IMPLEMENTATION OF A TELEMEDICINE SYSTEM FOR RURAL HEALTHCARE

Project Report submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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TABLE OF CONTENTS

DECLARATION BY THE SCHOLAR

I hereby declare that the work reported in the B-Tech thesis entitled **"IMPLEMENTATION OF A TELEMEDICINE SYSTEM FOR RURAL HEALTHCARE"** submitted at **Jaypee University of Information Technology,Waknaghat India,** is an authentic record of my work carried out under the supervision of **Dr. Sunil Datt Sharma**. I have not submitted this work elsewhere for any other degree or diploma.

Atul Tiwari Rupangi Vats Ramneet Singh

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Date: 1st May 2017

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the B-Tech project work entitled **"IMPLEMENTATION OF A TELEMEDICINE SYSTEM FOR RURAL HEALTHCARE"** submitted by **Atul Tiwari, Rupangi Vats and Ramneet Singh** at **Jaypee University of Information Technology, Waknaghat, India** is a bonafide record of his / her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.

DR. SUNIL DATT SHARMA

Assistant Professor (Senior Grade)

Date: 1st May 2017

ACKNOWLEDGEMENT

We especially thank **Dr. Sunil Datt Sharma**, our **project guide** for giving extremely valuable guidance and support throughout the course of the project. We would also like to express sincere appreciation to our **Head of Department**, **Prof. S.V.Bhooshan** for having extended all department facilities without hesitation. We thank almighty for giving us such excellent facilities and support through the way of **JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY**, for giving us the opportunity for completion of this project. We would also like to extend our heartfelt gratitude to our lab incharge Mr. Kamlesh whose constant encouragement and help and support made this project a fun-to-do activity. Last but far from least, we thank all the staff members of **Electronics and Communication Engineering Department** for their kind co-operation and timely help.

LIST OF ACRONYMS & ABBREVIATIONS

ECG	Electrocardiography
LabVIEW	Laboratory Virtual Instrument Engineering Workbench
STARPAHC	Space Technology Applied to Rural Papago Advanced Health Care
VSAT	Very small aperture terminal
ISRO	Indian Space Research Organization
ISDN	Integrated Services Digital Network
SATCOM	Satellite Communication
UWT	Undecimated Wavelet Transform
VI	Virtual Instruments
Hz	Hertz(Unit for frequency measurement)
NI DAQ	National Instruments Data Acquisition
URL	Uniform Resource Locator
mV	Milli Volts(Unit for Voltage measurement)
bpm	Beats per minute
FIR	Finite Impulse Response

LIST OF FIGURES

LIST OF GRAPHS

ABSTRACT

Medicine has always been a vital part of human existence but with the advent of technology this medicine has widened its influence with its evolution into Telemedicine. Telemedicine includes the use of communication and information technology for providing health care solutions to distant patients. With an aim to provide each and every individual quality health care services telemedicine has paved its way to rural areas. India is a country with second largest population in the world. According to the latest statistics India has 1 doctor for 2000 patients; these statistics have led to the widespread use of Telemedicine systems in India. With a greater demand of doctors and health care services these systems are gradually growing in number to provide effective health care solutions to patients. In our project, we have implemented a single channel telemedicine system for rural healthcare which measures the heart rate of the patient using ECG signal acquired from the patient. We are then processing this ECG signal in LabVIEW for noise removal and feature extraction. LabVIEW has various toolkits to process ECG signal. Specifically we are using biomedical and signal processing toolkits for this purpose. After the feature extraction we are calculating the heart rate of the patient to categorize it as bradycardia, tachycardia or normal. After the successful calculation and categorization of heart rate we attempt to send a signal to remote location using LabVIEW web publishing tool. Using this tool we have created a web page which we are displaying on the client computer by connecting to the web server created by the host computer using LabVIEW.

CHAPTER 1

INTRODUCTION

India is a fast developing country with a population of over 1 billion so one of the major concerns of its government is the health of its people. Especially when about 75% of the people are in rural areas, which makes it difficult for them to have access to proper specialized care. Also most of the time the government is unable to provide the facilities as some areas have inhospitable geographical terrain like isolated islands of Andaman and Nicobar or small villages in mountains of Himalayas. Keeping all these problems in mind the health care department of India has been on constant research for a solution.

1.1 PRESENT SCENARIO

Over the years a lot of research has been done and with the development in technologies many results have been accomplished. One such area of research has been telemedicine. Many institutes' especially biomedical engineering institutes are extensively working on this topic. Many projects have been successfully implemented. Not only government but private telemedicine providers have also come up in the past few years after its commercialization. Some of the players who are already in market are Apollo Alivector, Mediphone etc. With its large medical and IT professionals India holds a great promise to emerge as a leader in this field

1.2 MOTIVATION

In today's world where India has climbed the ladder of urbanisation and digital age there are aspects where citizens of country still face a problem in some form or the other. One such area is health care. The primary reason for lack of healthcare facilities in India are lack of quality infrastructure, dearth of qualified medical professionals, and non- access to basic medicines and medical facilities.

According to a statistical data in rural areas number of Primary health care centres (PHCs) is limited, 8% of the centres do not have doctors or medical staff, 39% do not have lab technicians and 18% PHCs do not even have a pharmacist.

Being engineers and problem solvers we have decided to come up with a solution to the rural healthcare problem. One of the serious hurdles in this problem is communication between rural and urban areas where most of the proficient medical services are available in urban areas. In an attempt to solve this problem we have implemented an Electrocardiogram (ECG) based telemedicine system for rural health care. It is an attempt to narrow the gap between the rural and urban areas by providing equal consultancy to everyone in the easiest, shortest and fastest way possible.

1.3 OBJECTIVE

In this project we have attempted to design an ECG based telemedicine system for rural healthcare. ECG is transmitted from the remote area to the specialists office before which the raw ECG signals are acquired, digitized and processed using LabVIEW for detection of heart rate. These data are transmitted using web publishing tool in LabVIEW lab to a qualified medical practitioner who can access information and advice patients.

