through the abdomen and ends by dividing into the two common iliac arteries, which continue to the legs.

Superior vena cava:

It is the vena cava which is superior the great venous trunks that return deoxygenated blood from the systemic circulation to heart more specifically right atrium.This originated from left and right brachiocphalic veins receive blood from the upper limbs,eyes and neck.No valve divides the superior vena cava from right atrium.As a result ventricular conduction into the internal juggler vein.

Inferior vena cava:

It is a large vein which carries deoxygenated blood from the lower middle of the body to the heart more specifically to the right atrium. The walls of inferior vena cava is very rigid it has valves so that blood does not flow down.It is joined of right and the left common iliac veins usually level of fifth lumbar vertebrae.

Atrial septum: The wall between the two upper chambers (the right and left atrium) of the heart.

Pulmonary trunk: It is a major vessel of human heart which is originated from right ventricles.It is a divided into right and left. Vessel

that transport deoxygenated blood from the right ventricle of the heart to the right and left pulmonary arteries, which move forward to the lungs. When the right ventricle contracts, the blood inner part of it are put under pressure and the tricuspid valve between the right atrium and right ventricle closes. The only way out for blood from the right ventricle is then through the pulmonary trunk. The arterial structure stemming from the pulmonary trunk is the only place in the body where arteries transport deoxygenated blood. Pulmonary veins: The vessels that transport oxygenated blood from the lungs to the left atrium. The pulmonary veins are the exceptional veins which carry oxygenated blood.

Valves of the Human heart:

Four heart valve is there in the human body .That is tricuspid valve, bicuspid valve or mitral valve, aortic valve, pulmonary valve.

Tricuspid valve:

Tricuspid valve is the one of the major valve right side of the heart. Tricuspid valve has three leaflets which can be open or close.This valve allow the blood to flow the blood from right atrium to left ventricles.It prevents backflow from the right ventricles to right atrium. Tricuspid valve has three leaflets is connected to chordae tendineae to the anterior ,posteror,septal papillary muscle of the right ventricles.Tricuspid valve functions function is a oneway valve that closes ventricular systole.

Infected valves can result in endocarditis which is an inflammation inner layer of the heart in intravenous drug users. Patients who inject narcotics or other drugs intravenously may introduce infection, which can travel to the right side of the heart, most often caused by the bacteria *S. aureus*. In patients without a history of intravenous exposure, endocarditis is more frequently left-sided. The tricuspid valve can be affected by the disease by rheumatic fever, which can cause tricuspid stenosis or tricuspid spewing which can be narrowed by the opening of

the tricuspid valve. Some individuals are born with abnormalities of the tricuspid valve.

Bicuspid heart valve:

Bicuspid or mitral valve are the valve which is known as atrioventricular valve. It has two leaflets. One is anteriomedical leaflets and another is anterio medial leaflet ,another is posterior medial leaflet. The anterior leaflet takes up a larger part of the ring and rises higher, the posterior leaflet has a large surface area. The mitral valve has the surface area of 4 to 6 centimeter.During left ventricular diastole, after the pressure drops in the left ventricle due to relaxation of the ventricular myocardium, the mitral valve opens, and blood travels from the left atrium to the left ventricle. About 70 to 80% of the blood that travels across the mitral valve occurs during the *early filling phase* of the left ventricle. This early filling phase is due to active relaxation of the ventricular myocardium, initiating a pressure gradient that allows a quick flow of blood from the left atrium, across the mitral valve. This early filling across the mitral valve is realise on Doppler echocardiography of the mitral valve as the *E wave*.

AORTIC VALVE:

Aortic valve which situated between the left ventricles and aorta.It is one of the semilunar valve of the heart. It is the last structure of the heart which travels through the heart before systemic circulation. It normally has three cusps. They has three different names-left coronary, right coronary, non-coronary cusp. The function of the aortic valve is when the ventricles contract pressure rises in the left ventricles. When the pressure of left ventricles rises above the pressure of aorta, the aortic valve open, permit the blood to left ventricles in the destination of aorta.It closes when ventricles return and prevent the backflow of the blood.

Pulmonary valve:

It is the one directional blood that moving smoothly through the various parts of the body. It distinguish between right ventricle and pulmonary artery. When right ventricles contract it permit the blood to the right ventricles to the pulmonary artery. These blood flows to the lungs to be pure. After transferring the blood when ventricles relaxes it closes to prevent backward flow of blood.

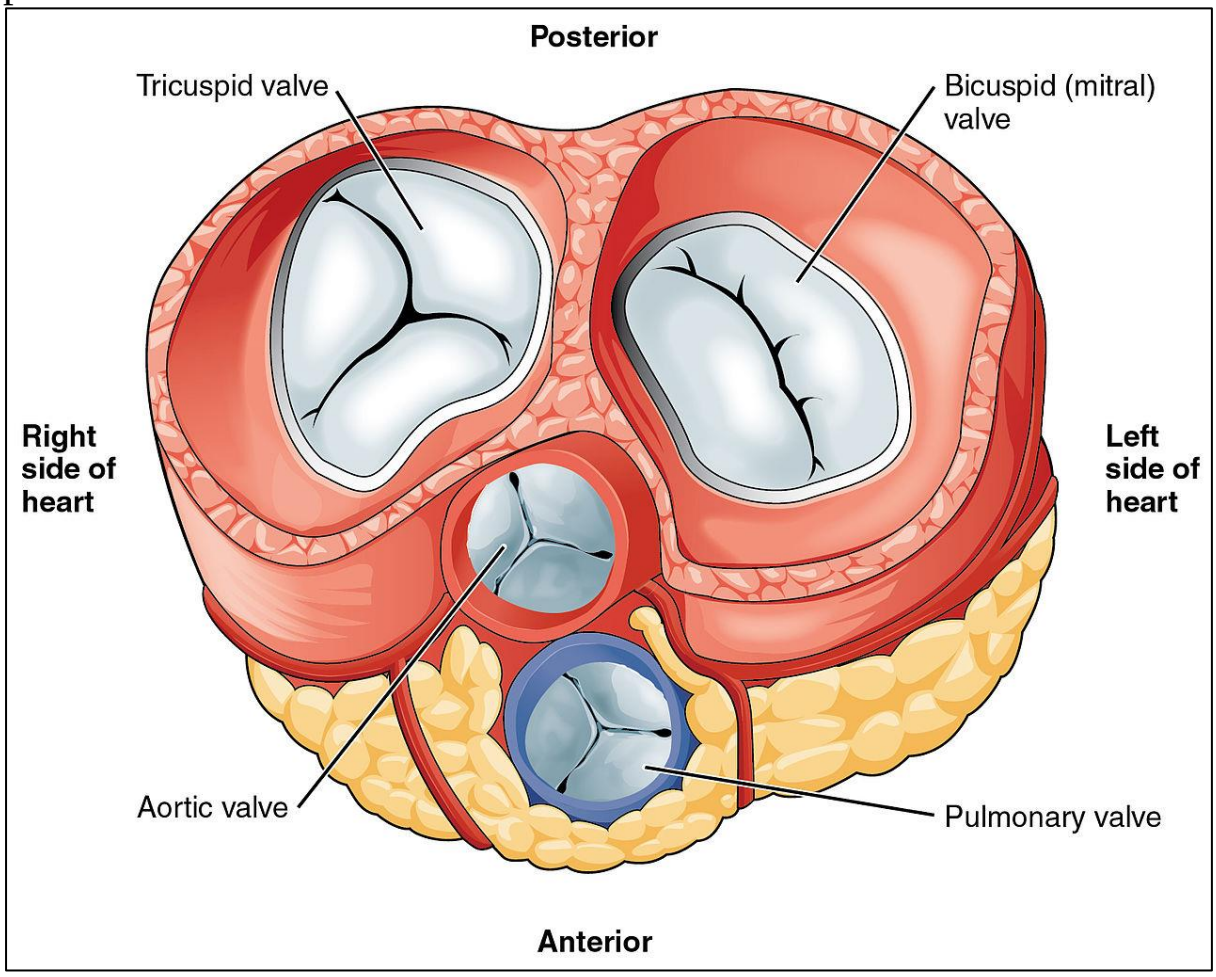


FIGURE: Cross sectional area of heart valve. IN picture we can see tricuspid valve, bicuspid valve, pulmonary valve and aortic valve.

Heart valve disease

Heart valve related disease has great impact of one's life. It is one of the main cause of cardiovascular morbidity and mortality all over the world. It has been estimated that about 2, 75000 heart valve replacement take place all over the world. Cording to the report of world health organization 17.5 million people died because of

cardiovascular illness. Disease generally because of heart valve failure generally huge.

Different type of heart valve disease:

REGURGITATION:

In this condition, the valve flaps does not close tightly, for that reason blood leak backward with in the heart. This commonly occurs due to valve flap's bulging back, that condition is known as prolapse

STENOSIS:

In this condition valve flaps become thick and stiff and they may fuse together.As a result the valve opening become narrowed and amount of blood flow through the heart become reduced.

ATRESIA:

In this formation condition valve is not normally formed with a solid sheet of tissue blocks that flow between the heart chambers from atria to ventricles.

CAUSES OF HEART VALVE DISEASE:

There is two types of heart valve disease one which is develop before birth, another one is acquired with in life time. Sometime valve disease happen to the human being the cause of which is still unknown.

SOME OF THE COMMON HEART VALVE DISEASE:

CONGENITAL VALVE DISEASE:

This form of valve disease most often affects the aortic and pulmonary valve.Valve size may be abnormal, malformed leaflets or cusps.leaflets and cusps are not connected properly.

BICUSPID AORTIC VALVE DISEASE:

This is also an inborn disease that effects the aortic valve. Some time in case of three leaflets that has only two. Without third mitral valve become stiff.

ACQUIRED HEART VALVE DISEASE:

It means in the time of heart it was normal. For some of disease valve structure changes due to infections or may be for some disease. Causes are mention bellow-

Rheumatic fever:

This type of disease happened due to some untreated infections. This disease causes inflammation in the heart valves. It cannot be seen until 20 to forty years later.

Endocarditis:

This occurs when germs especially bacteria enter blood stream and attack the heart valve causing holes and growths in the valve orscarring.It can lead to leaky valves.

Mitral valve prolapse:

It is a very common condition affecting 1 or 2% of population. It causes tissues of the valve become defective which causing the valve to leak. Mitral valve blood left back to left atrium.

Risk factor of heart valve disease:

i. Older age
ii. History of infection which can damage or cause inflammation the heart
iii. History of heart disease

iv. Uncontrollable over weight, high cholesterol,diabetis and many other diseases are the risk factor for the heart disease

Heart condition present in the time of birth also a risk factor for the heart valve disease.

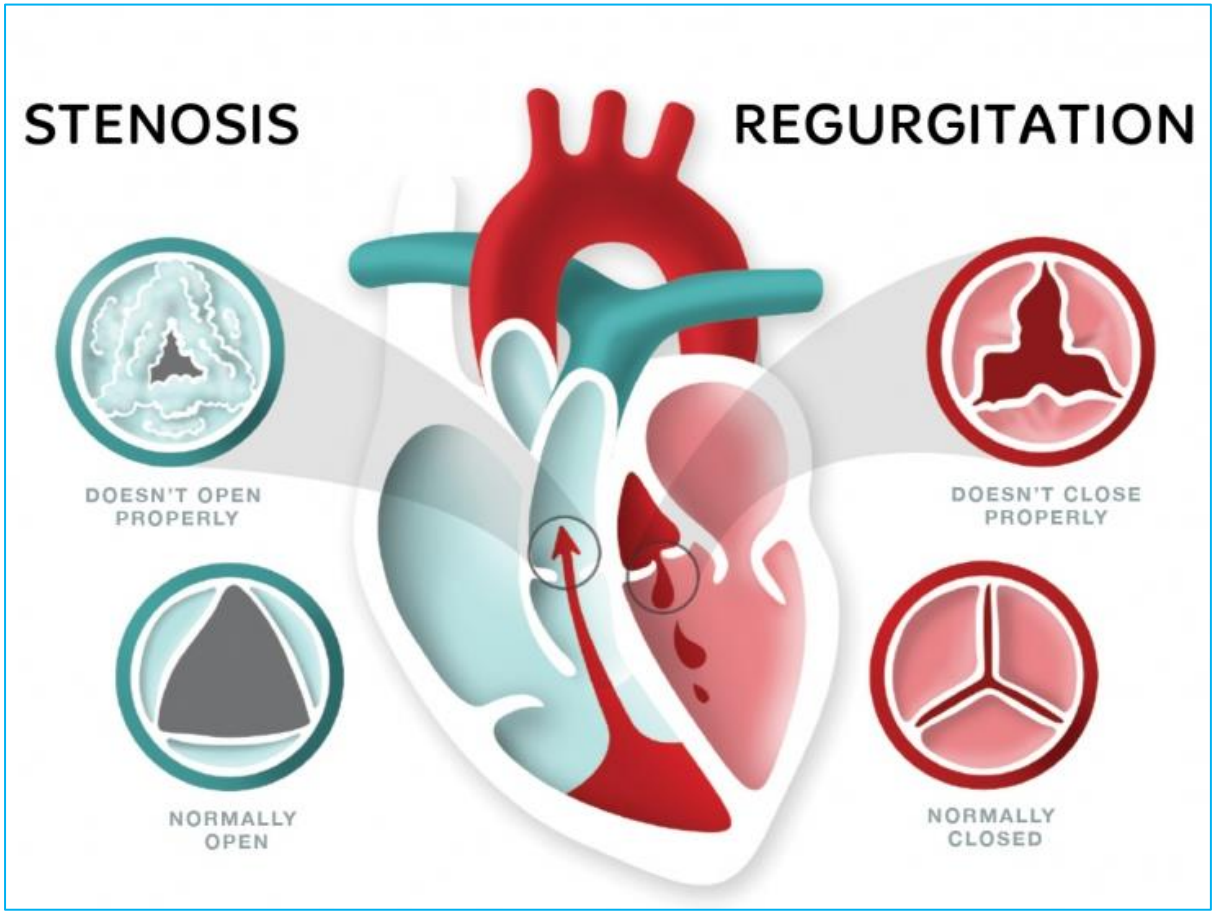


FIGURE: Heart valve problem

HOW TO DIAGNOSE HEART VALVE DISEASE PROBLEM:

First doctor diagnose the problem of heart valve by the use of stethoscope. They will try to find out the murmurs of the sound come

out of the heart. After listening the sound of murmurs they can some time ensure there is any abnormality in heart or not.

Echocardiography is another test to diagnose heart valve disease. It can show the certain things.

- Size and shape of the heart and heart chamber
- How efficiently the heart pumping
- Whether a valve is narrow or has a back flow

ECG or Electrocardiography can detect irregular and signs of previous heart attack. It can also show whether the chamber is enlarged or not.

Chest X ray, Stress test, Cardiac Magnetic Resonance Imaging are the other method for the detecting heart valve problem is there or not.

Heart valve replacement:

Heart valve replacement is process to root out diseased heart valve and replace the new one. Damage of heart valve cause several impediment, it is life threatening's the diseased heart valve should be repaired or to be replaced. When normal function of heart valve gets affected. Drugs can be used to relieve the symptom. Some medications are commonly called blood thinner, they can prevent the blood from clotting. There are many types of heart valve medications. That is-

ACE INHIBITORS:

It means open the blood vessels more fully and can help to prevent high blood and slow heart failure.

ANTI ARRHYTHMIC MEDICATIONS:

Help to prevent abnormality of the heart and restore healthy pumping system of the heart.

ANTIBIOTIC:

It is given to the patient for the prevention of any infection.

ANTICOAGULANT:

Decrease the risk of developing blood clot inside the heart. For the blood clots, stroke can be happen. So it is very dangerous.

DIURETIC:

Reduces amount of fluid in the tissue and blood stream which can help to reduce the work load of heart.

VASODILATOR:

It can reduce hearts work by opening and relaxing the blood vessel, reduce the pressure may encourage the blood to flow in the forward direction.

Valve replacement surgery is advised when the valve is totally damaged and life threatening risk. Biological valve and mechanical heart valve these are the two varieties of heart valve which is used for heart valve replacement.

Different types of heart valve replacement given –

Biological heart valve:

Bio prosthetic heart valves (BHVs) do not have long durable thrombogenicity problems due to their biocompatibility and improved physiological hemodynamic but have a shorter lifespan induced by the glutaraldehyde fixing process of the pericardium. It has the characteristics of natural heart valve. For that reason it is the first choice of the patient whose life expectancy of 10 to 15 years.Bioprosthetic valve used biological constituent from the vessel tissue of donor or an animal or valve itself. Tissue and part biological heart valve-Allograft and Xenograft.Allo, transplantation is the number of cell, tissue or organ to resiliently non identical donar of the same species.Xenograft is the heterologous transplant living tissue or organs from different species.

MECHANICAL HEART VALVE:

This type of implantation are two types

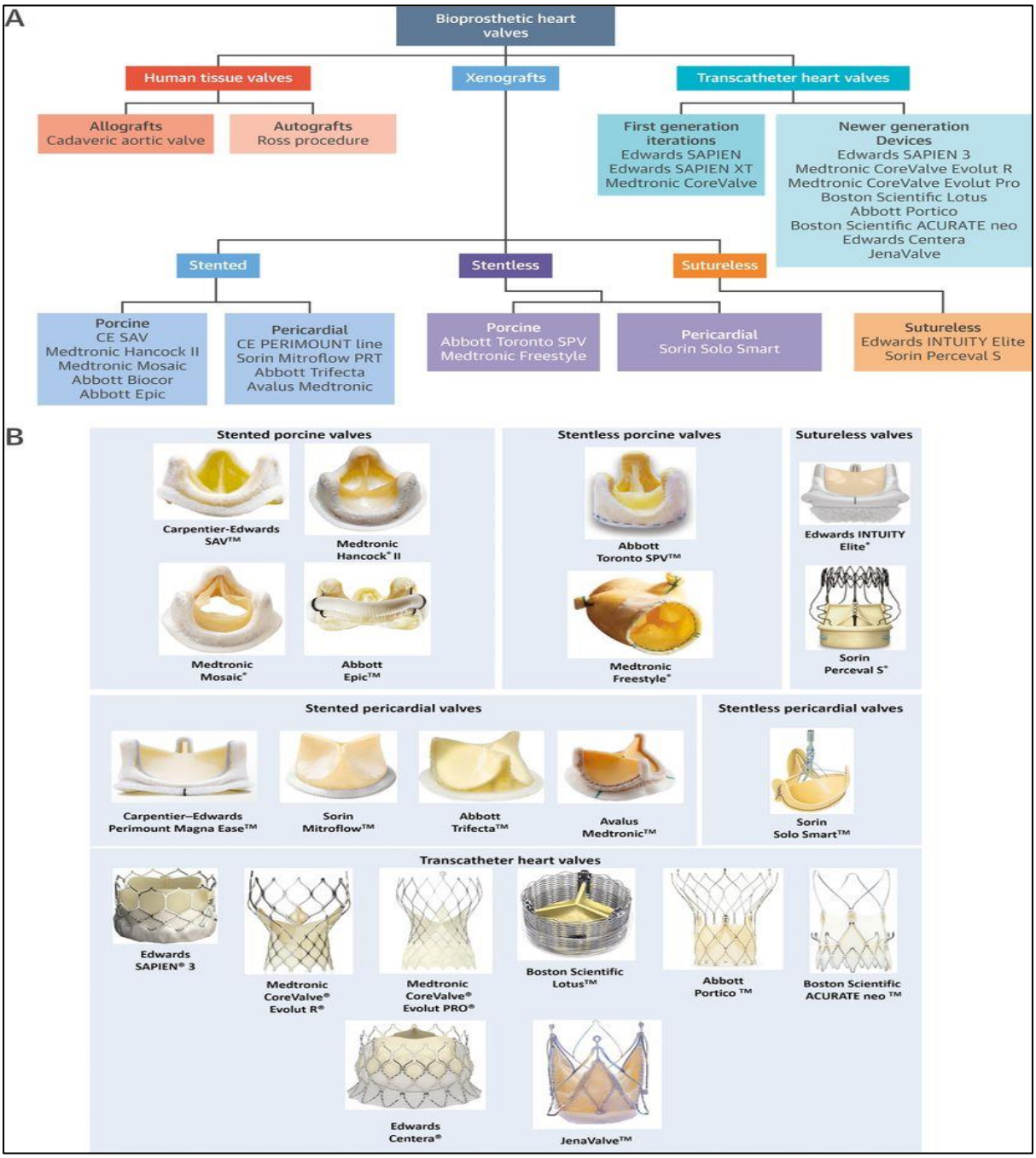
Percutaneous implantation:

Stent framed

Not framed

Sternotomy implantation-

- Cage ball design
- Tilting disc
- Bileaflet heart valve
- Trileaflet heart valve



Different types of heart valve implantation

First artificial heart valve which was developed first that is cage ball design which is utilizes metal cage to house a silicone elastomer ball.

Soon after there is another discovery that is tilting disc valves. This invention first available in 1969.Tilting disk valve has a single

circular occuluder controlled by metal strut. It is made of one type of fabric that is called EPTTE fabric. Full form of these is polytetrafluroetylene.

Durability of mechanical heart valve:

Mechanical heart valve is traditionally considered to be more durable in comparison to mechanical heart valve.

This is the artificial heart valve now available in market if heart valve replacement is there.

PONOCARDIOGRAPHY:

A Ponocardiogram is a high quality production of sound or murmurs which is made by heart when the closure of heart valve with a assistance of a device that is called ponocardiograph. Thus ponocardiography is recording of all sounds made by heart during the cardiac cycle. In my work I have tried to find out the subject whether have any heart valve problem or not by simple analysing the PCG signals by data acquisition and its analysis by Mat-lab.

CHAPTER TWO: LITERATURE REVIEW

WHAT IS PONOCARDIOGRAH AND HOW IT IS WORK

LITERATURE REVIEW:

This device which is called ponocardiogram that can record the sound or murmurs of the heart during the closure of the heart valve that is called the ponocardiograph.

John Keefer invented phonocardiogram in 1970 while he was in U.S. government service. The original patent description indicates that it is a device which via *electrical voltage* satirists the human hearts *sounds*. It has developed continuously to perform a key role in the proper and perfect analysis the defects of the heart. As usually with the stethoscope, it requires highly and skilled physicians to recited the phonocardiogram. A diagnostic system based on Artificial Neural Networks (ANN) is implemented as a detector and classifier of heart diseases. The output of the system is the classification of the sound as either normal or abnormal, if it is abnormal what type of abnormality is present.

CHAPTER THREE: Methodology, system design and fabrication

3.System Design and Fabrication and methodology

Process is inserted a condenser based miniaturized microphone inside the stethoscope. From the stethoscope I used a stereo male jack to extract the output. This output inserted to the PCG system design by me and after amplification and passing through band pass filter having the range of 4Hz-1.5 KHz the system output placed at oscilloscope to see the wave form or for data acquisition by NI data acquisition card. For visualizing the PCG wave form on computer by audacity software the output inserted to computer audio input. Though the frequency range of PCG lies between 4-200Hz, and the high cut-off of the band pass filter is kept very high to detect the murmur condition of heart in which the frequency range exceeds 1kHz.The output of the band pass filter will be given to a normal amplifier. I have used IC- OP 741 for this purpose. Then the stereo output can be given in to the system or directly to the audio input of the computer. Data of normal and disease patient has collected by NI-Daq through LABVIEW and data of heart valve patients has taken from Physionet to find out a relation between them to detect the patient having different heart valve problem.

The basic audio amplifier used in our system is given below,

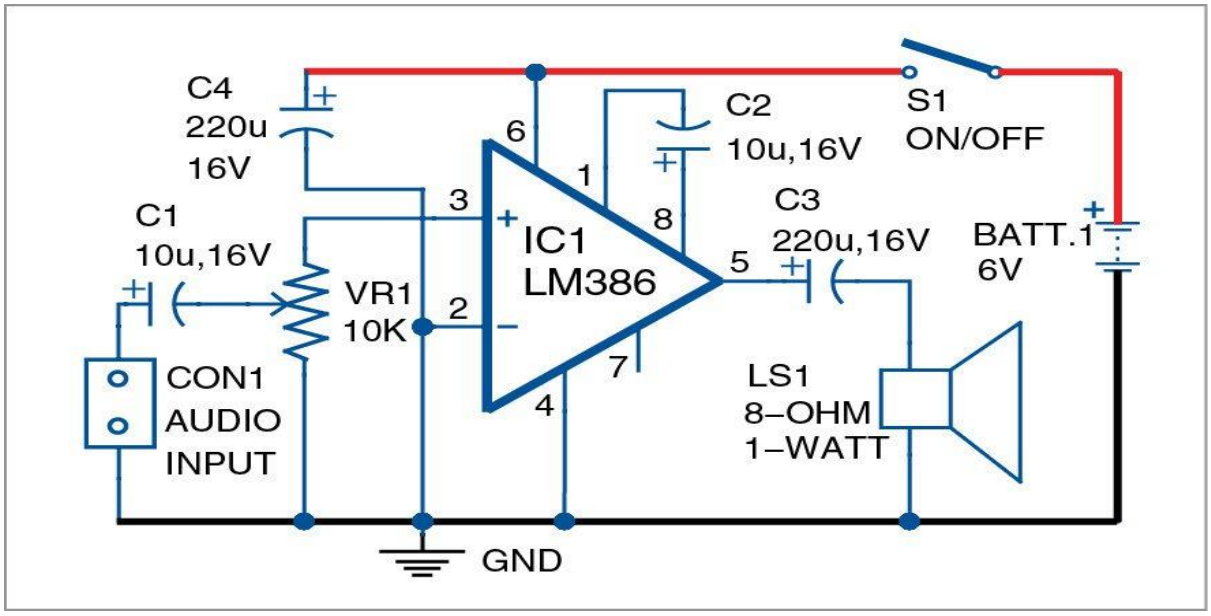


Fig : Basic diagram of Audio Amplifier circuit of the System

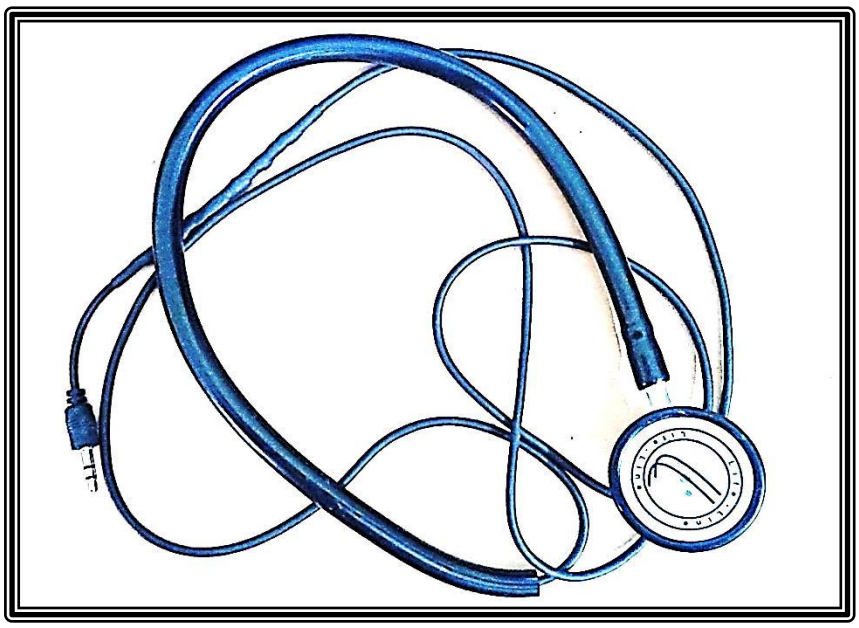
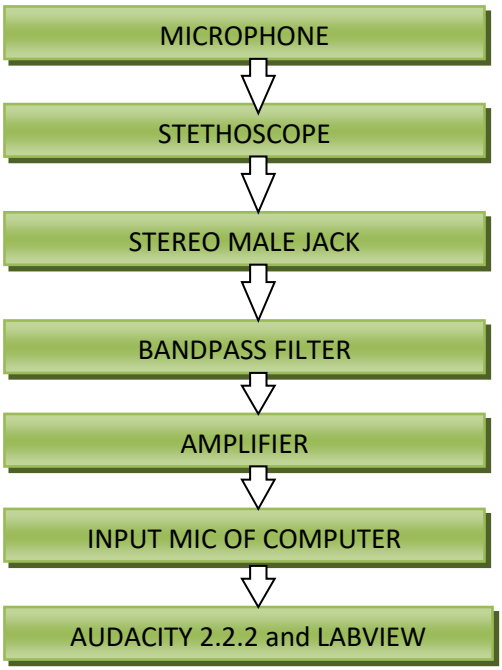
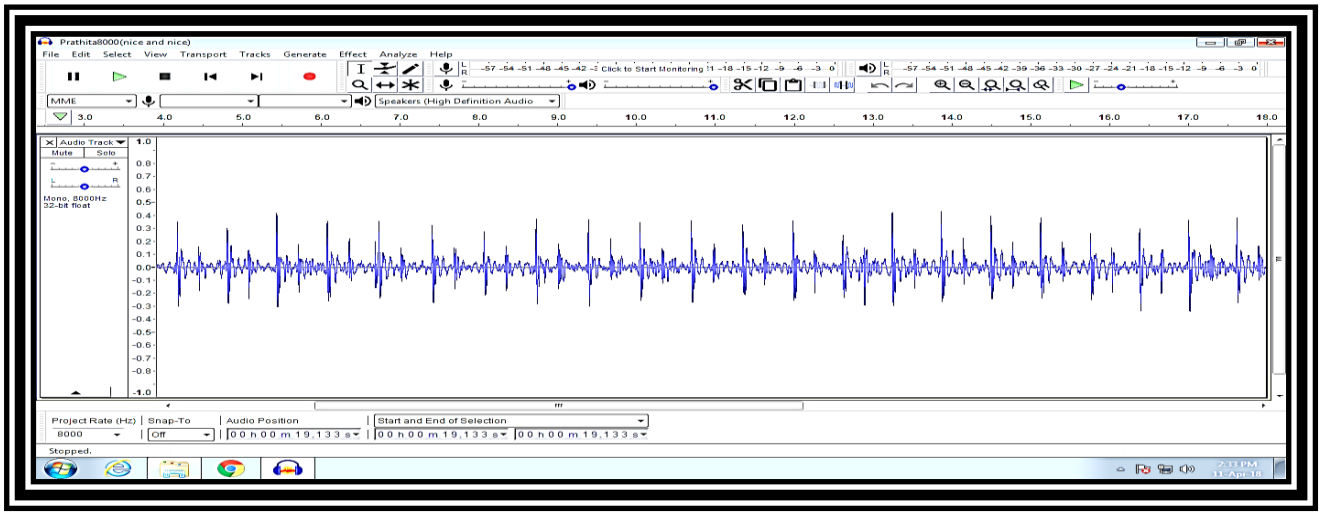


Fig: Condenser Microphone based Stethoscope



Basic Block Diagram of PCG System

The input signal is taken with the help of microphone present inside the stethoscope, and then the signal is passed through preamplifier and audio amplifier. From audio amplifier it is connected to a specially designed band pass filter and the output is taken from stereo output.



Wave form pattern of heart sound in audacity software

In case of any problem in heart which can affect the PCG wave, it can be determined by the spectrum analysis of the PCG wave or by the waveform recorded at the Audacity 2.2.2 software.

The output wave also have seen in oscilloscope and using Lab-View.

In my project work I have recorded data of PCG signal of 15 numbers young healthy person those considered as normal subject using NI Data acquisition card by Lab-View and due to short period of time and unavailability of heart valve problematic patient I have taken data of PCG signal of 15 numbers heart valve problem patient from physionet those have considered as abnormal subject.

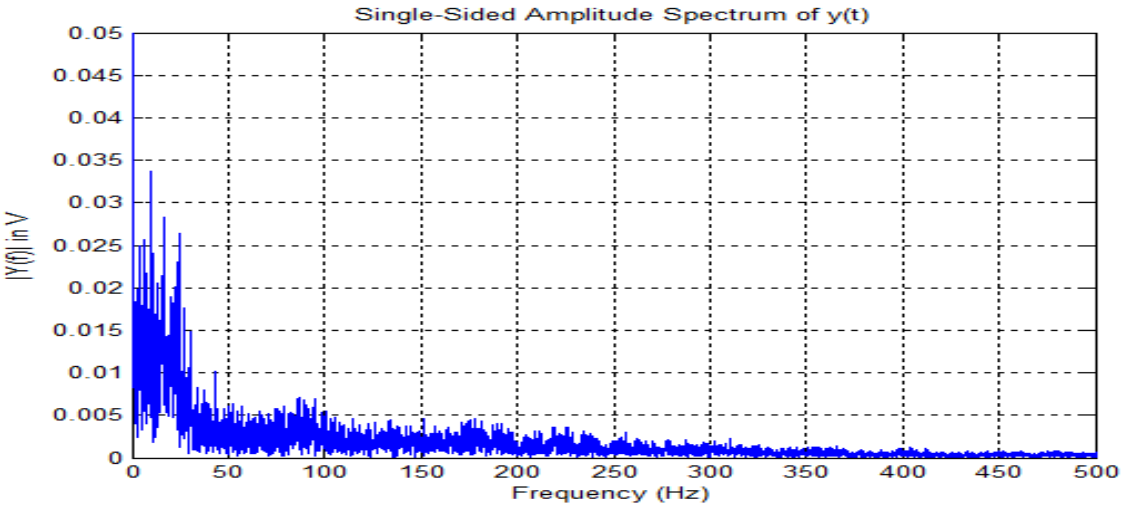
After data acquisition I have used Mat-Lab for further analysis of the recorded data to find out the suitable relation to detect the patient having problem in heart valve from PCG signal.

Chapter 4

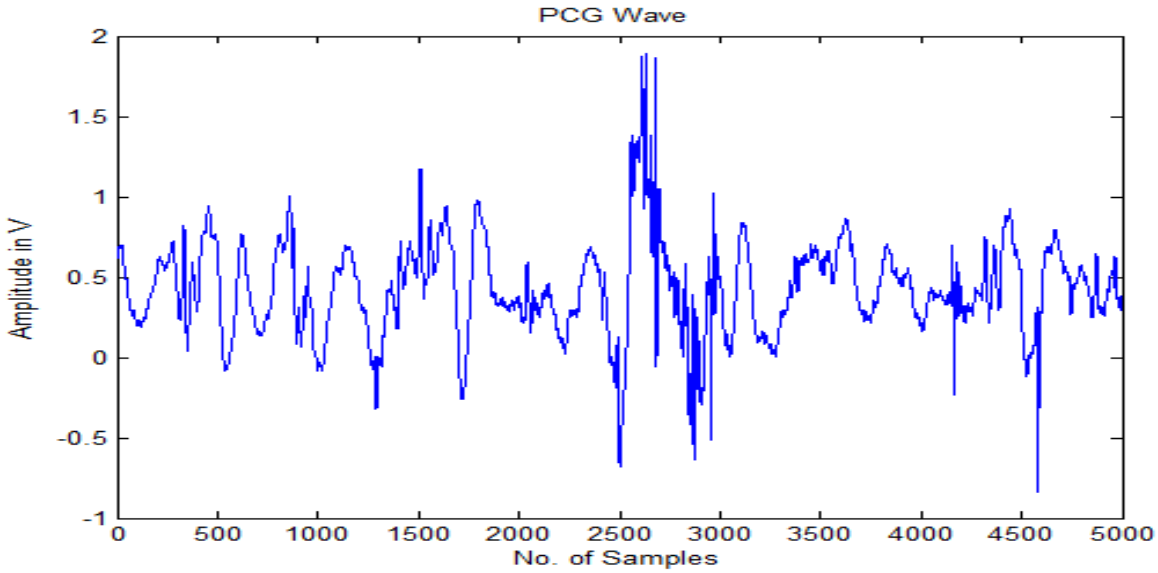
RESULT DATA AND DISCUSSIONS

Result:

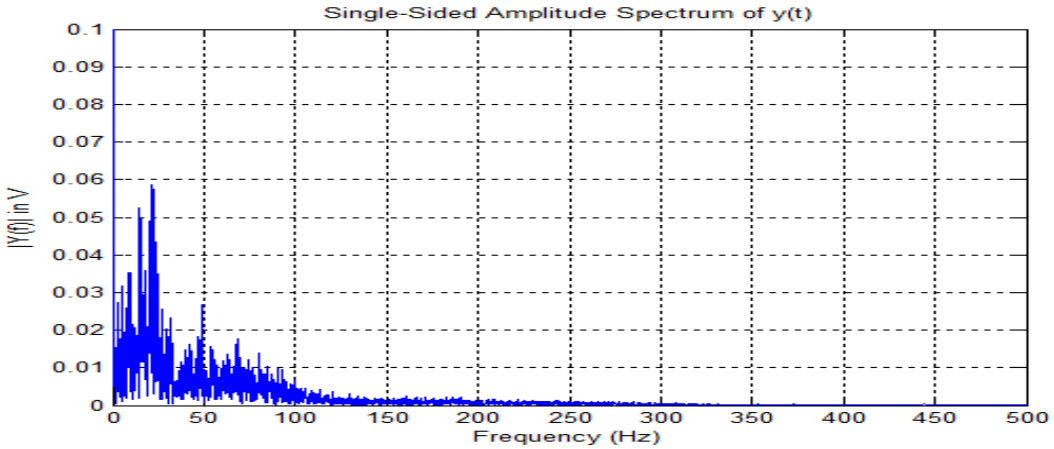
The FFT Spectrum and PCG wave spectrum are given below of normal 15 numbers of the subject.