CHAPTER 2

TELEMEDICINE

Telemedicine also referred to as e-health is a modern day technology has shortened the geographical barriers amongst people. It is a facility where a medical professional can proactively monitor its patients health across the globe by sitting in his/her own workplace. It involves technologies such as advanced computing softwares, tools and most importantly internet which has made world a global village. It reduces efforts both on doctor's and patient's part due to less amount of travel. This technology is increasingly becoming a boon for human civilization. Not only it has crossed technological barriers but it has also bridged the gap of social barriers where not only rich and wealthy are entitled for good medical services but also poor. Telemedicine also allows local practitioners to consult with their peers and with clinical experts when needed. Telemedicine further allows them to participate in grand rounds and education opportunities they would not normally have access to without travel and time away from their patients.

2.1 HISTORY

The early footprints of telemedicine go back to 1924 with the development of radio communication. But the concept truly came into existence under the project Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) by NASA in 1960s and over the years as technology as grown and moved towards artificial intelligence the concept of telemedicine was also changed and grown.

In India telemedicine was first introduced in 1997 by Apollo group of hospitals in Andhra Pradesh. They started with simple web cameras and ISDN telephone lines. Today, the village hospital has a state-of-the-art videoconferencing system and a VSAT (Very Small Aperture Terminal) satellite installed by ISRO (Indian Space Research Organization). Not only this since the year 1999 ISRO has been developing a SATCOM-based telemedicine network across the country.

2.2 APPLICATION OF TELEMEDICINE

There are many applications of the telemedicine systems. Some of them are:-

A. Rural Health:

One of the challenges of telemedicine is to provide “on time” medical solutions to rural people who do not have medical facilities at their doorstep. To bridge the gap between different geographical locations various technologies have evolved ever since making our lives much easier and smoother. In support to the above application of telemedicine various technologies such as video chats from remote locations , internet based health care platforms , educating rural people about the use and benefits of these technologies have evolves and has been evolving ever since.

B. School-Based Health Centers:

School-based telemedicine system has achieved a great milestone in making our future generations healthy. Telemedicine helps manage chronic conditions for such as asthma, diabetes and obesity. The telemedicine allows school authorities to remotely access expert medical opinion for students that need it. This enables to eradicate one more social cause of “absenteeism” by enabling students to minimize getting absent from their classes due to medical reasons.

C. Mobile Health Clinics:

Telemedicine based rural healthcare system has been given new dimension by the introduction of Mobile Health Clinics. In this technology doctor proactively manages its patients using smart phones. Many applications have been developed in this regard. The user interface of the app combines all the modern day communication features such as chats, video chats, instant-messaging, booking appointments, recording various healthcare parameters such as blood pressure, heart rate, etc. In this regard soon mobile health clinics will replace the physical clinics with doctors.

D. Disaster Relief:

Some things are beyond the control of humans. Disasters are one such thing where loss of life and property is huge and irreversible. Though since the onset of technological era humans have developed many such technologies but then also these instruments fail to deliver 100% accurate results, It is due to this reason that we must be prepared for emergency and post disaster mitigation techniques. One such technique is using telemedicine system in places of disaster. This will not only enable doctor’s to see disaster struck victims from anywhere in the world but also increase the rate at which people are been looked upon thus decreasing the mortality rates due to accidents.

CHAPTER 3

ELECROCARDIOGRAPHY

Electrocardiography (ECG) is a test that is used to study the patient's heart. It monitors the electrical and muscular activity of the heart. ECG is performed by placing electrodes on the patient's body. These electrodes generate voltage deflection which is recorded by the machine after it has been amplified by the instrumental amplifier. It is represented in form of a graph plotted using the acquired data points. This graph is then analyzed by the doctor for diagnostics. The ECG signal is mainly used to calculate the heart rate and also various other parameters such as the abnormality in the size of the heart etc.

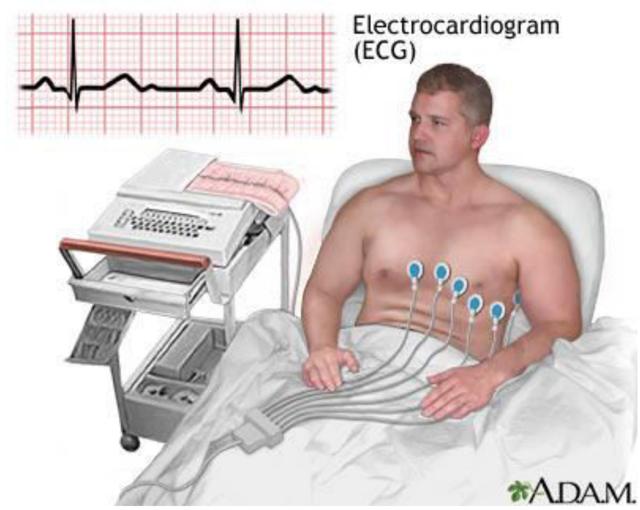


Figure3.1 Placing of Electrodes

Through ECG analysis we can find:

- The cause of unexplained chest pain or pressure.
- The cause of symptoms of heart diseases.
- Thickness of the walls of the chamber
- Effects of other diseases on the heart

Figure3.2 An ECG Signal

As we are using ECG signal to calculate heart rate and we need to study various components of the ECG signal waveform which are:

1. P wave: It is the first positive deflection on the ECG and represents atrial depolarization.
2. R wave: It is the first upward deflection after the P wave and represents early ventricular depolarization
3. Q wave: A Q wave is any negative deflection that precedes an R wave