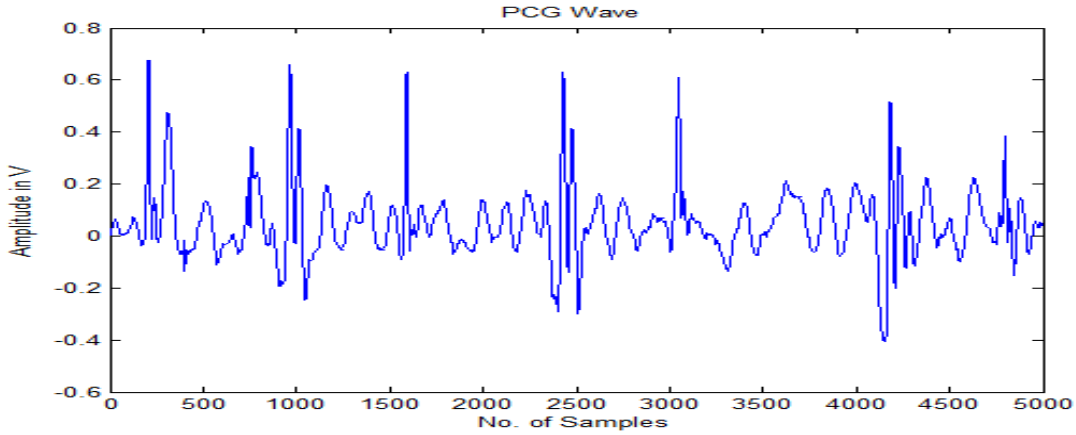
FFT Spectrum of PCG wave of Normal Subject 1



PCG wave of Normal Subject 1

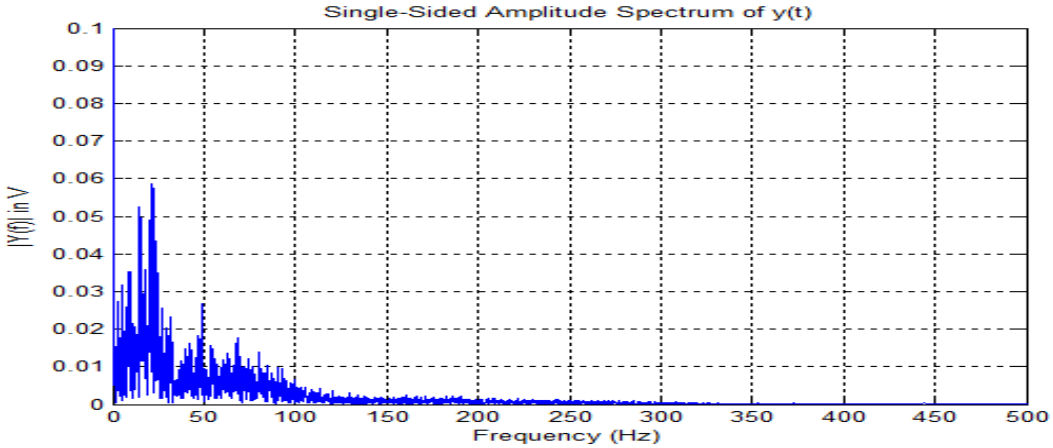


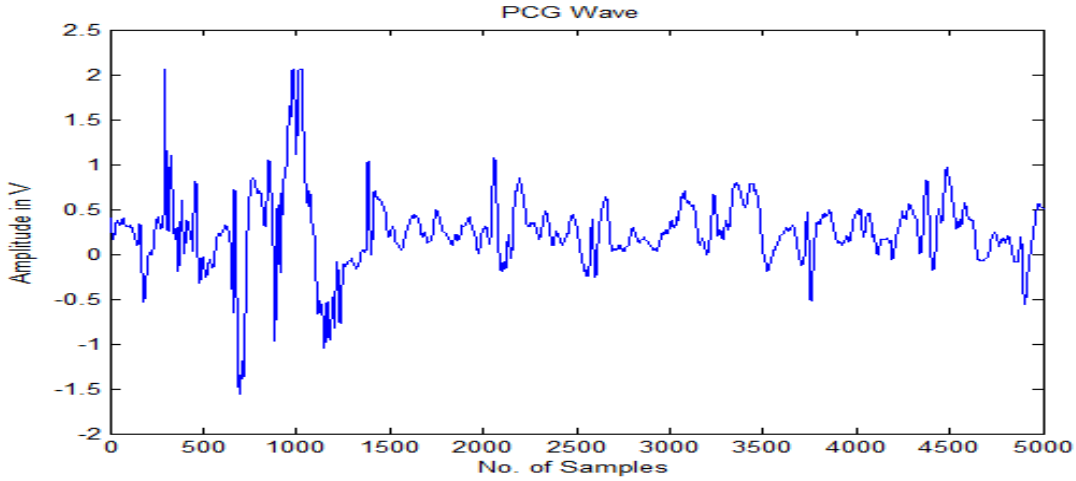
FET SIGNAL PCG wave of Normal Subject 2



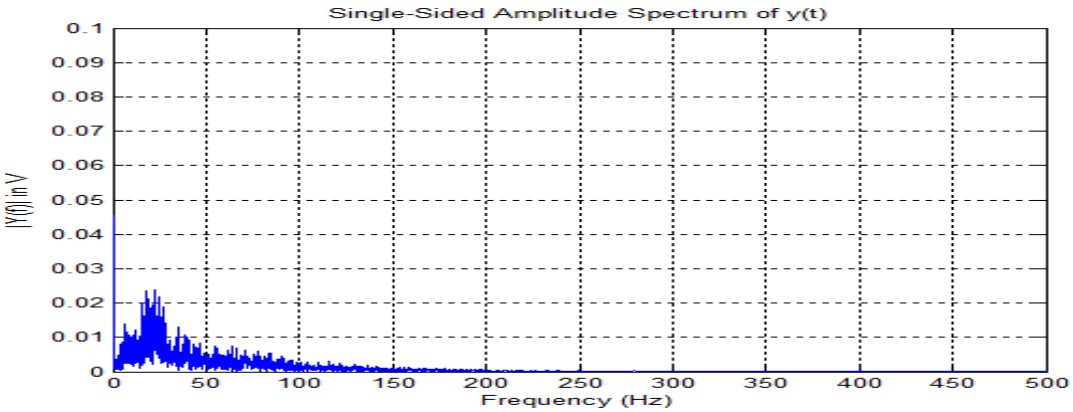
PCG wave of Normal Subject 2

FET SIGNAL PCG wave of Normal Subject 3

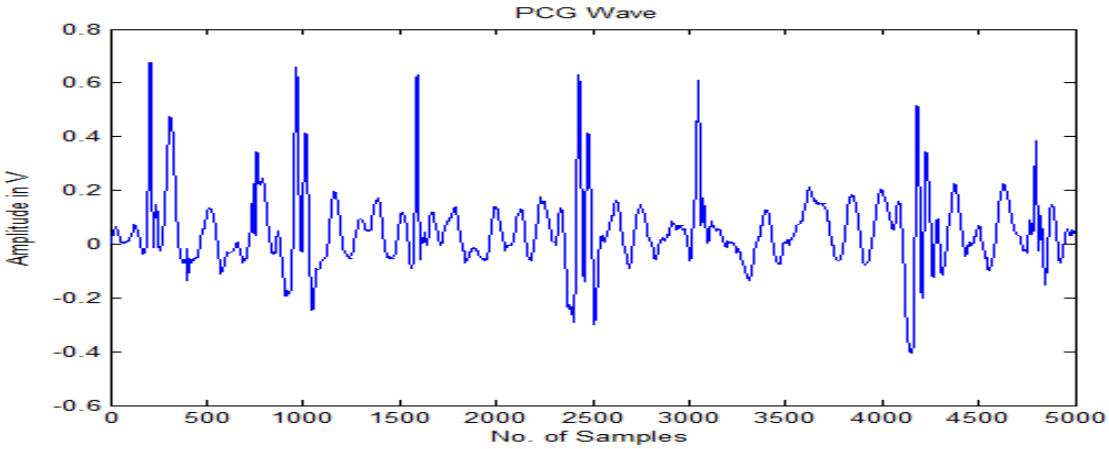




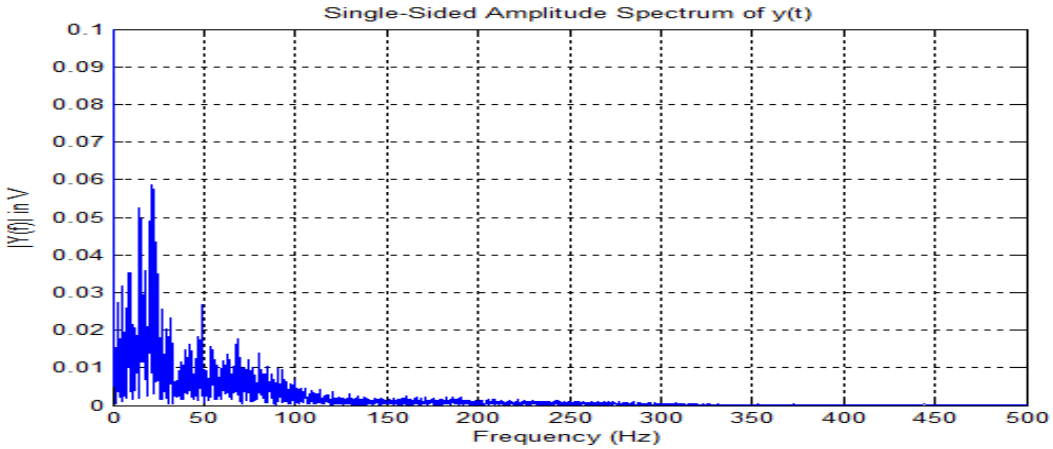
PCG wave of Normal Subject 3



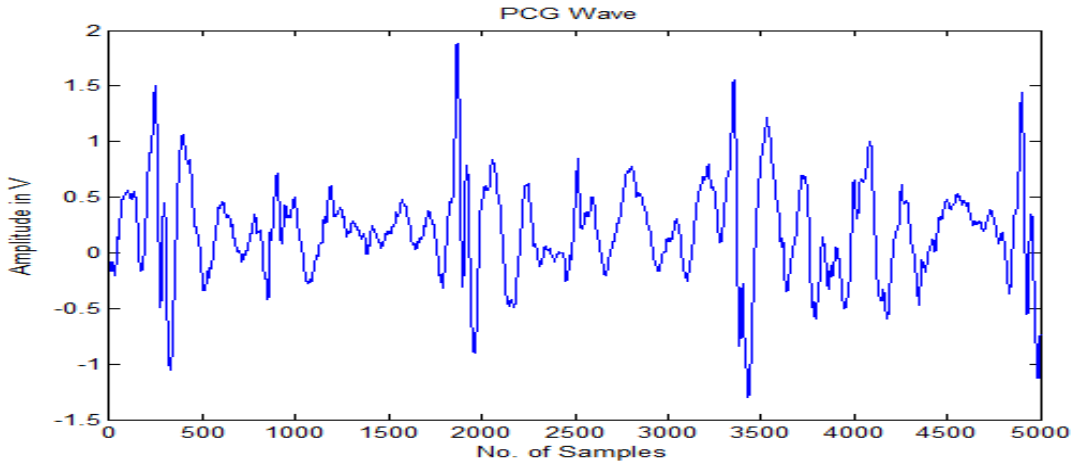
FFT Spectrum of PCG wave of Normal Subject4



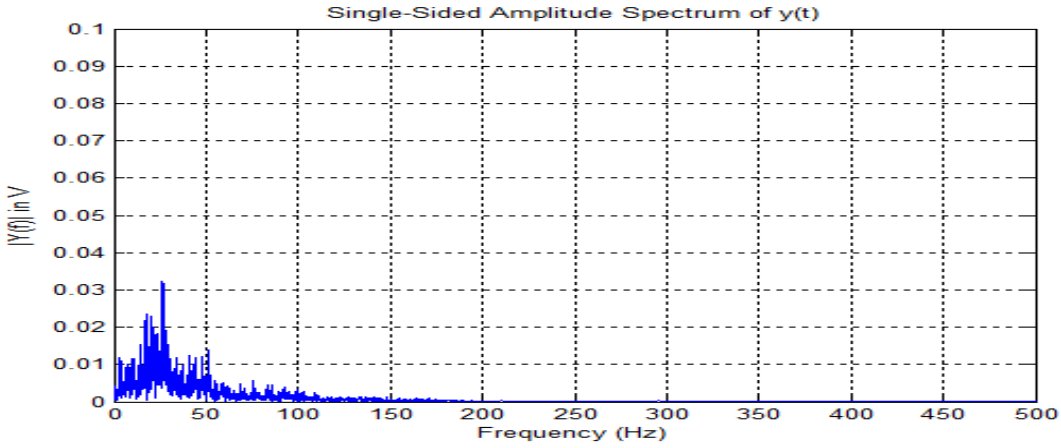
PCG wave of Normal Subject 4



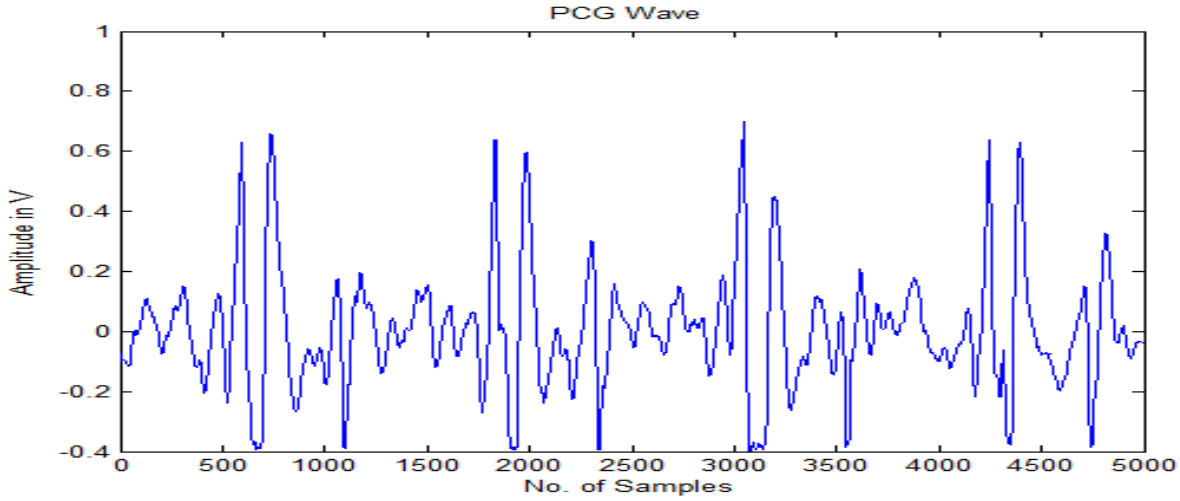
FFT Spectrum of PCG wave of Normal Subject 5



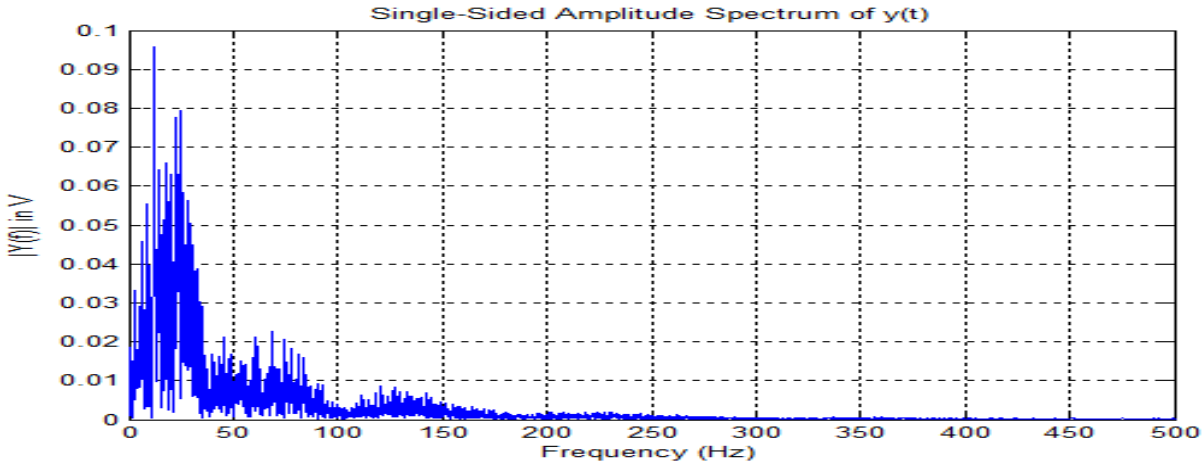
PCG wave of Normal Subject 5



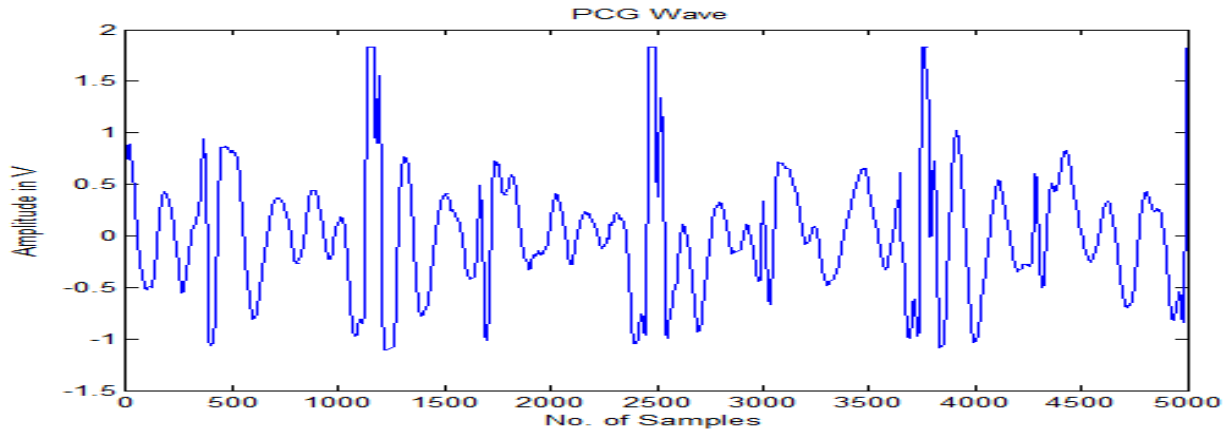
FFT Spectrum of PCG wave of Normal Subject 6



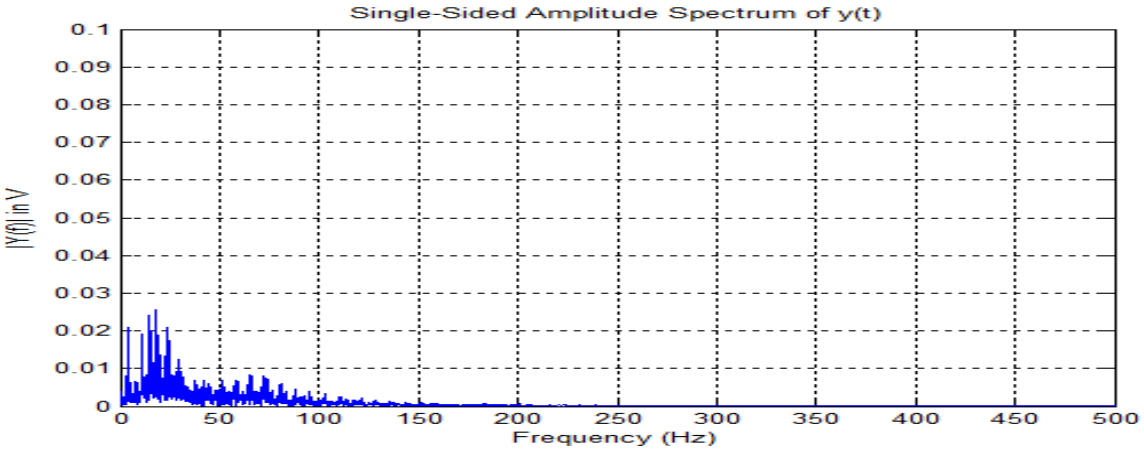
PCG wave of Normal Subject 6



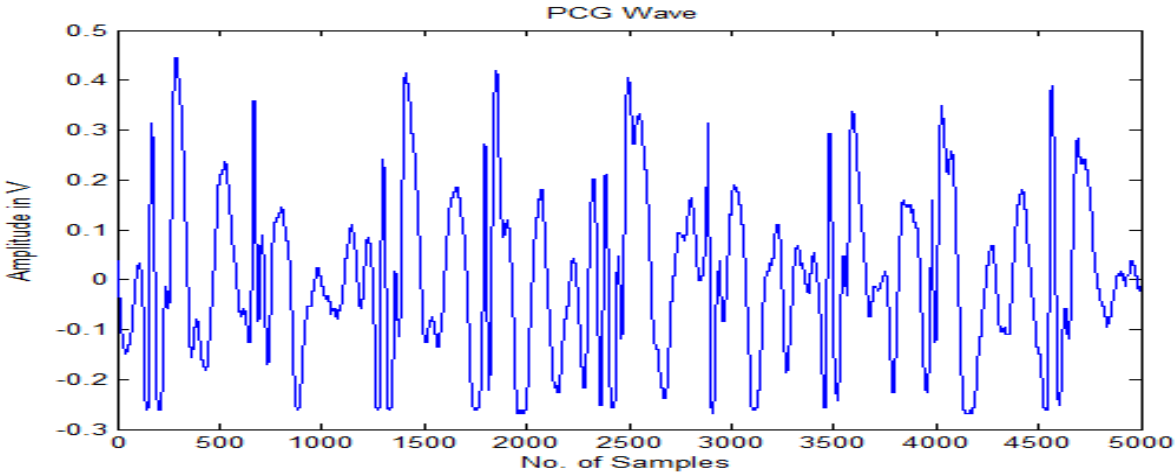
FFT Spectrum of PCG wave of Normal Subject 7



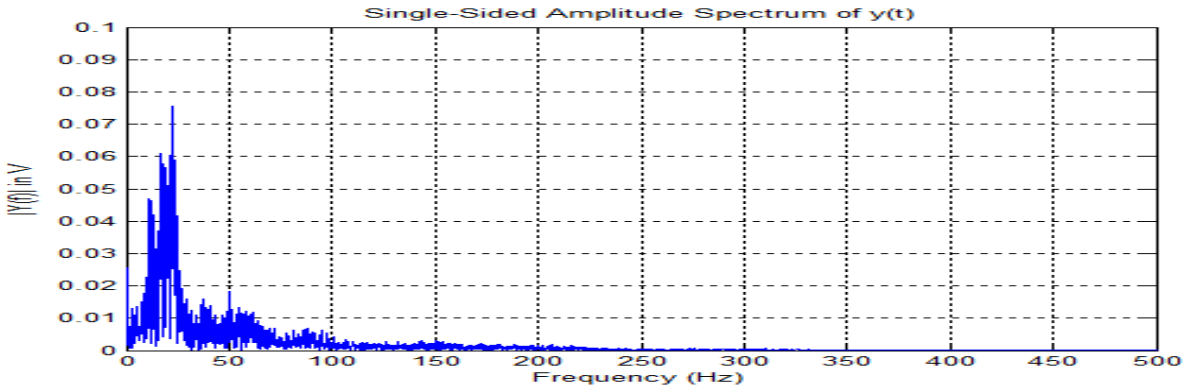
PCG wave of Normal Subject 7



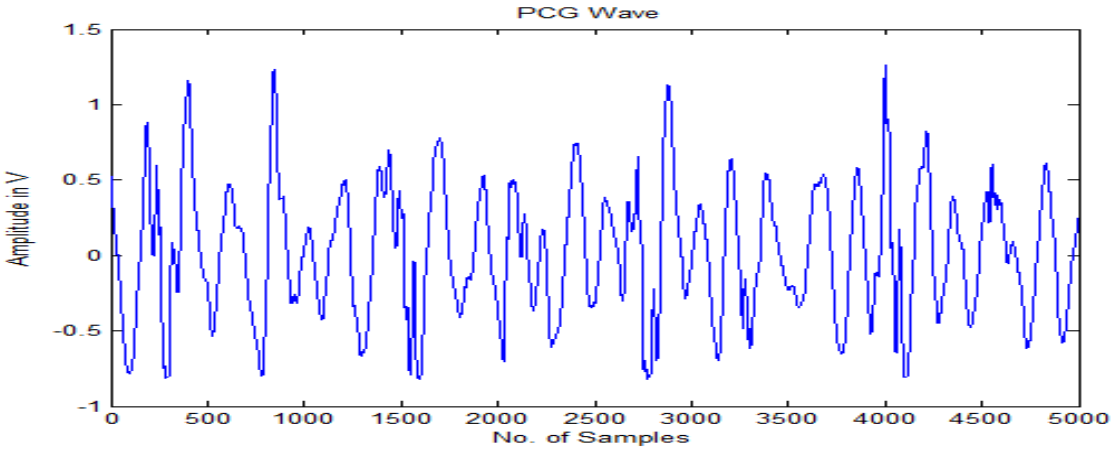
FFT Spectrum of PCG wave of Normal Subject 8



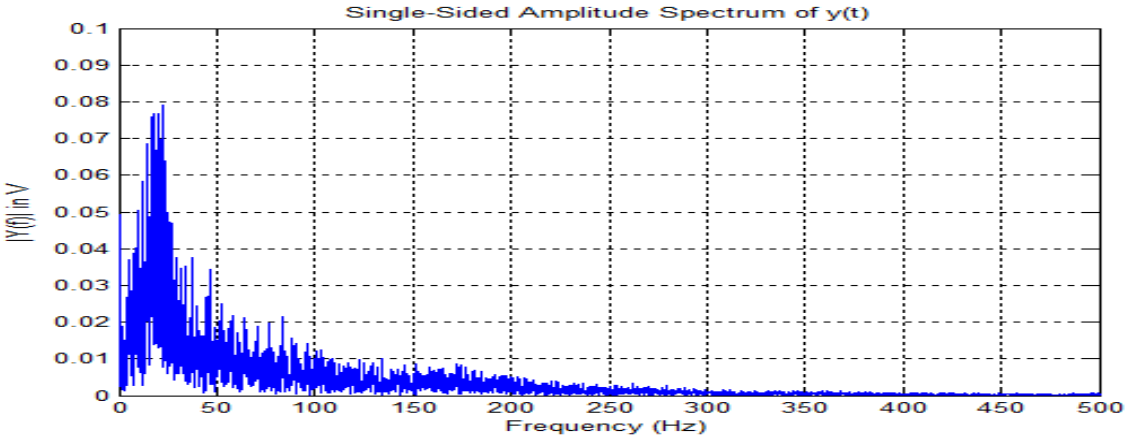
PCG wave of Normal Subject 8



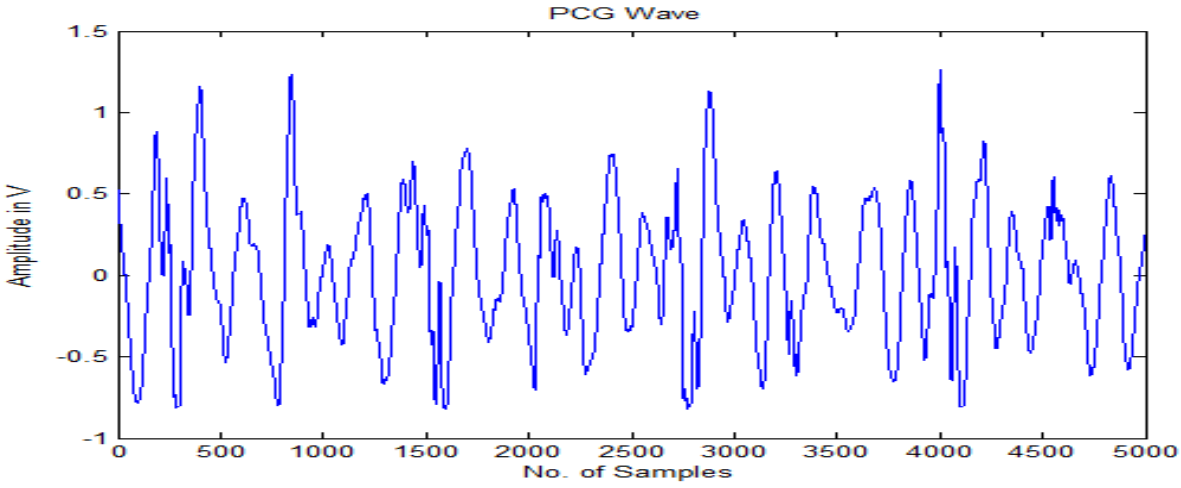
FFT Spectrum of PCG wave of Normal Subject 9



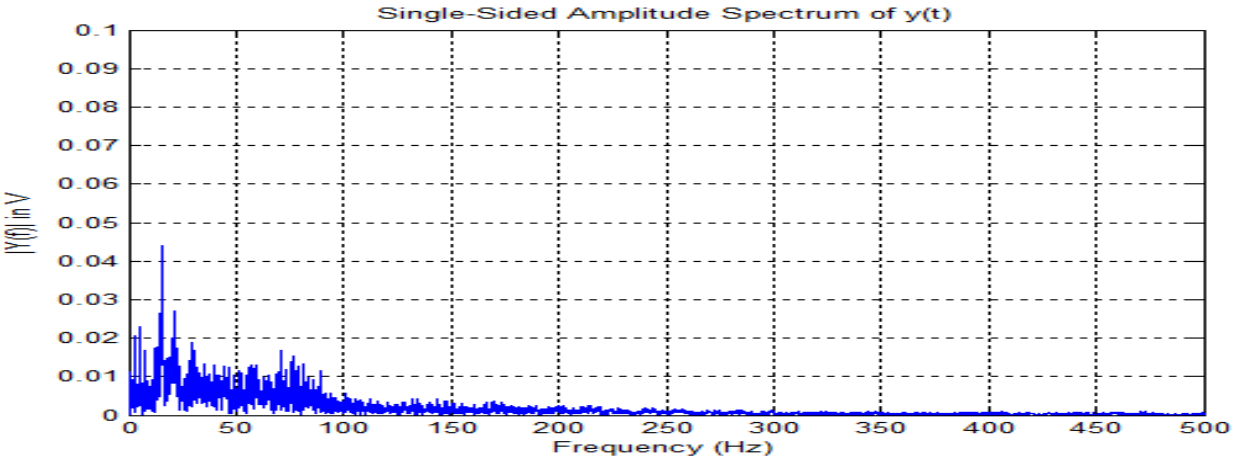
PCG wave of Normal Subject 9



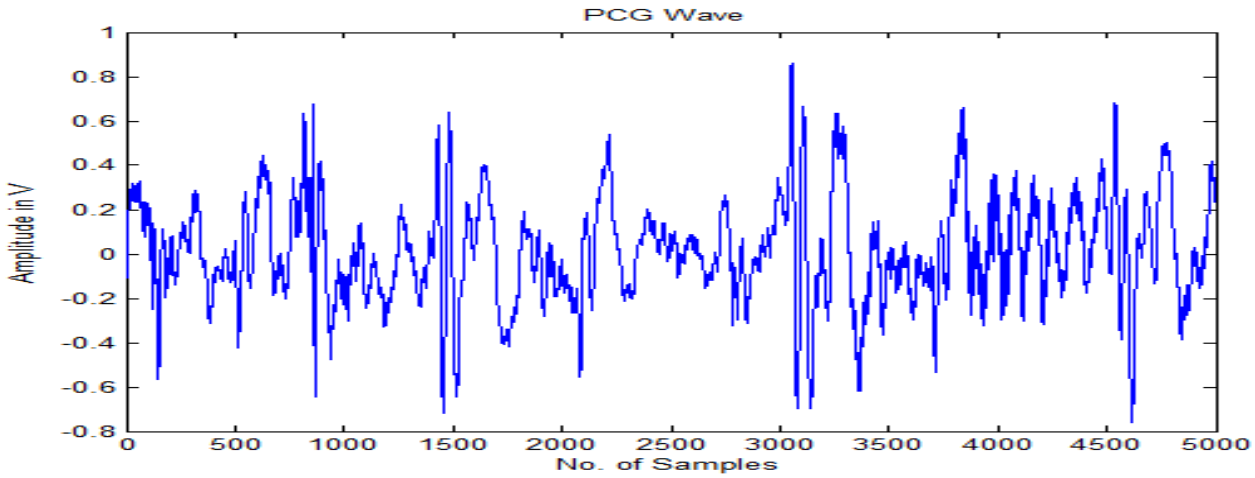
FFT Spectrum of PCG wave of Normal Subject 9



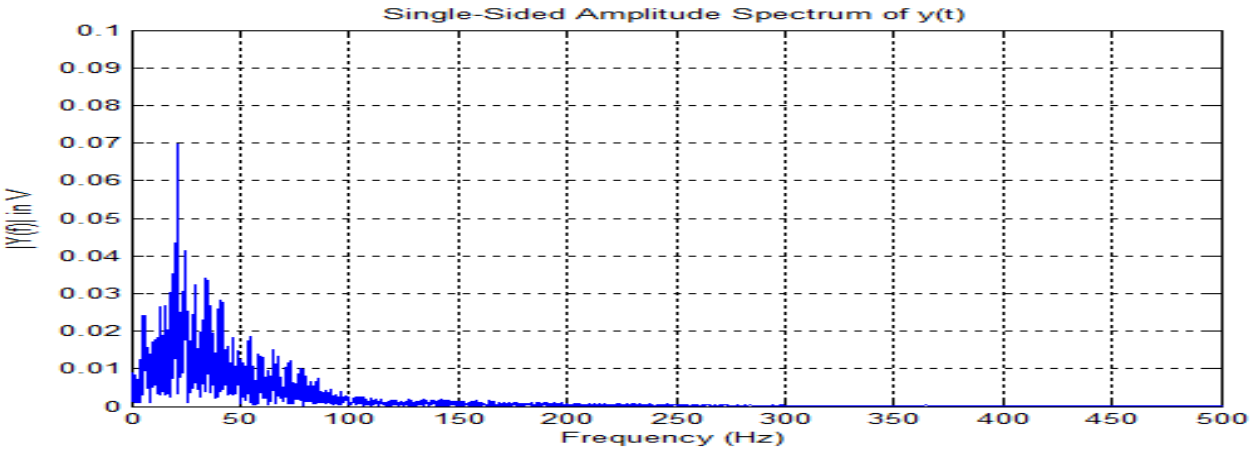
PCG wave of Normal Subject 10



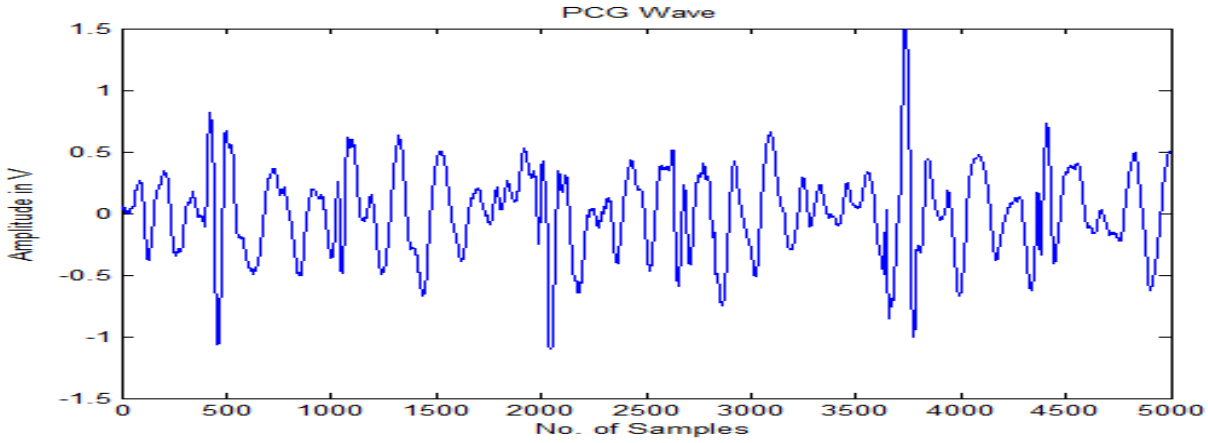
FFT Spectrum of PCG wave of Normal Subject 11



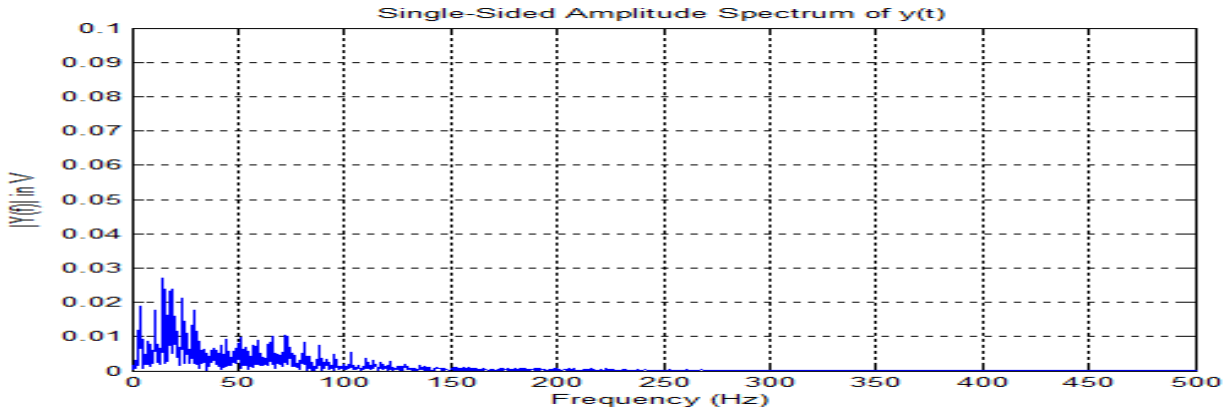
PCG wave of Normal Subject 11



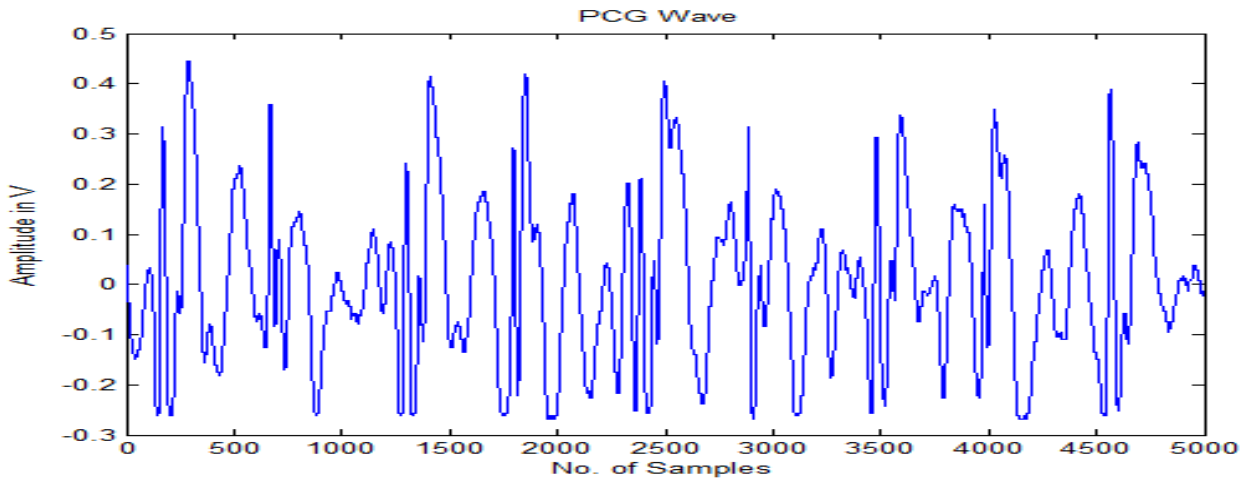
FFT Spectrum of PCG wave of Normal Subject 12