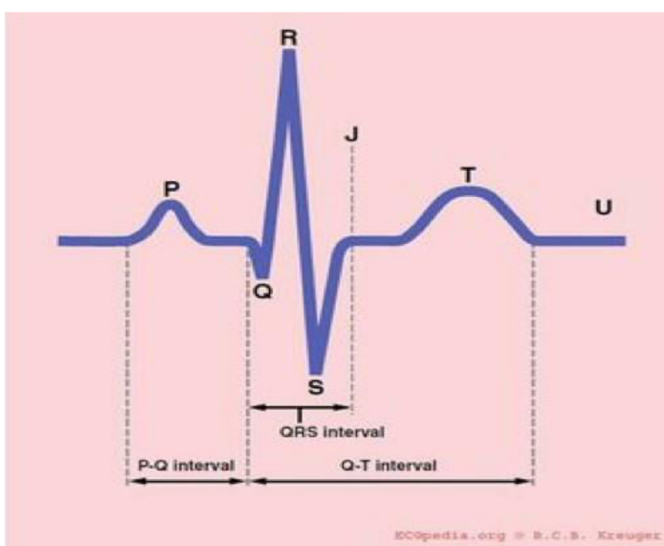


Figure3.3 Components of ECG signal

1. We use **frequency of QRS complex range to** measure ventricular rate. [2]
2. The Q, R, and S waves occur in rapid succession.[2]

3.1 METHODOLOGY OF HEART RATE CALCULATION

An approximate estimation of the heart rate (HR) can be made from an ECG recording. For this we calculate the distance between the R-R peaks of the ECG signal. To calculate the distance between R-R peaks we have used various tools for LabVIEW toolkit.

After calculating the distance between the R-R peaks we have divided this distance by 60 to calculate the heart rate.

FORMULA FOR HEART RATE CALCULATION

Heart Rate (HR) = 60/(R-R interval)

3.2 CATEGORIZATION OF HEART-RATE

- **Normal(** heart beat greater than 60 but less than 100 times a minute**)**
- **Bradycardia(** heart beat less than 60 times a minute**)**
- **Tachycardia(** heart beat greater than 100 times a minute**)**

CHAPTER 4

LABVIEW SOFTWARE

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a software designed by National Instruments which provides a platform for system design and a visual programming environment.

LabVIEW is an integrated development environment designed specifically for engineers and scientists building measurement and control systems. It has features that are required to build the optimal solution that can meet custom requirements and solve the challenges at hand. Some those features that make it such unique software are:

- a native graphical programming language
- built-in IP for data analysis and signal processing
- an open architecture enabling integration of any hardware device and any software

Figure4.1 Logo of the LabVIEW software

4.1 HISTORY

NI LabVIEW is a simple software which allows interface with measurement hardware. Originally it was released only for Apple Macintosh in 1986 with the idea to revolutionise the measurement and automation industry. It brought forward the concept of virtual instrumentation which provided scientists and engineers a platform to customize measurement system to suit their needs. After 1992 it was made available for other Operating Systems such as Windows, LINUX, etc. Since then it has under gone many up gradations. The latest version in use now a day is LabVIEW 2016 which was released in 2016.

4.2 APPLICATIONS

LabVIEW is one such software that truly has a wide range of applications some of them are:-

- Acquiring data and processing signals
- Instrument /control
- Automating test and Validation System
- Embedded monitoring and controlling
- Academic Learning

Among all the benefits of the software some of the important ones are:

- Interfacing to devices.
- Code compiling
- Large Libraries
- Parallel Programming

4.3 FEATURES

4.3.1 WINDOWS

There are two types of windows in LabVIEW:

4.3.1.1 FRONT PANEL WINDOW

When we open a new or existing VI the front panel window opens. It is the user interface for the VI. It contains the output components such as indicators, graph display window, value display boxes, etc.

The components of front panel can be categorized into controls and indicators. Controls represent the inputs to the VIs and are used to provide data to the block diagram, where as indicators represent the outputs from the VIs, used to display the data the block diagram generates.

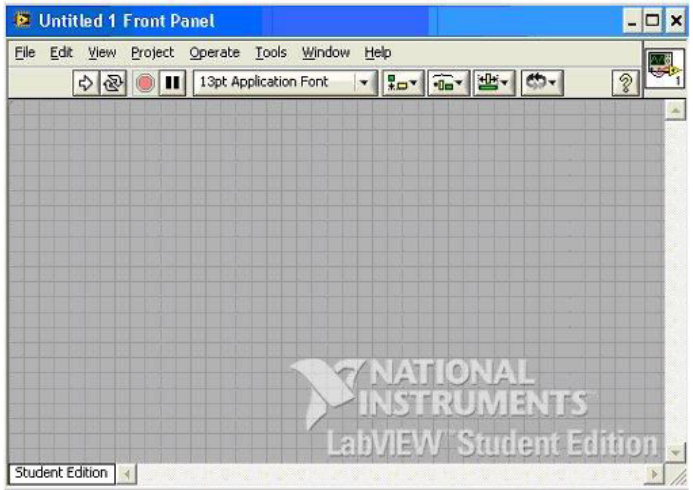


Figure 4.2 Front Panel Window

4.3.1.2 BLOCK DIAGRAM WINDOW

Block diagram window contains icons, functions and other LabVIEW objects. All the programming components are available in block diagram window. It contains the graphical source code. This is workspace in LabVIEW where all the programs are implemented.

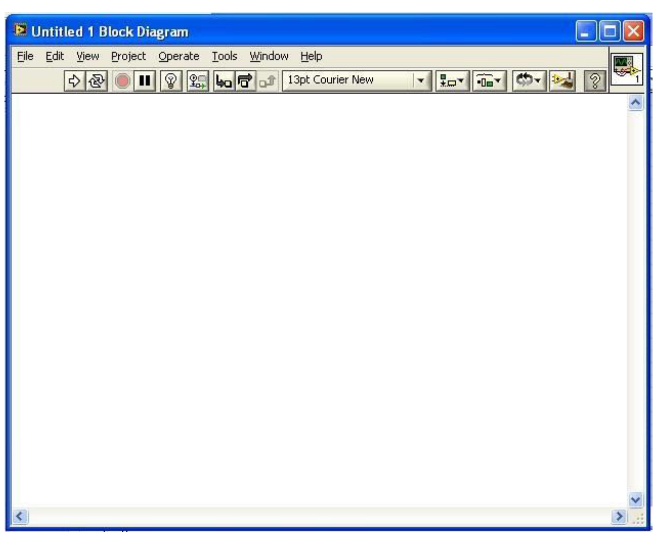


Figure 4.3 Block Diagram Window

4.3.2 PALETTES

4.3.2.1 CONTROL PALETTE

The control palette is used to create all the indicators and controls in the front panel. It can be accessed by right clicking on the panel or from view option on menu bar. All the controls and the indicators are divided into categories as shown in the figure bellow.