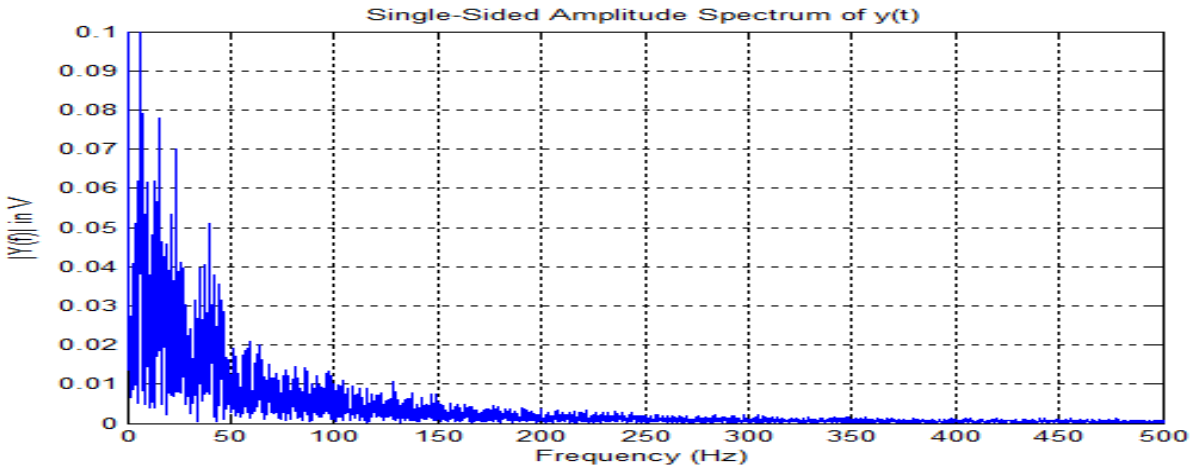
PCG wave of Normal Subject 12



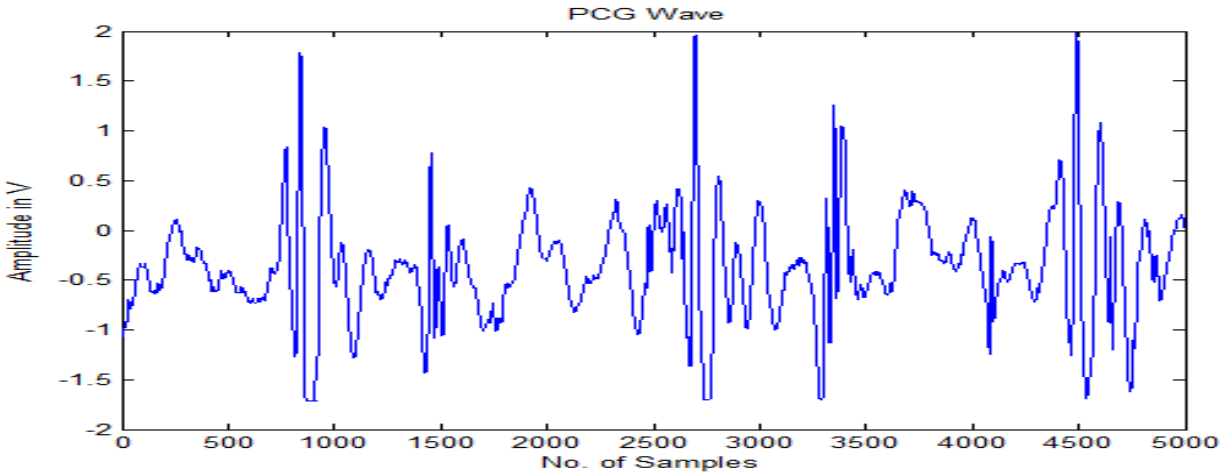
FFT Spectrum of PCG wave of Normal Subject 13



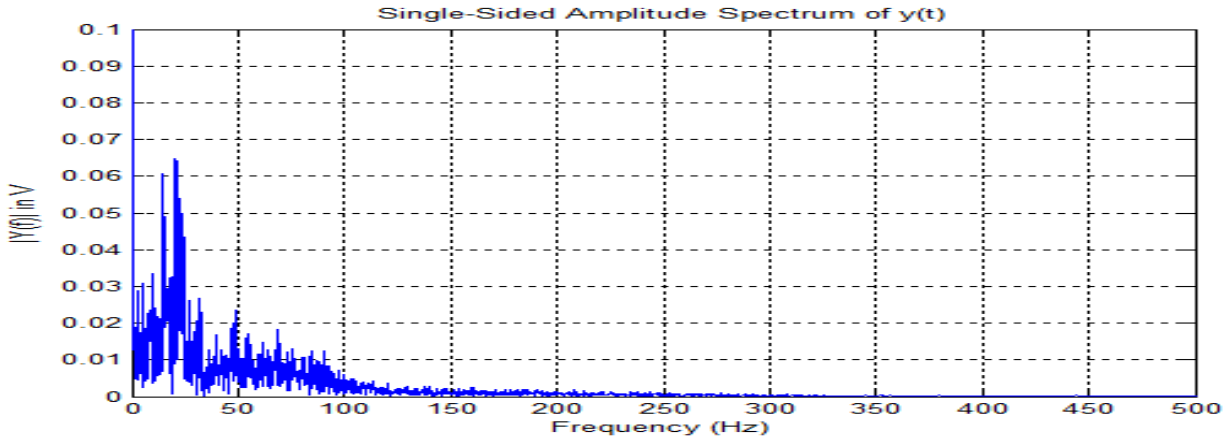
PCG wave of Normal Subject 13



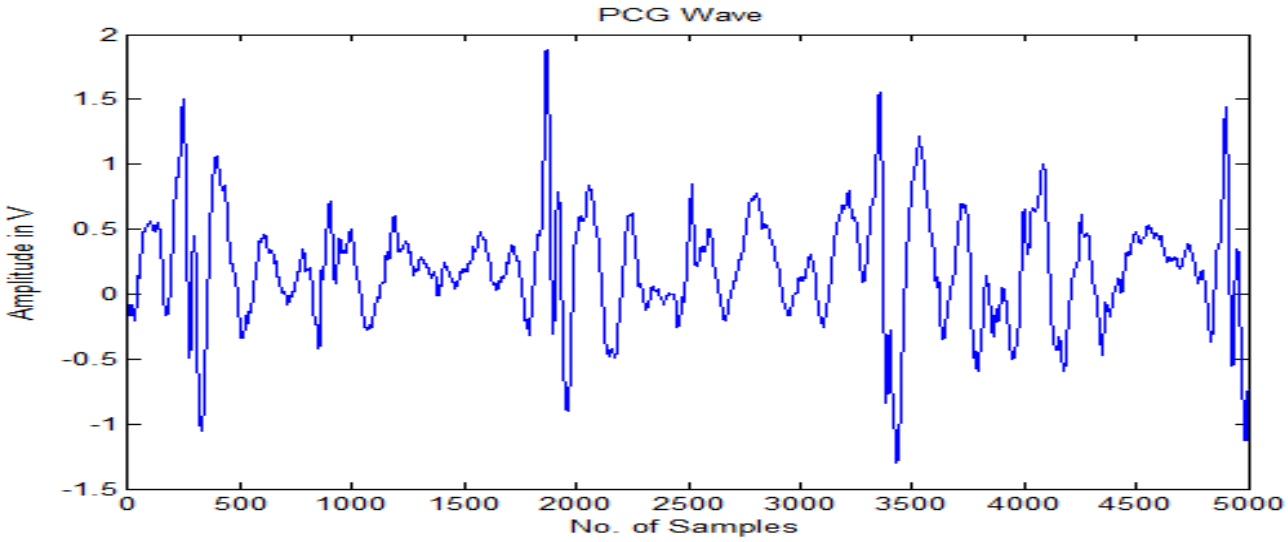
FET SPECTRUM OF NORMAL SUBJECT 14



PCG wave of Normal Subject 14



FFT Spectrum of PCG wave of Normal Subject 15



PCG wave of Normal Subject 15

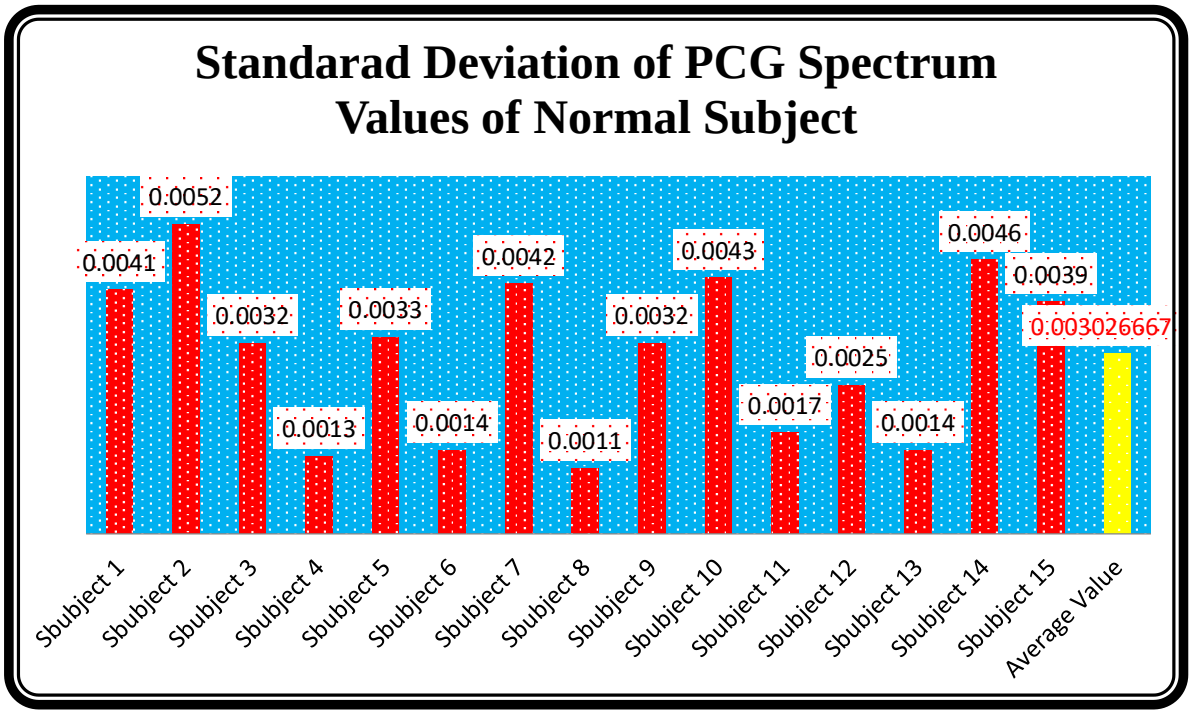
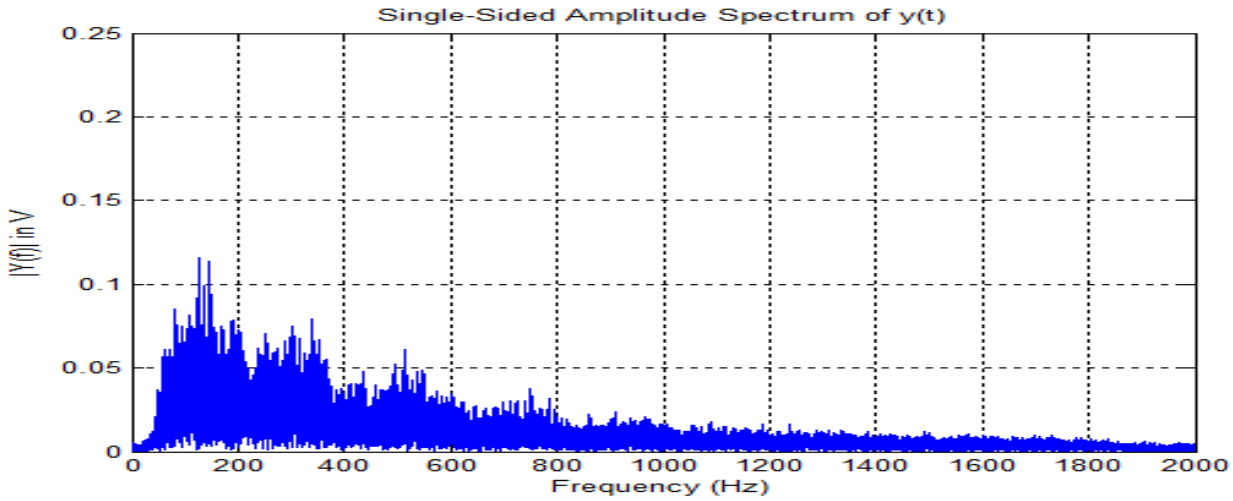
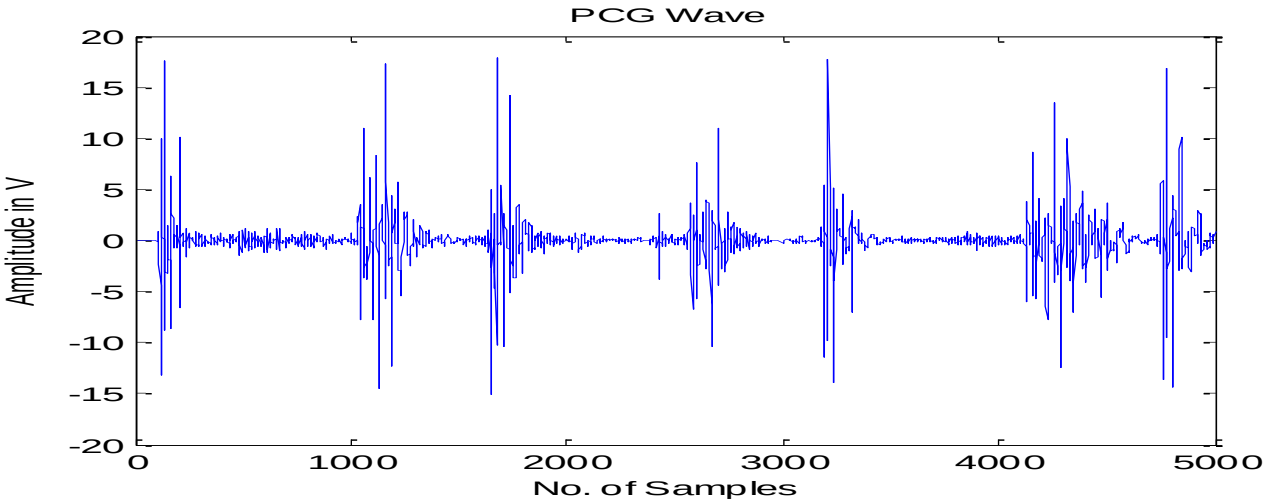


Fig: Standard Deviation of PCG Spectrum Values of Normal Subjects

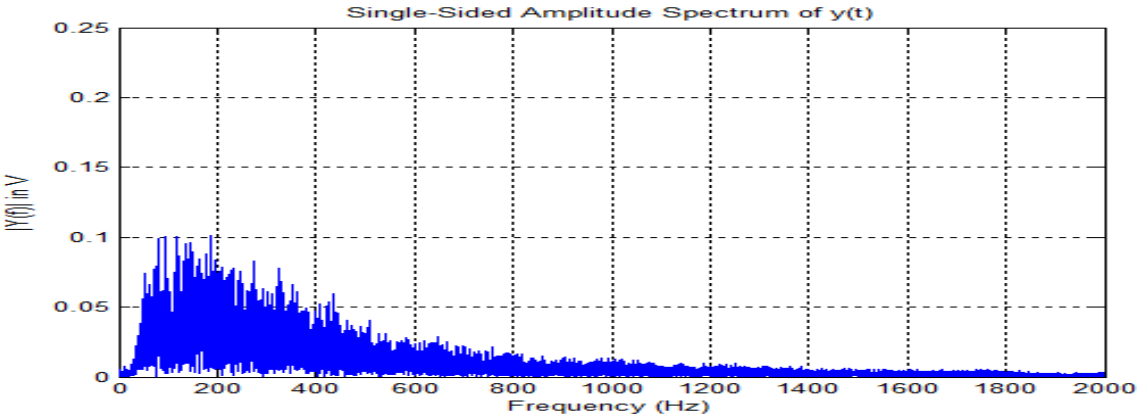
NOW WE WILL SEE THE ABNORMAL DATA OF 15 PEOPLE WHO HAVE THE PROBLEM OF HEART VALVE



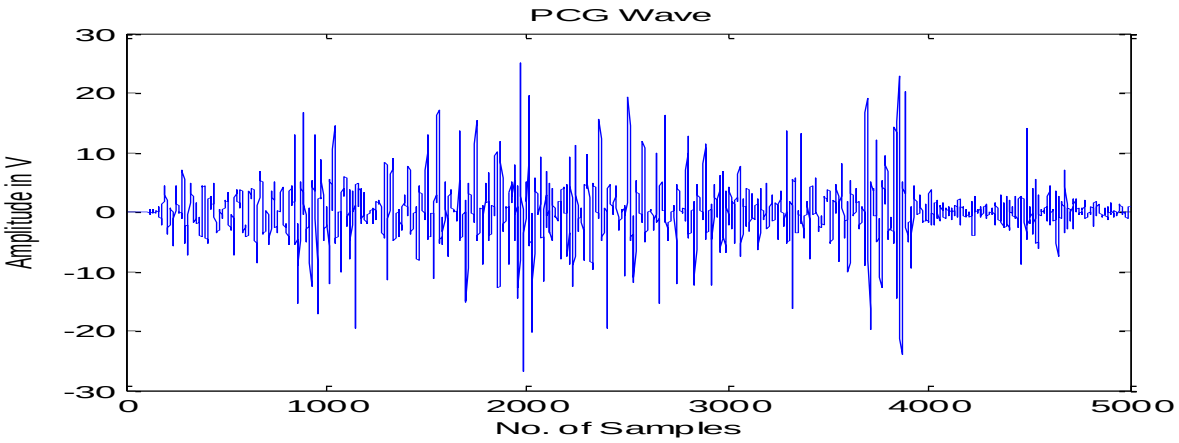
FFT Spectrum of PCG wave of Abnormal Subject 1



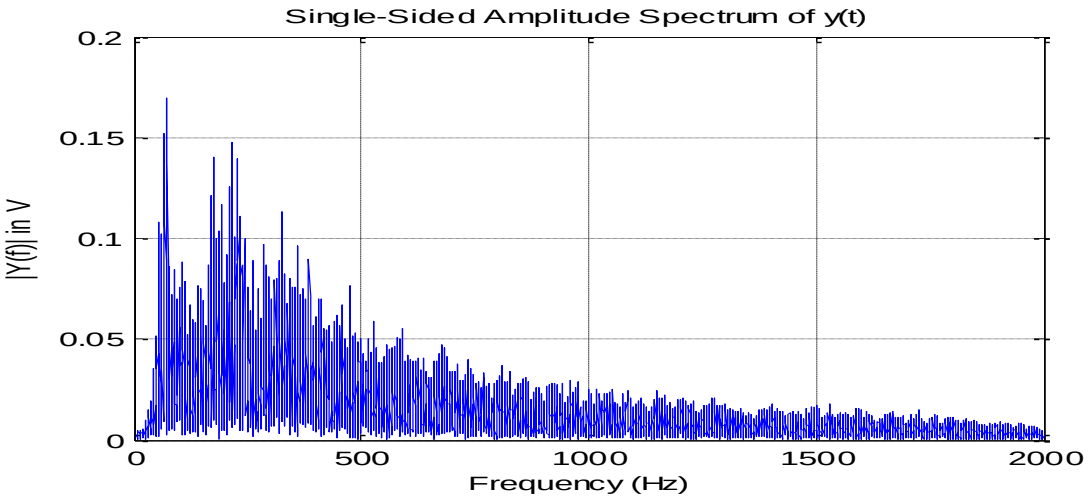
PCG wave of Abnormal Subject 1



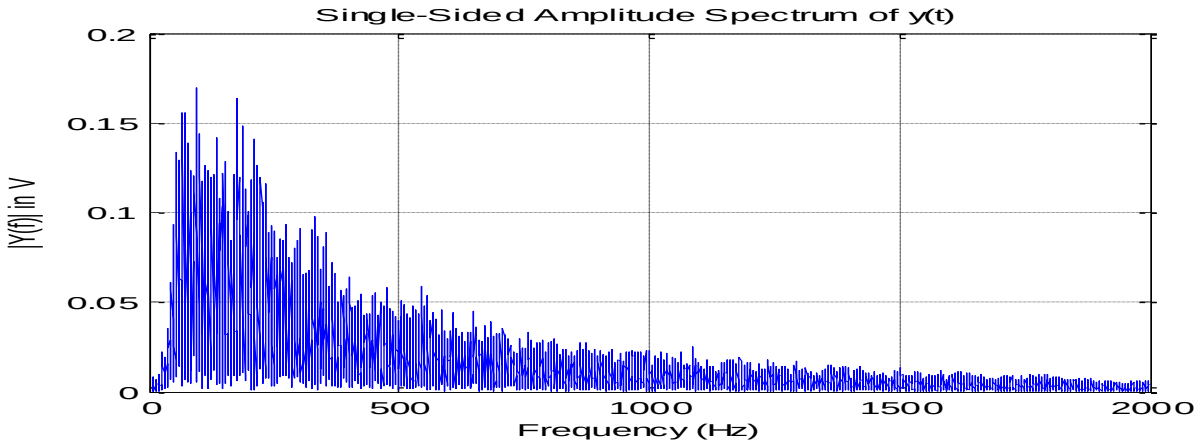
FFT Spectrum of PCG wave of Abnormal Subject 2



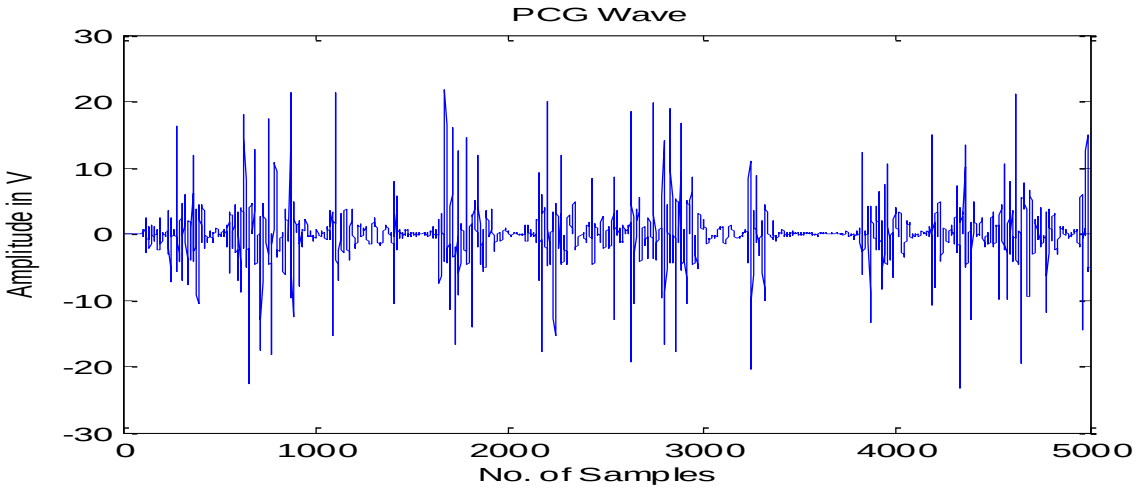
PCG wave of Abnormal Subject 2



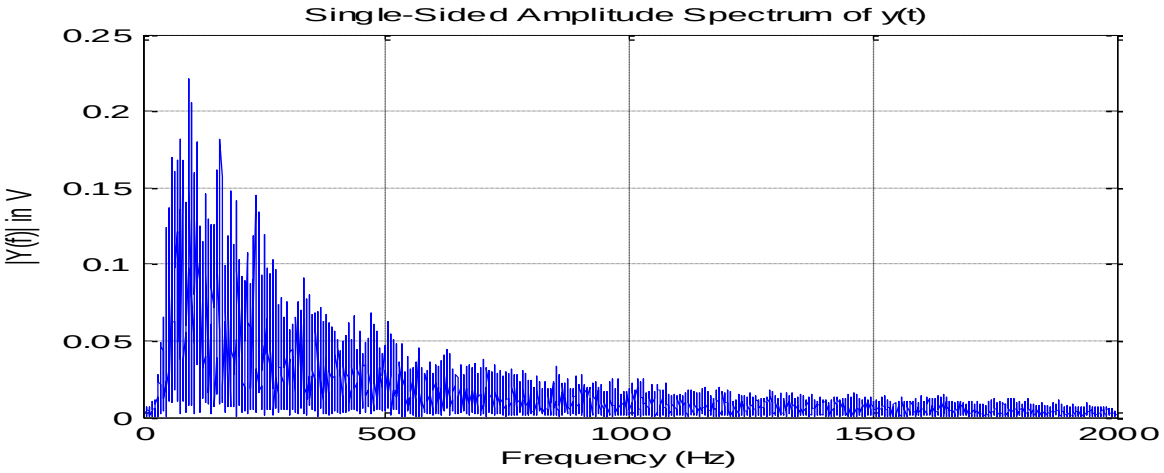
FFT Spectrum of PCG wave of Abnormal Subject 3



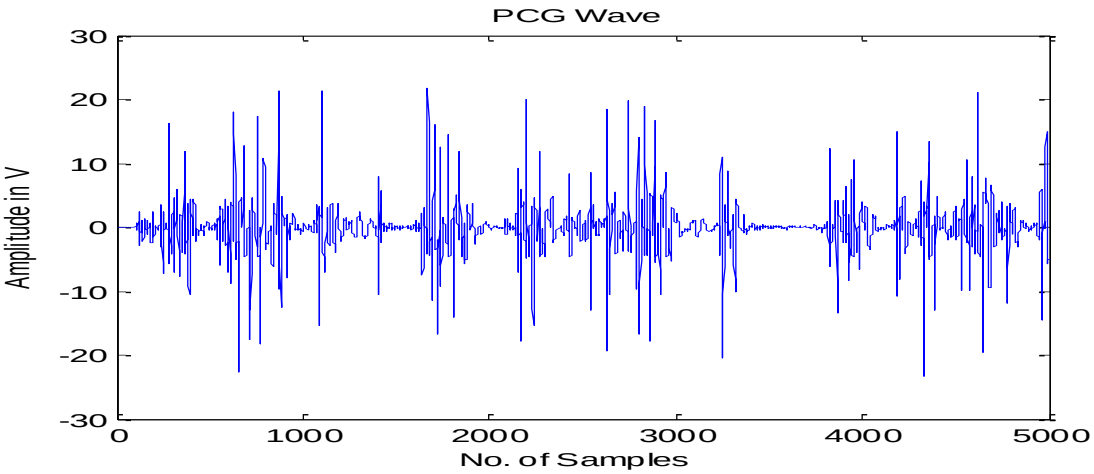
FFT Spectrum of PCG wave of Abnormal Subject 3



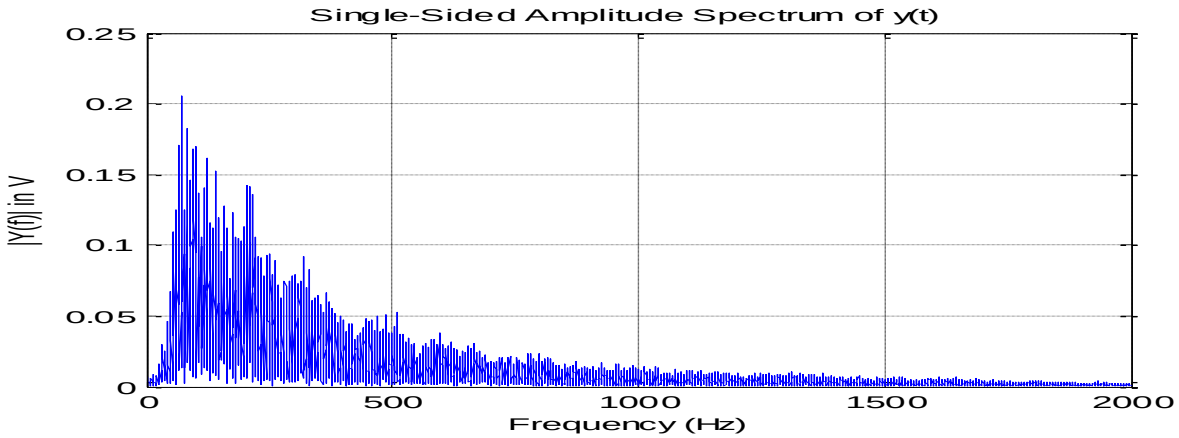
FFT PCG wave of Abnormal Subject 3



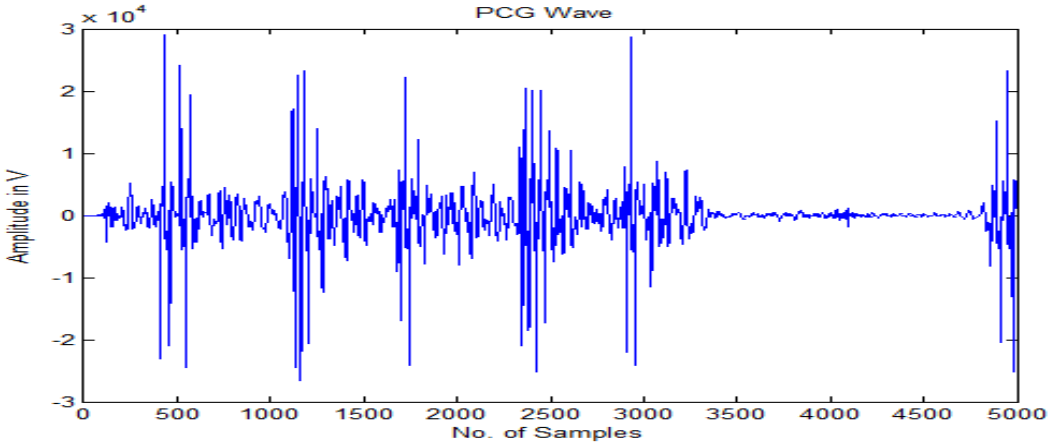
FFT Spectrum of PCG wave of Abnormal Subject 4