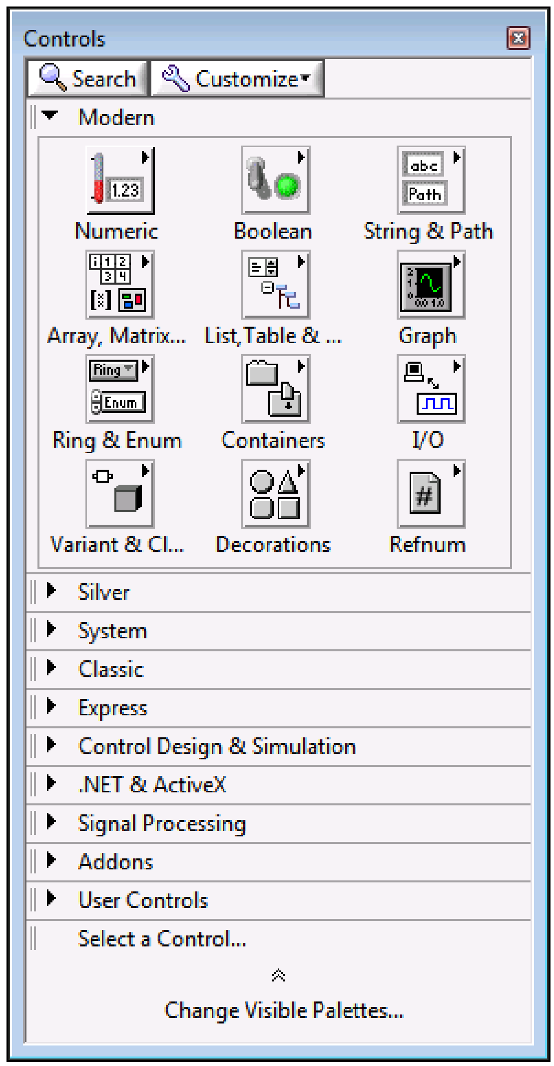


Figure 4.4 Control Palette

4.3.2.2 FUNCTION PALETTE

The function contains all the VIs, sub VIs and function required to design block diagram. They are divided into categories according to their uses and functionality. We can access it by right clicking on the block diagram window or from View o the menu bar.

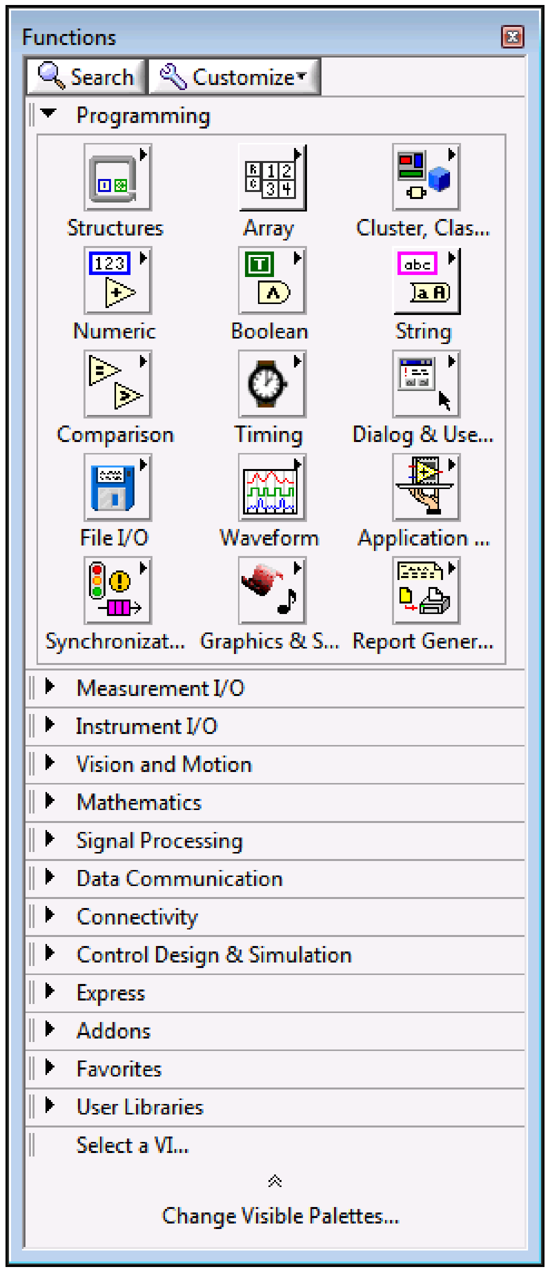


Figure 4.5 The function Palette

CHAPTER 5

IMPLEMENTATION

To implement the Telemedicine System we have divided the process into three different steps which are as follows

5.1 DATA ACQUISITION SYSTEM

For acquiring ECG data we have used an Express VI called Simulate ECG which is available from Biomedical Toolkit and we have added noise to the ECG signal by configuring Simulate ECG ExpressVI.

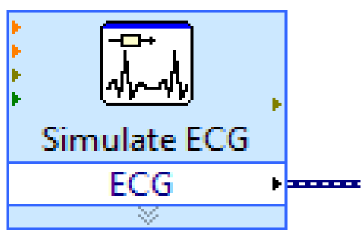


Figure 5.1 Simulate ECG Express VI

Basic Configuration of Simulate ECG Express VI to simulate ECG signal are as follows:-

- **White noise amplitude**
  This VI adds white noise (in millivolts) to the simulated ECG signal and by changing this parameter we can change the amplitude of the noise added. Value of this parameter should be greater than or equal to zero. We have taken this parameter as 0.22mV.

- **Sampling rate**

  Sampling rate (in hertz) of the simulated ECG signal is decided by this parameter and it should be in between 10 and 1000. We have taken this parameter as 512 Hz.

- **Heart Rate**

  Heart rate (in beats per minute) of the simulated ECG signal is set by using this parameter and value of this parameter should be greater than 10 and less than 300. We have taken this parameter as 70bpm.

- **Signal type**

  There are various ECG signals that can be simulated using "Simulate ECG Express VI" such as Hyperkalemia, Atrial Tachycardia, Normal etc..The signal type which we have used is Normal here.

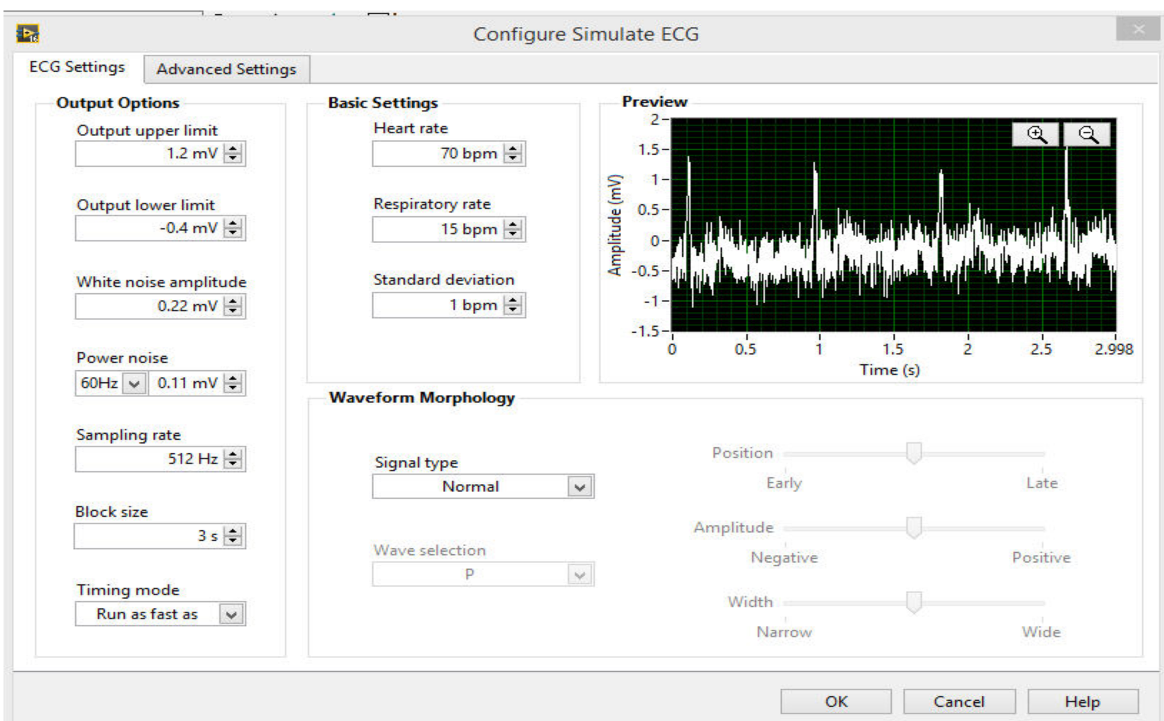


Figure 5.2 Configuration of Simulate ECG Express VI

5.2 PROCESSING ECG SIGNAL

Now the noise is removed from the simulated ECG signal, Simulated ECG signal is fed as an input to the Highpass digital filter, where the baseline wandering is removed and output of the filter is given as the input to the Wavelet Denoise Tool, which removes the wideband noise here. The raw ECG signal contains various kinds of noises which need to be filtered before analysis of the signal for any medical purposes. Some of these noises are:

a. Power line interference**-** The power line interference is a narrow-band noise centered at 60 Hz (or 50 Hz) with a bandwidth of less than 1 Hz. Usually the ECG signal acquisition hardware can remove the power line interference but it can also be removed using a digital notch filter.

Contact noise – It is causes due the difference in the position of the electrode and the heart and can cause sudden changes in the amplitude of the

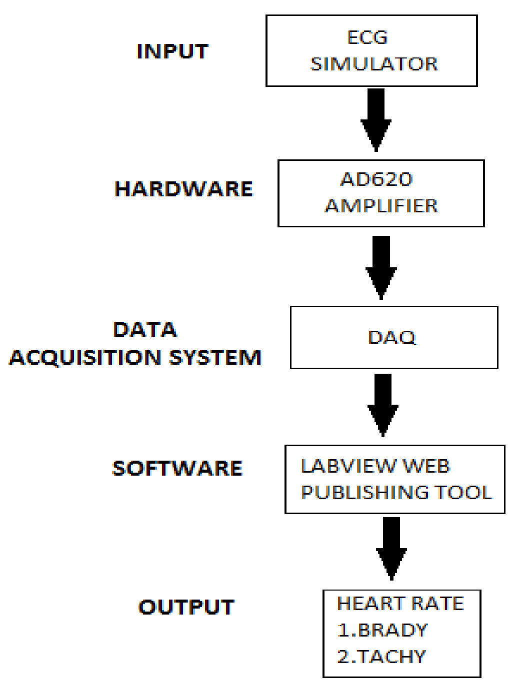


Figure5.3 Block Diagram of Telemedicine System

b. Signal and low frequency baseline shifts. [5]

c. Base line wandering- It usually comes from respiration at frequencies between 0.15 and 0.3 Hz, and can be suppressed by using any of the two techniques mentioned below

- Digital filter- We use a FIR high pass filter in order to remove base line wanders. This filter can be designed in LabVIEW by using the filter VI present under Signal Processing Toolkit.