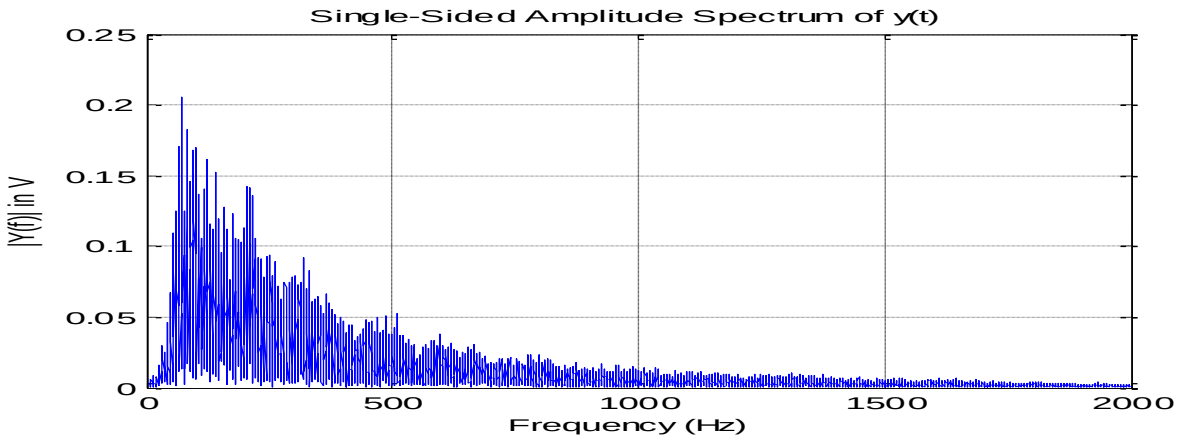
PCG Signal wave for normal subject 4



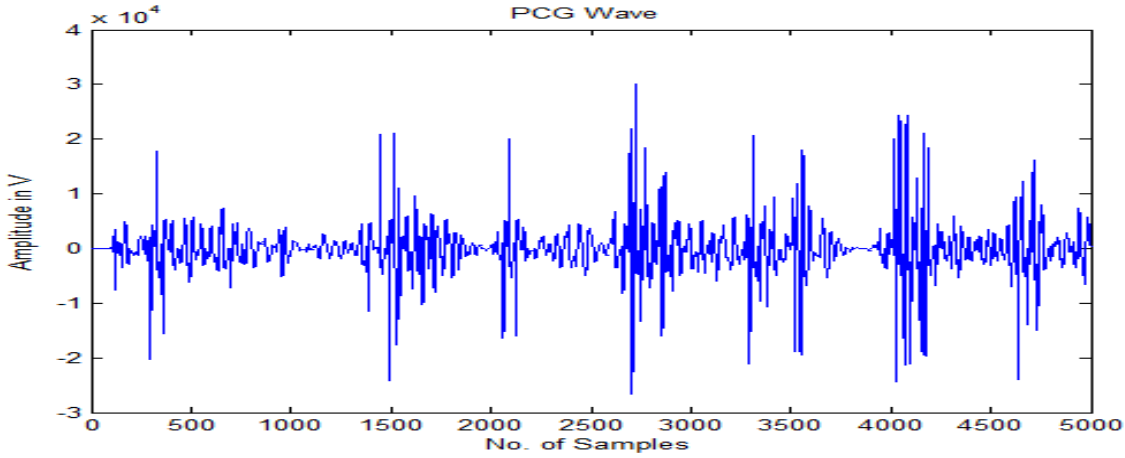
PCG wave of Abnormal Subject 5



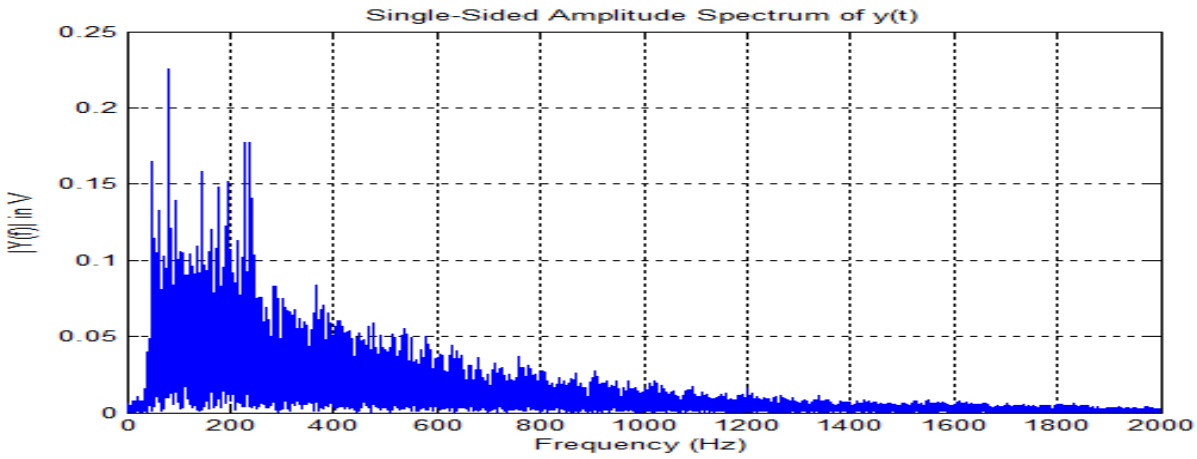
PCG wave of Abnormal Subject 5



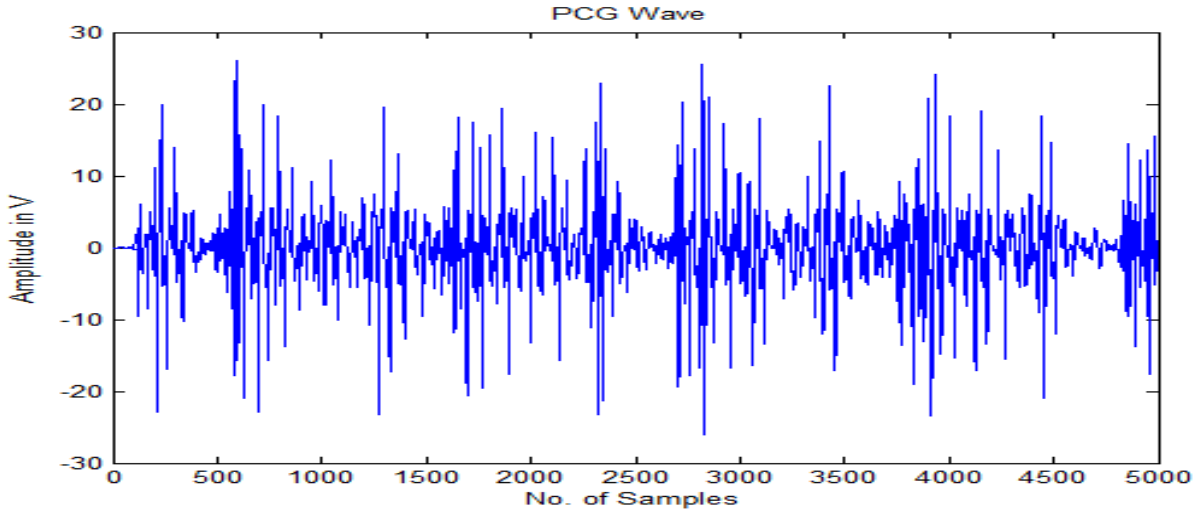
FET Spectrum Abnormal Subject 6



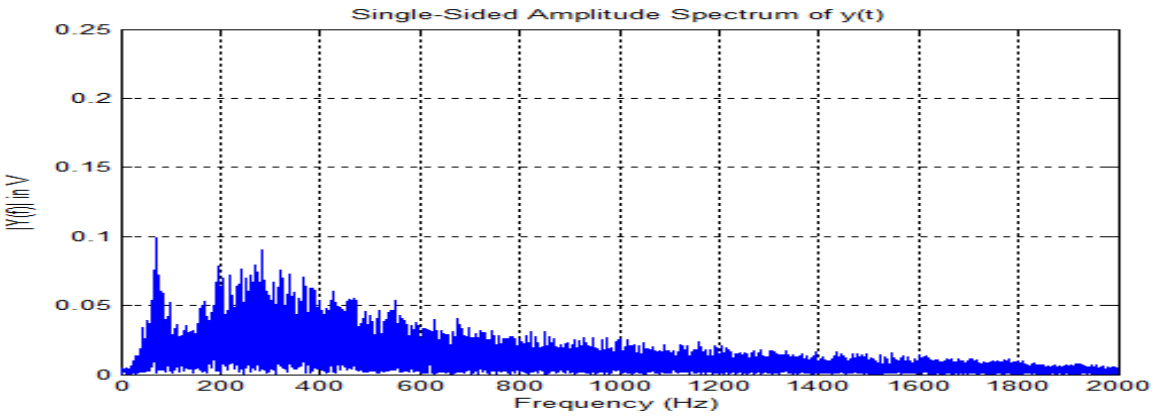
PCG wave of Abnormal Subject 6



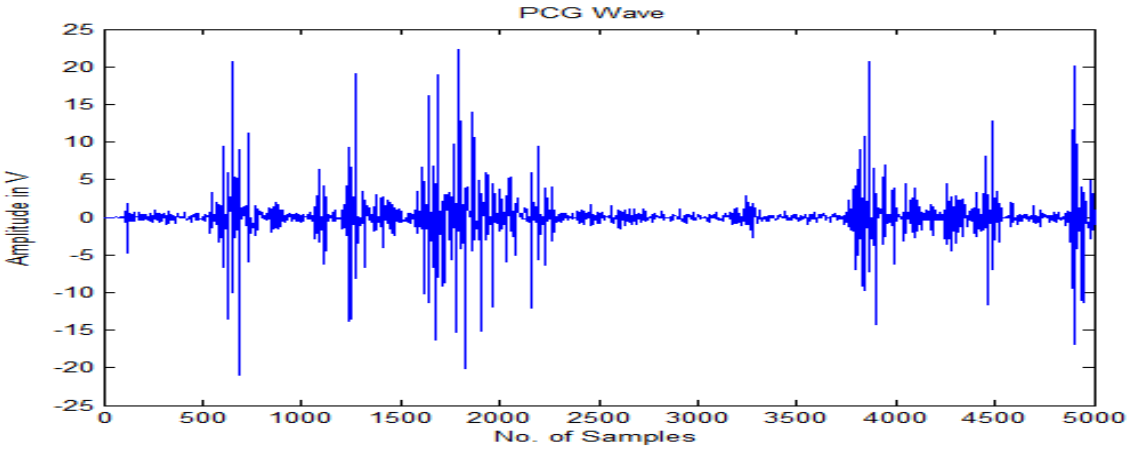
FFT Spectrum of PCG wave of Abnormal Subject 7



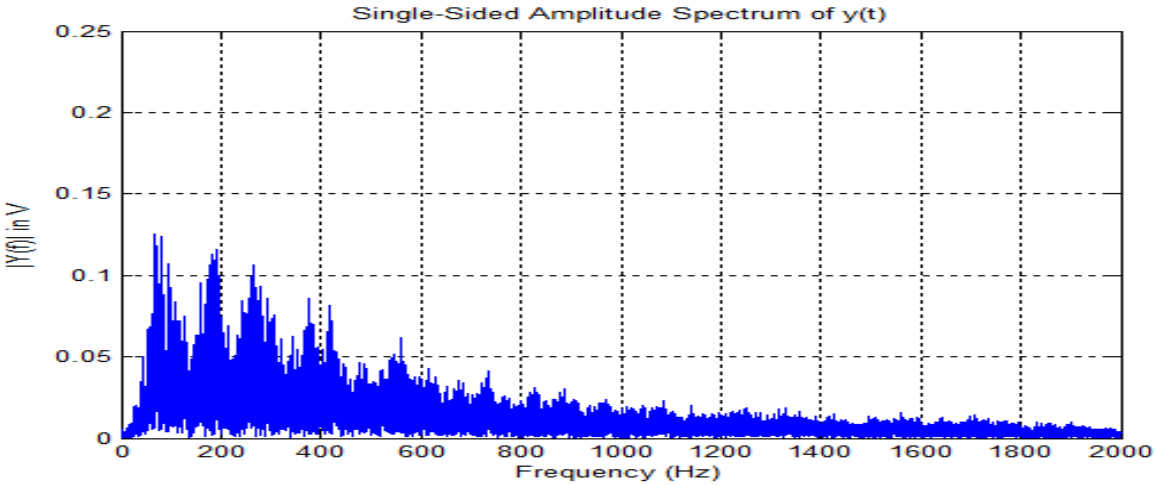
PCG wave of Abnormal Subject 7



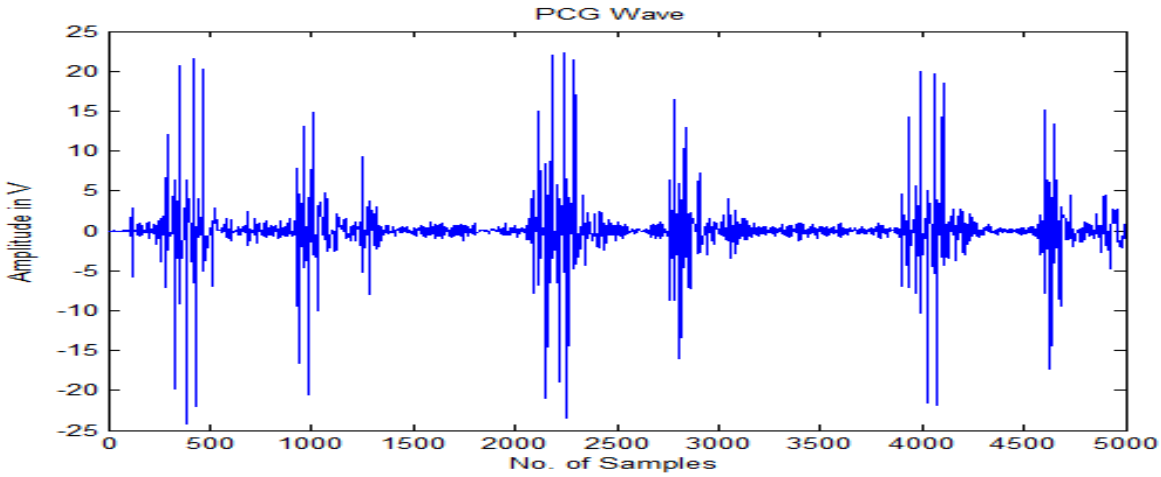
FFT Spectrum of PCG wave of Abnormal Subject 8



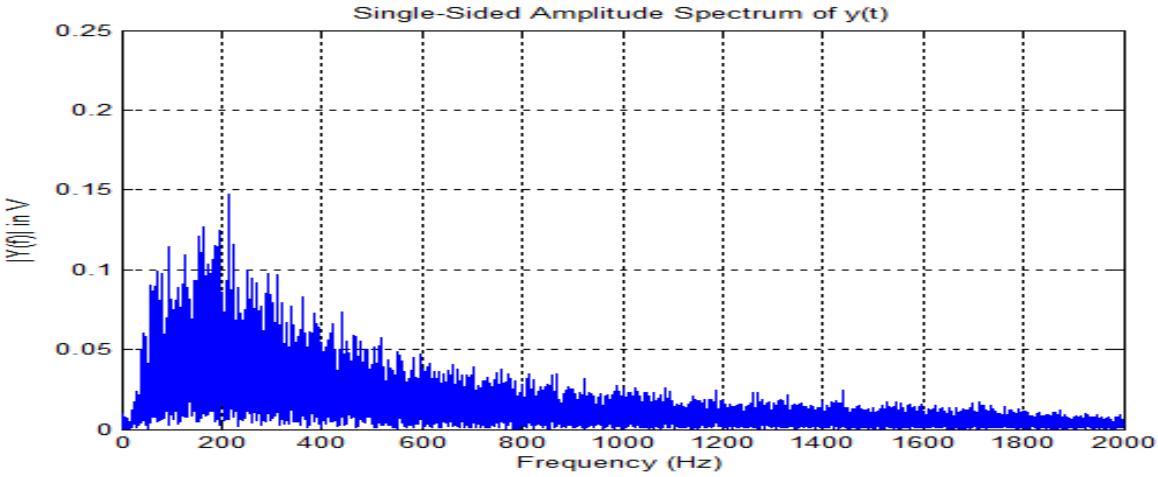
PCG wave of Abnormal Subject 8



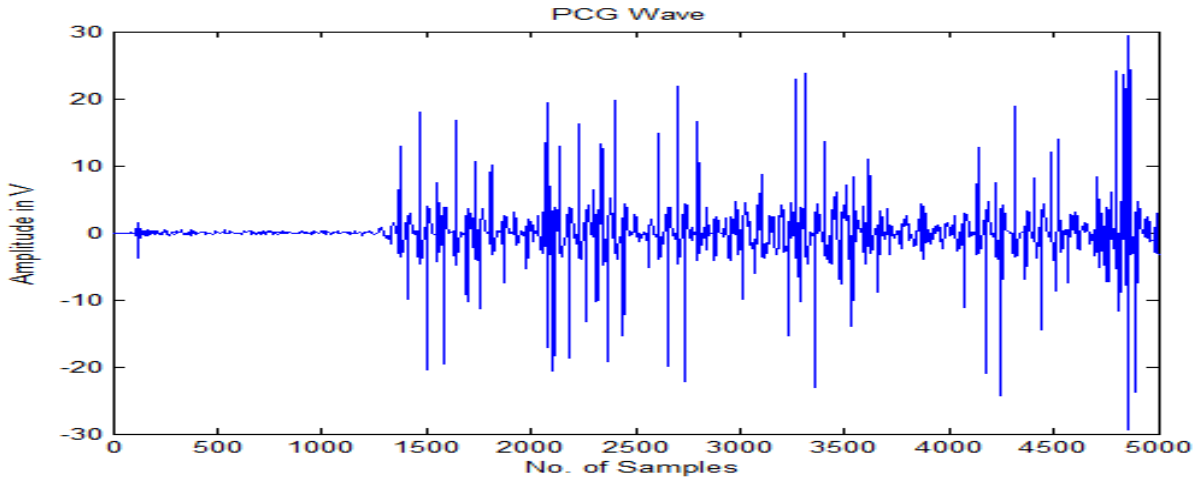
FFT Spectrum of PCG wave of Abnormal Subject 9



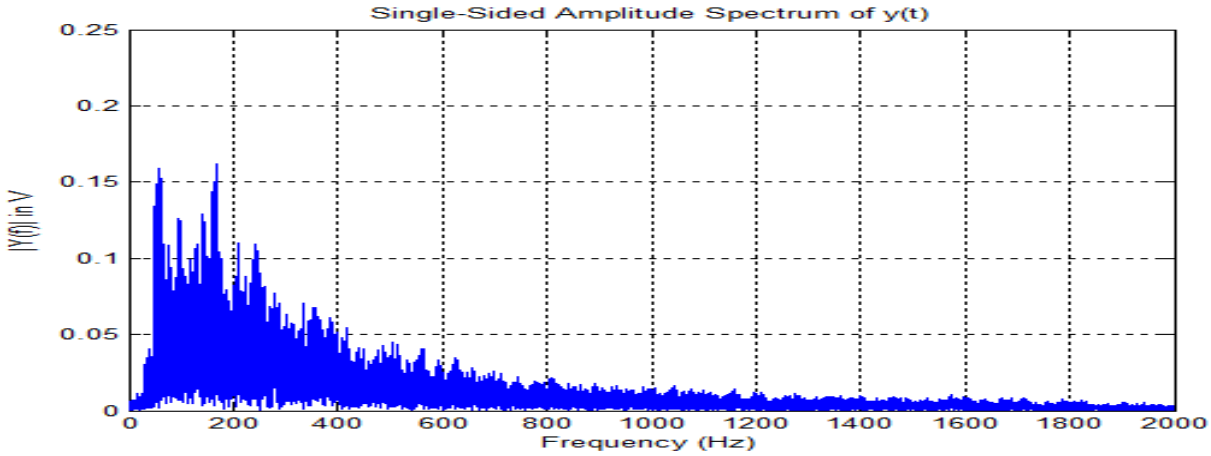
PCG wave of Abnormal Subject 9



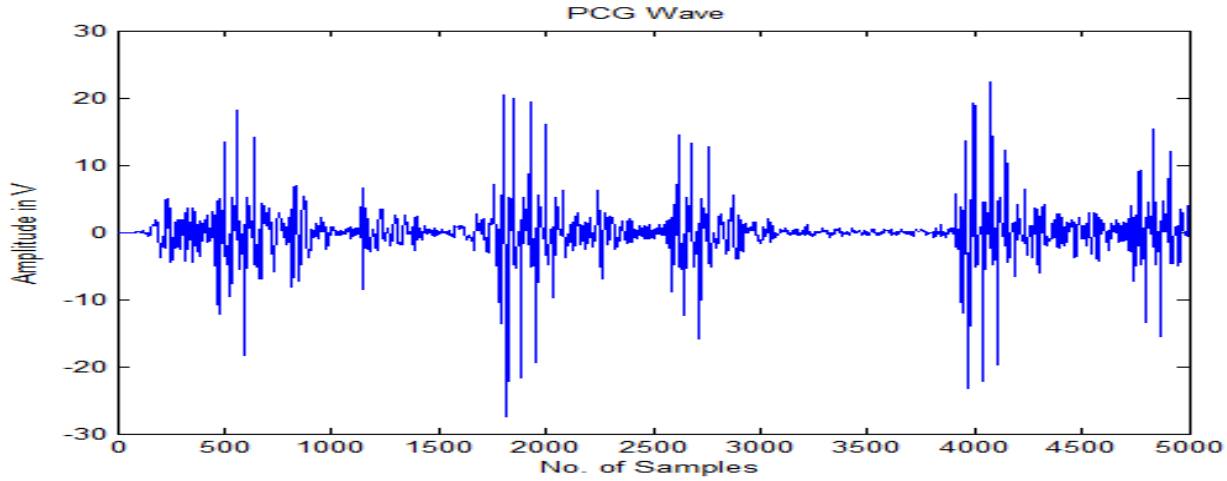
FFT Spectrum of PCG wave of Abnormal Subject 9



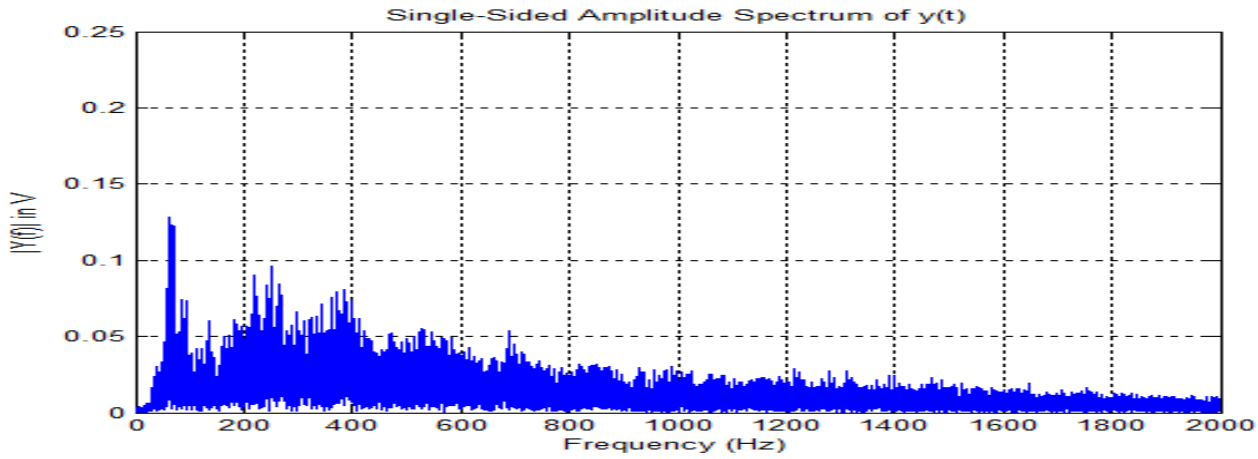
PCG wave of Abnormal Subject 9



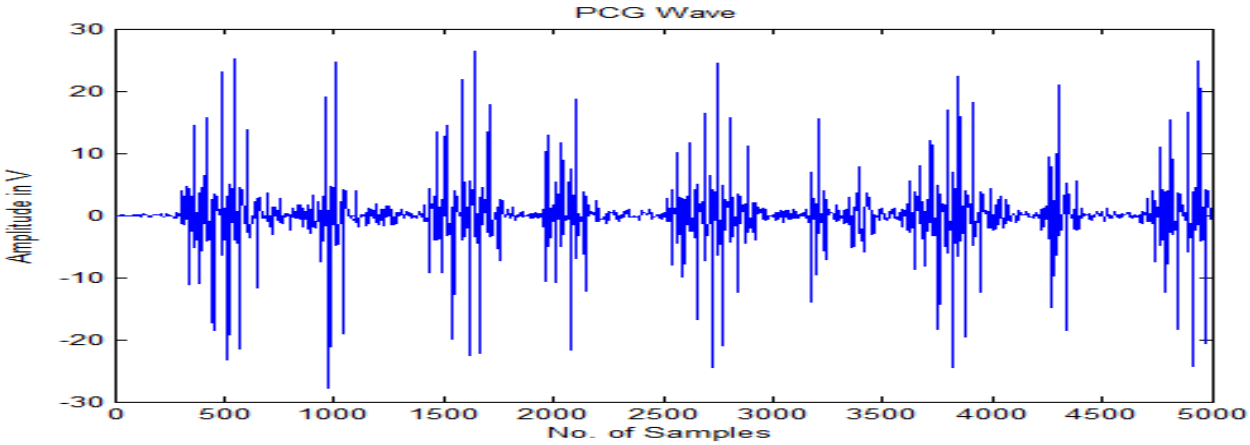
FFT Spectrum of PCG wave of Abnormal Subject 10