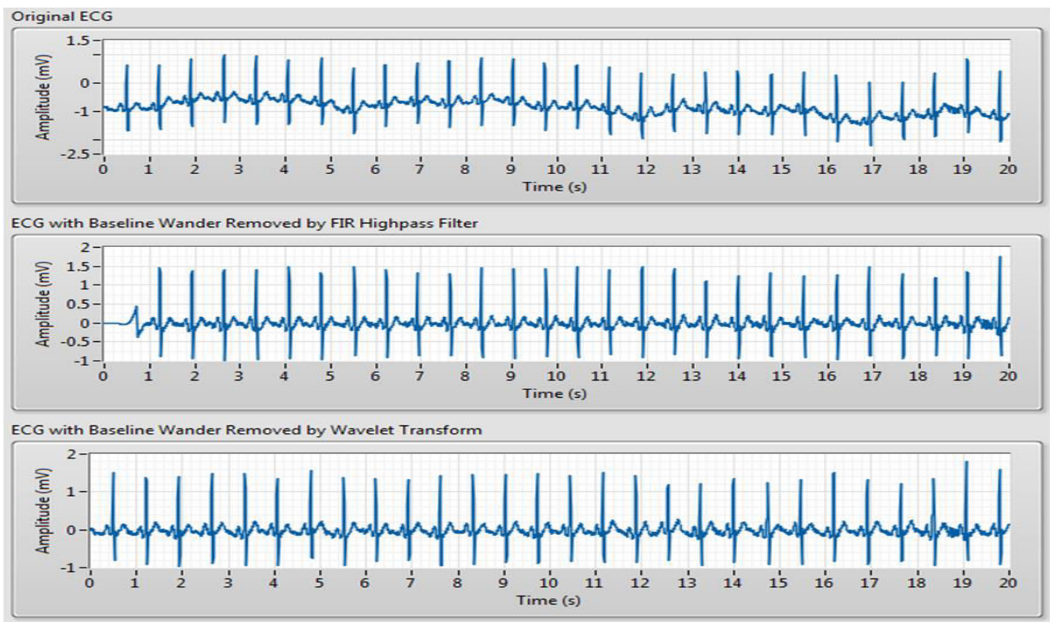


Figure 5.4: Comparing the digital filter-based and wavelet transform-based approaches

- Wavelet transform- We use db6 i.e. the Daubechies6 wavelet as it quiet similar to the ECG signal.

After removing baseline wandering, the resulting ECG signal is more stationary and explicit than the original signal. However, some other types of noise might still affect features of the ECG signal. These noises may be complex, so we cannot remove them by using traditional digital filters so to remove the wideband noises; we use the Wavelet Denoise Express VI. In this we use Undecimated Wavelet Transform (UWT) as it provides more accuracy and smoothness.

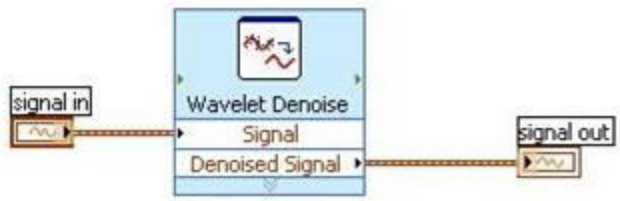


Figure5.5: Wavelet Denoising VI

The filtered ECG is differentiated and squared to enhance the high frequency R-waves present and the peaks are then smoothened using moving window integrator which is essential to avoid multiple counting. [1]

5.2.1 BIOSIGNAL FILTERING VI (Waveform Classical Filter)

Baseline wandering in the simulated ECG signal is present at low frequencies (due to respiration) so in order to remove that noise we have used Biosignal Filtering VI. This VI is available in LabVIEW Biomedical toolkit under biosignal measurements in the biosignal pre-processing palette.

We have designed a Kaiser Window FIR highpass filter using this VI to remove the baseline wandering.

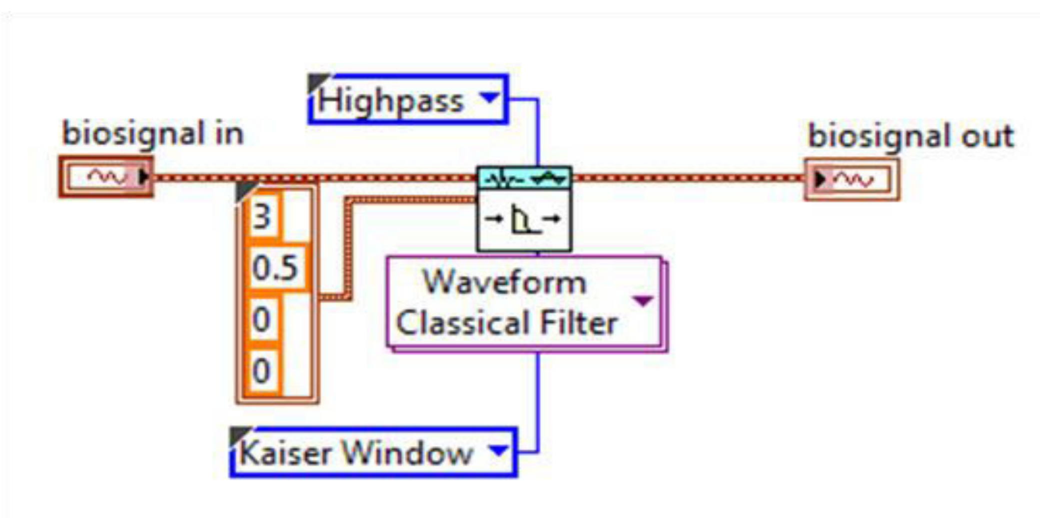


Figure5.6: Designing a highpass filter for removal of baseline wandering

Basic Configuration of Waveform classical filter is as follows

Filter type: It can be lowpass, highpass, bandpass or bandstop, we need to design a highpass filter so we have selected highpass.

Biosignal in: This parameter here specifies the simulated ECG signal coming in to the filter

Freq specs: This parameter specifies the frequency specification of highpass filter

Fpass 1: This describes the first passband edge frequency (in hertz) and we have selected value of this parameter as 3**.**

Fstop 1: This describes the second stopband edge frequency (in hertz) and we have selected value of this parameter as 0.

Design method: There are a number of methods to design a filter such as Chebyshev, Butterworth, Kaiser Window, etc. We have chosen Kaiser Window to design the filter.

Biosignal out: This returns the filtered ECG signal.

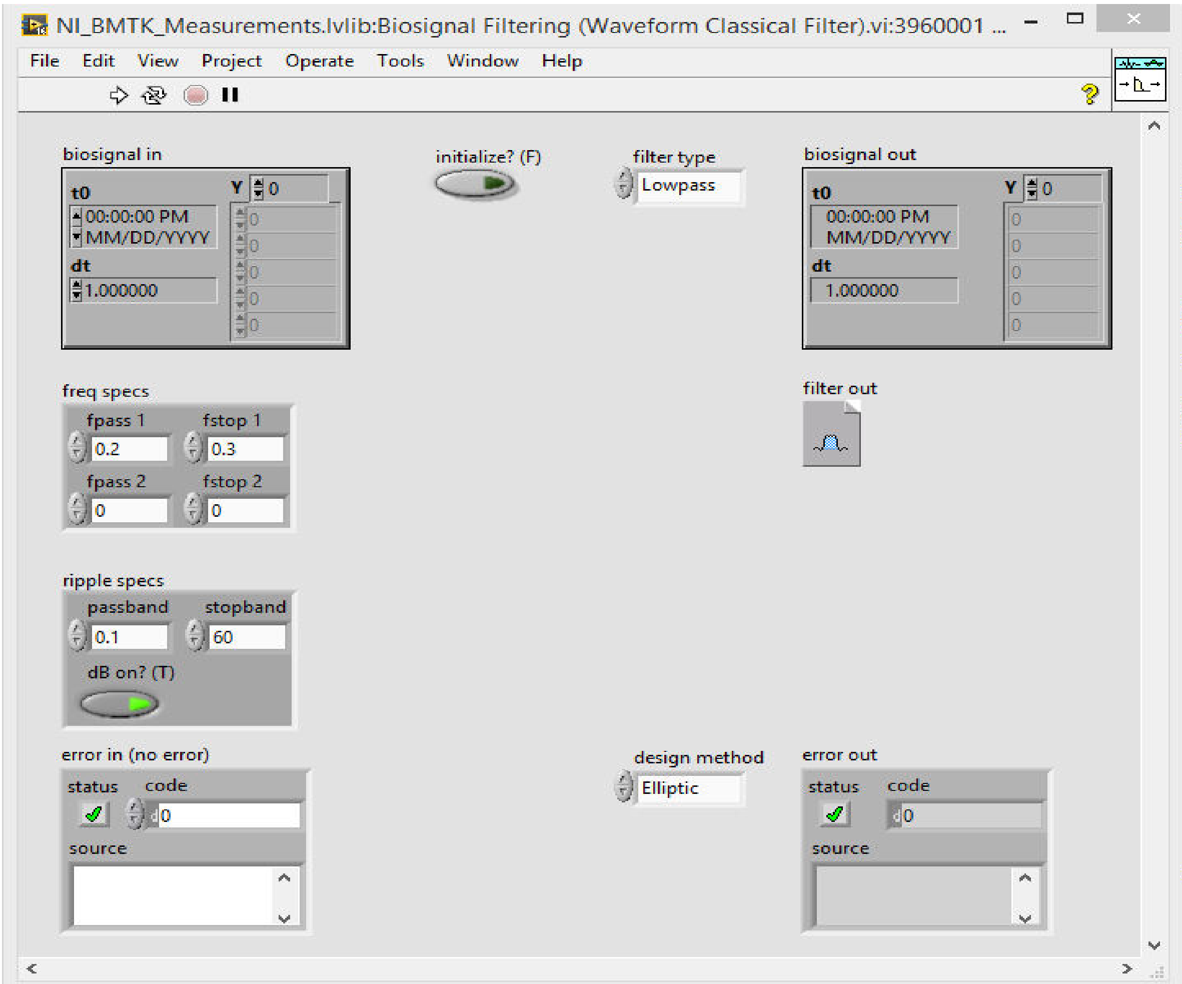


Figure 5.7 Configuration of Biosignal filtering VI(Waveform classical filter)

5.2.2 WAVELET DENOISE EXPRESS VI

After removing baseline wandering through highpass filter some other types of noise still may be present in the ECG signal. The noise may be present in the form of wideband and may be complex which cannot be filtered out using digital filters, so to remove wideband noise we are using wavelet denoise Express VI.