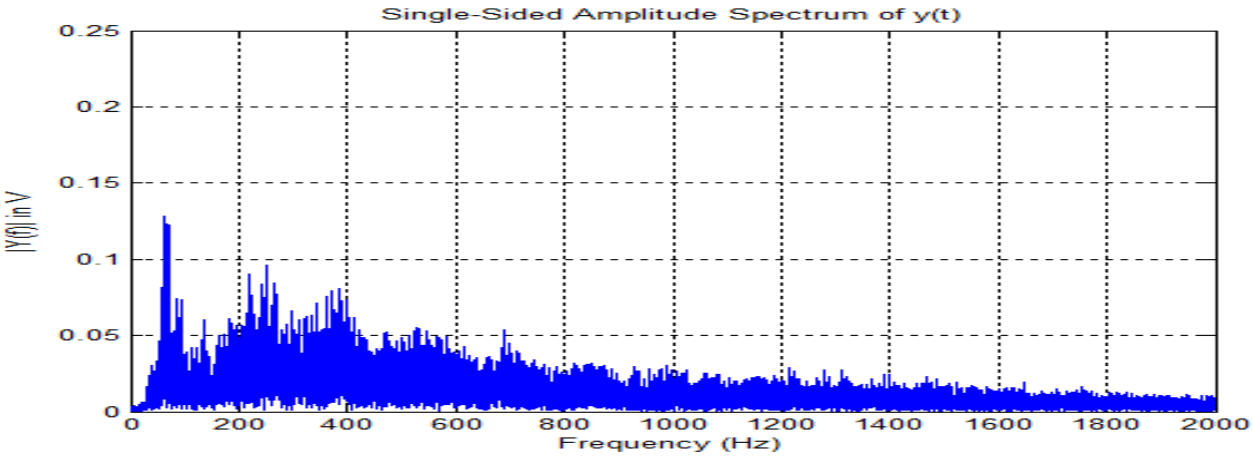
PCG wave of Abnormal Subject 10



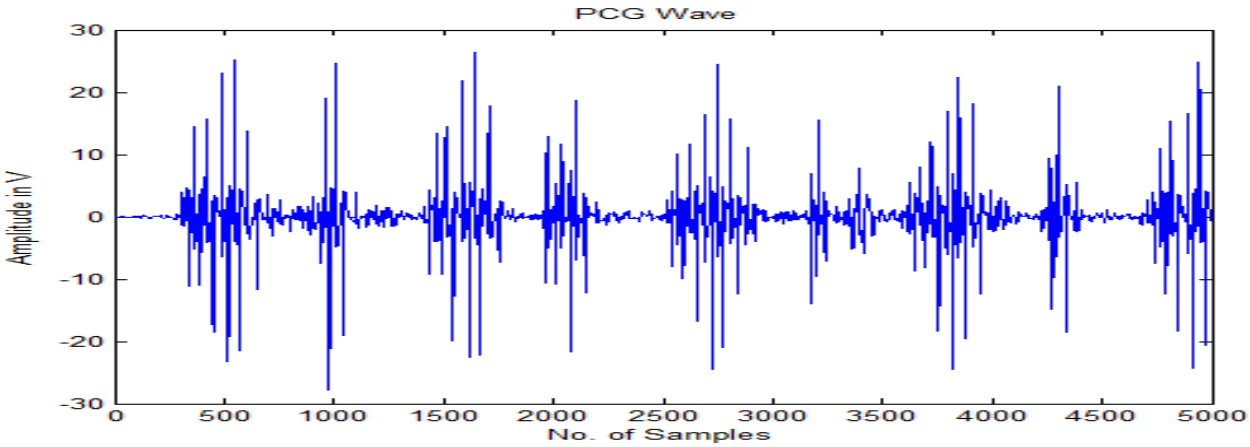
FFT Spectrum of PCG wave of Abnormal Subject 11



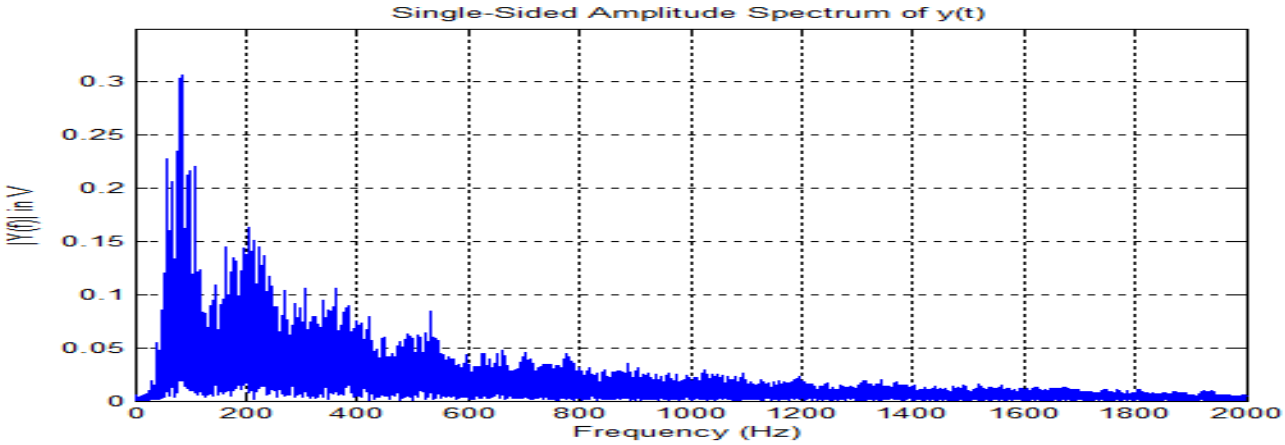
PCG wave of Abnormal Subject 11



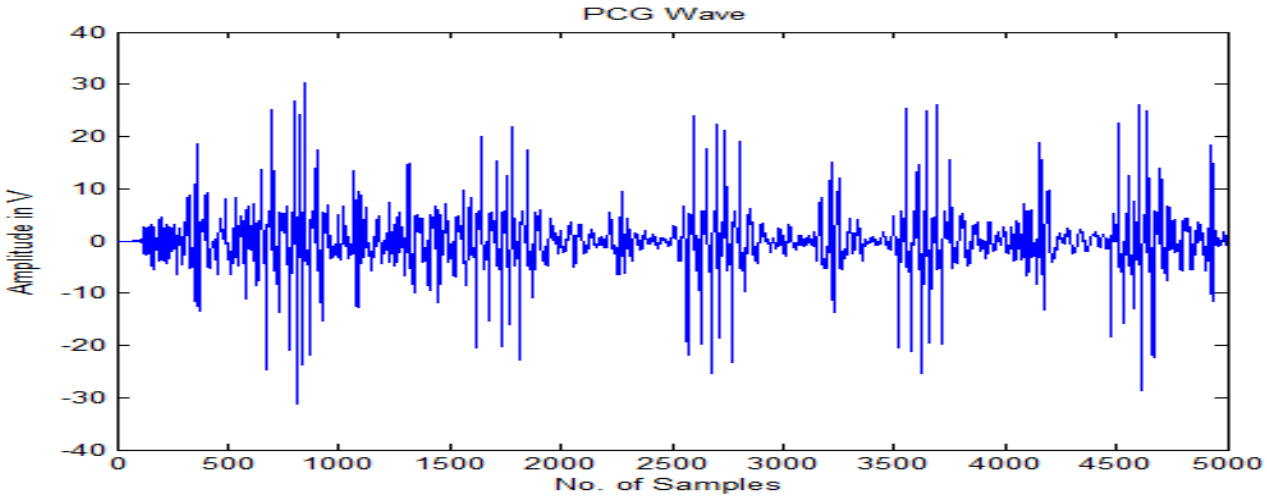
FFT Spectrum of PCG wave of Abnormal Subject 12



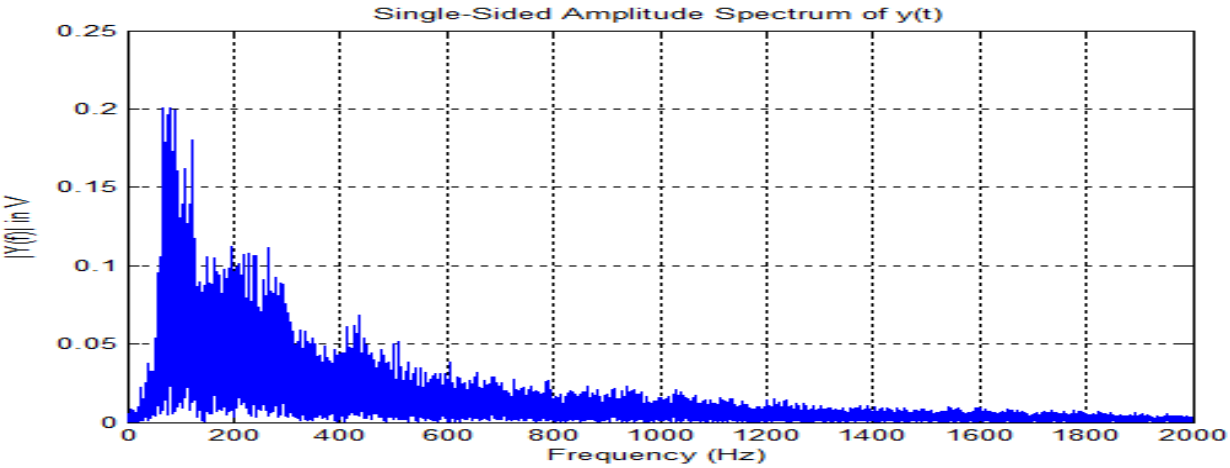
PCG wave of Abnormal Subject 12



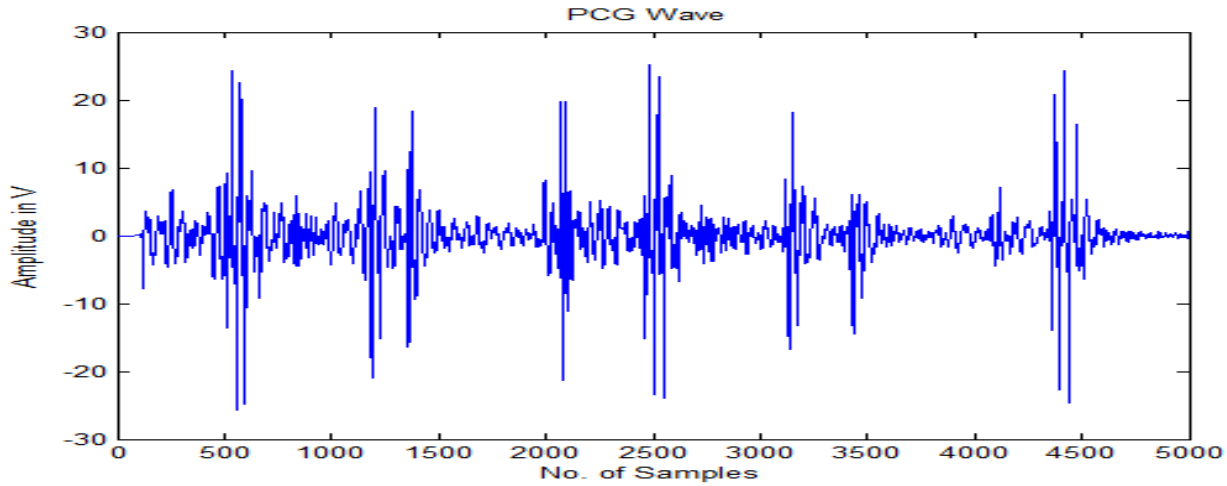
FFT Spectrum of PCG wave of Abnormal Subject 13



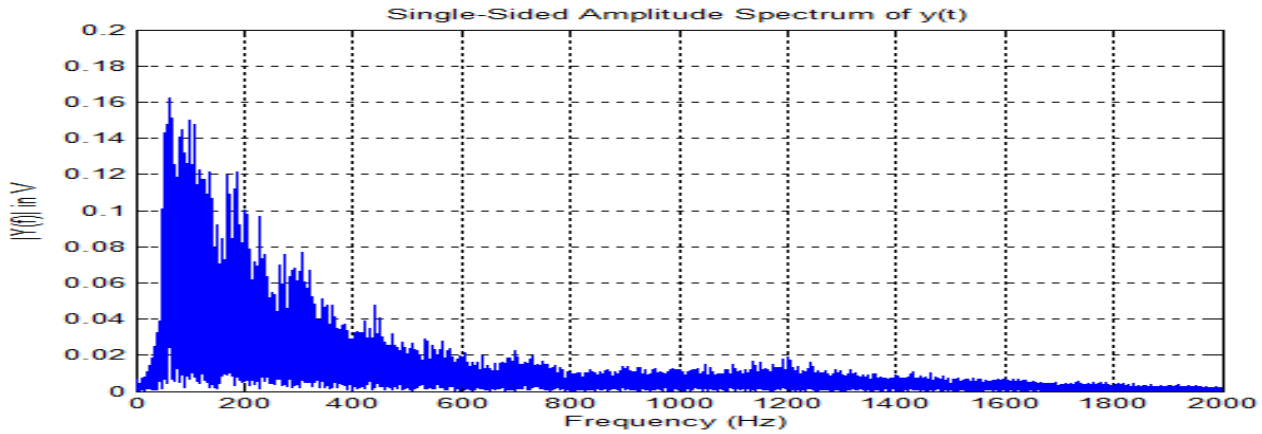
PCG wave of Abnormal Subject 13



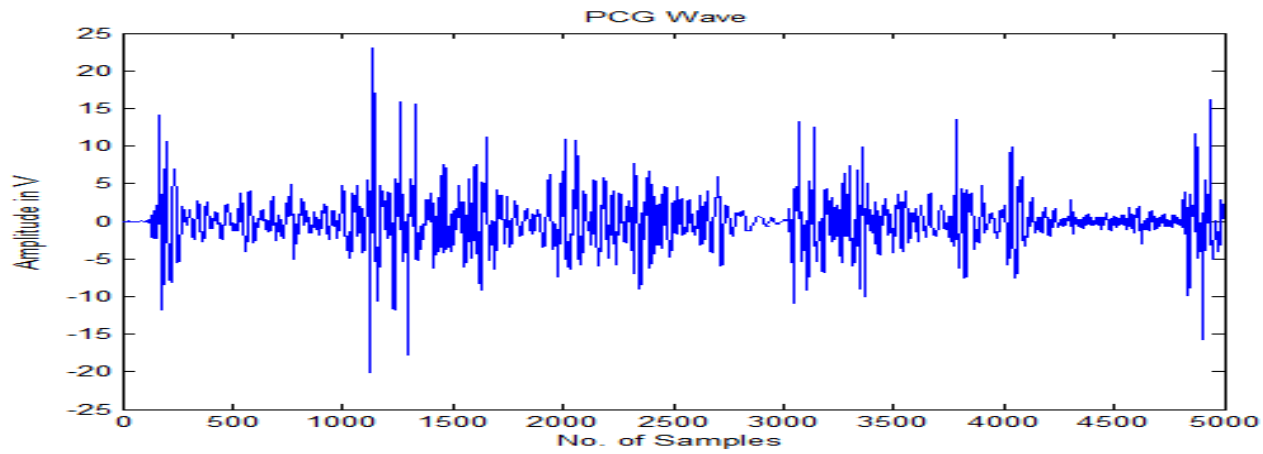
FFT Spectrum of PCG wave of Abnormal Subject 14



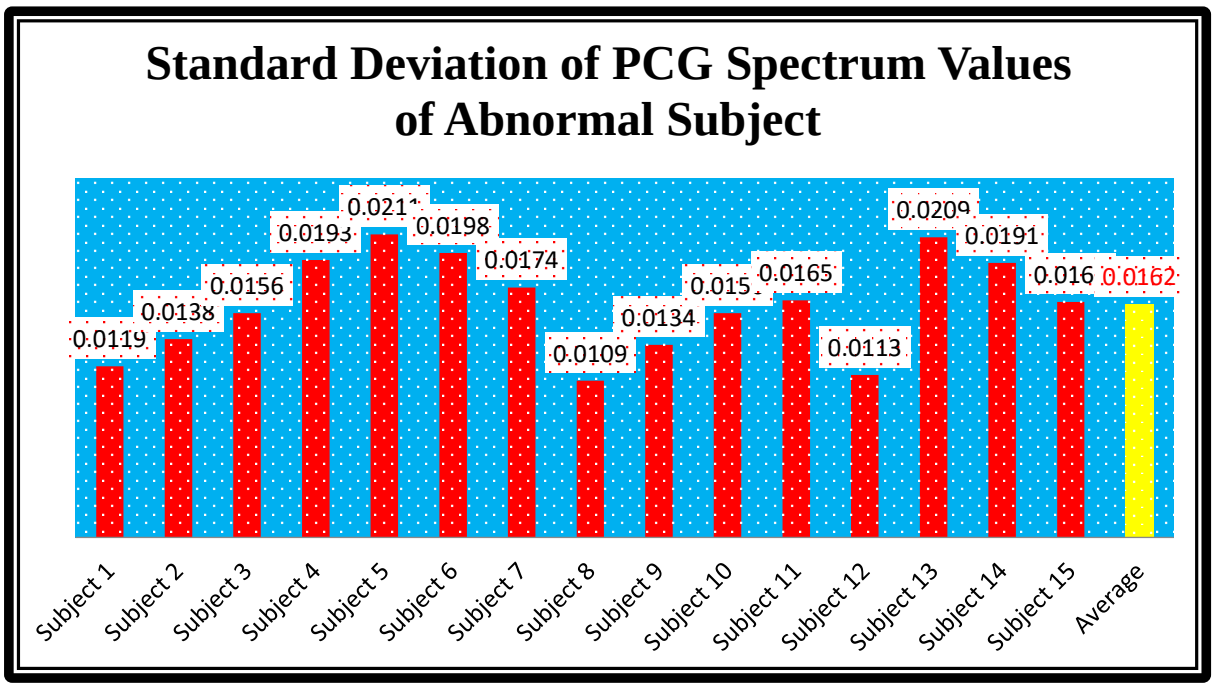
PCG wave of Abnormal Subject 14



FFT Spectrum of PCG wave of Abnormal Subject 15



PCG wave of Abnormal Subject 15



Standard Deviation of PCG Spectrum Values of Abnormal Subjects

Analysis

The normal frequency element of the PCG signals vary between 4 to 250 Hz where as if there is any heart valve related abnormality is present the frequency components goes up to 1200Hz. If frequency components of PCG Signals go above 500 Hz there is high chance heart valve related disease. In above FFT of all abnormal patients shows presence of high frequency component in FFT spectrum where as in normal subject all the frequency component is within 120 to 150 Hz. Another important observation from bar graph.It is that the average standard deviation value of PCG spectrum for normal subject is very low with respect to abnormal subject.

CHAPTER 6

CONCLUSION AND FUTURE WORK SCOPE

Conclusion

The analysis of the results (FFT spectrum and Standard deviation) clearly indicating that if we get frequency component more than 500 Hz in PCG spectrum analysis of any subject then the subject must have valvular insufficiency not only that another clear observation is that, if average value of Standard deviation of FFT spectrum of PCG signal is higher than 0.009 the subject may have heart valve disease.

Future Scope:

This system can be used to determine various heart valve problems in future. Data will be collect from patient using LABVIEW and that can be achieved by the comparison of spectrum and other statistical analysis of PCG wave of normal and diseased heart. Heart valve diseases like valvular insufficiency (also called regurgitation), or leaky valve can lead to severe medical conditions. Our future goal is to design a algorithm which can determine the **Specific** heart valve problems effortlessly.

I have got is excellent in comparison to the circuits which exist in the market. It is also low in cost than the other circuits. The audacity software we have used is easily available in the internet and the normal software which is used in PCG machine is very expensive. The software we have used has many features useful for better result and analysis of heart valve diseases.

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