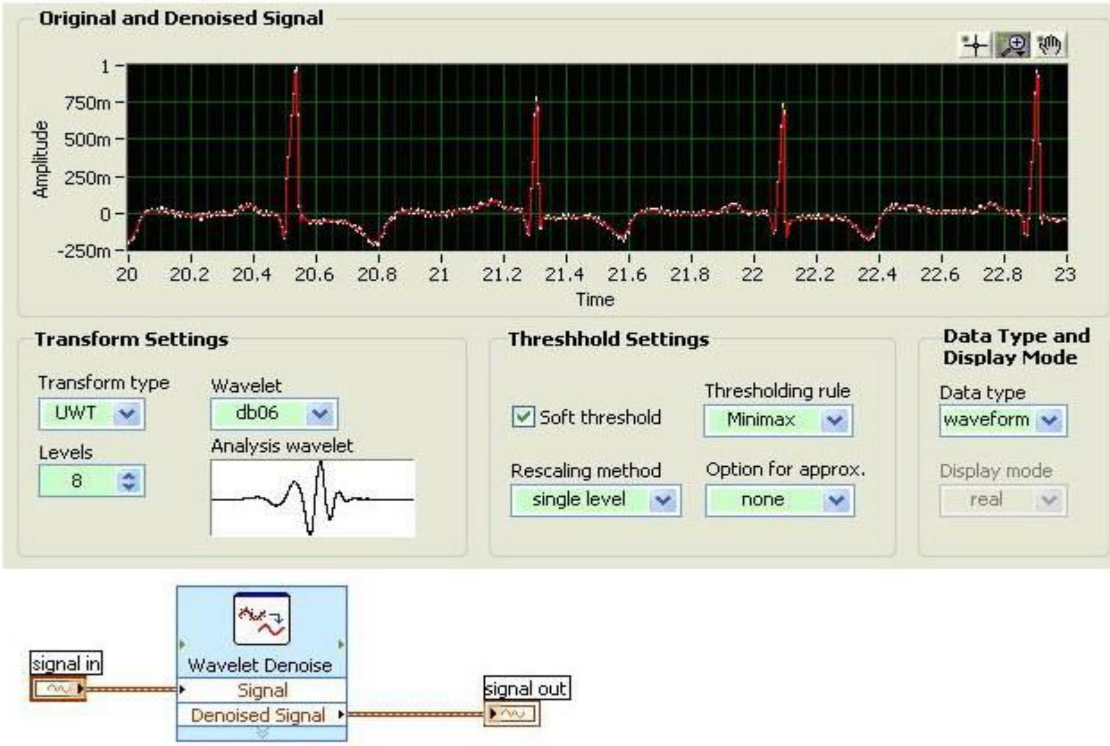


Figure 5.8 Wavelet denoise Express VI Configuration.

5.2.3 COLLECTOR EXPRESS VI

This Express VI collects input signal and returns the most recent samples collected upto the number of samples configured.

We have selected maximum number of samples as 15000.

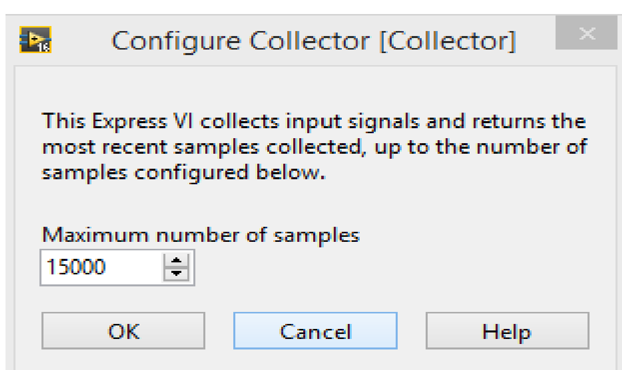


Figure 5.9 Configuration of Collector Express VI

5.2.4 STATISTICS EXPRESS VI

This VI is used to detect various features of the waveform for e.g.

- statistical calculations
- extreme values
- sampling characteristics.

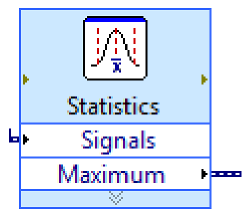


Figure 5.10 Statistics Express VI

We have measured maximum value of the waveform from extreme values.

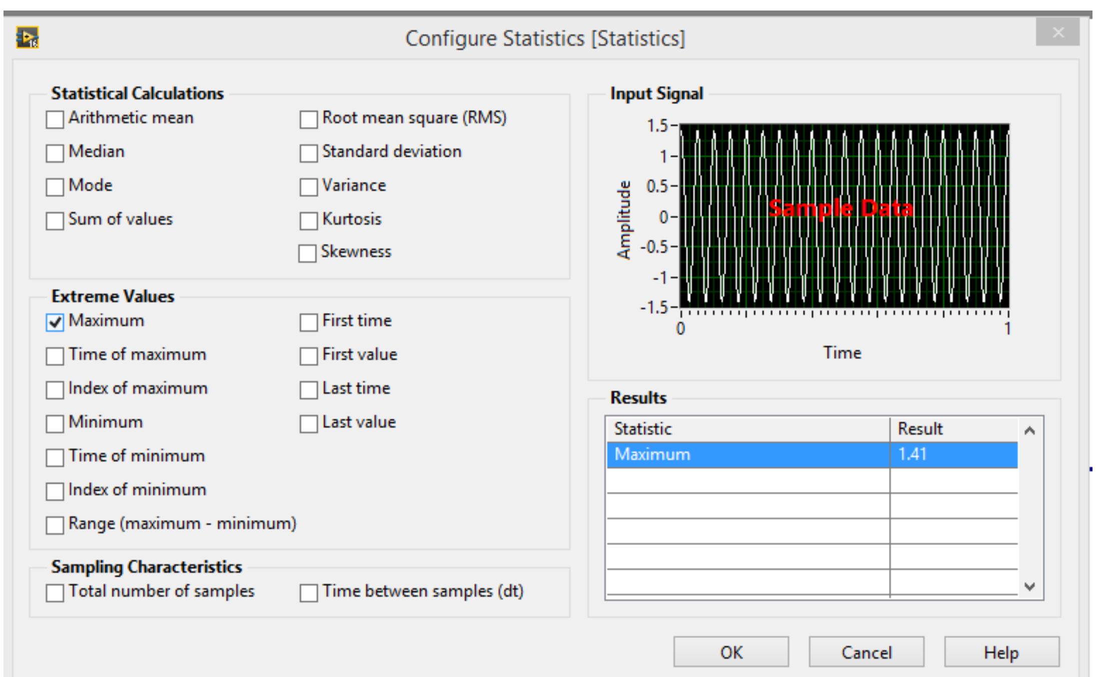


Figure 5.11 Configurations Of Statistics Express VI

5.2.5 PEAK DETECTOR VI

This VI is used to detect the peaks or valleys in a given waveform. We have measured peaks for detection of R-R peak signals.

Configuration:-

- **Threshold**

  0.0

- **Width**

  3

- **Peaks/Valleys**

  Peaks

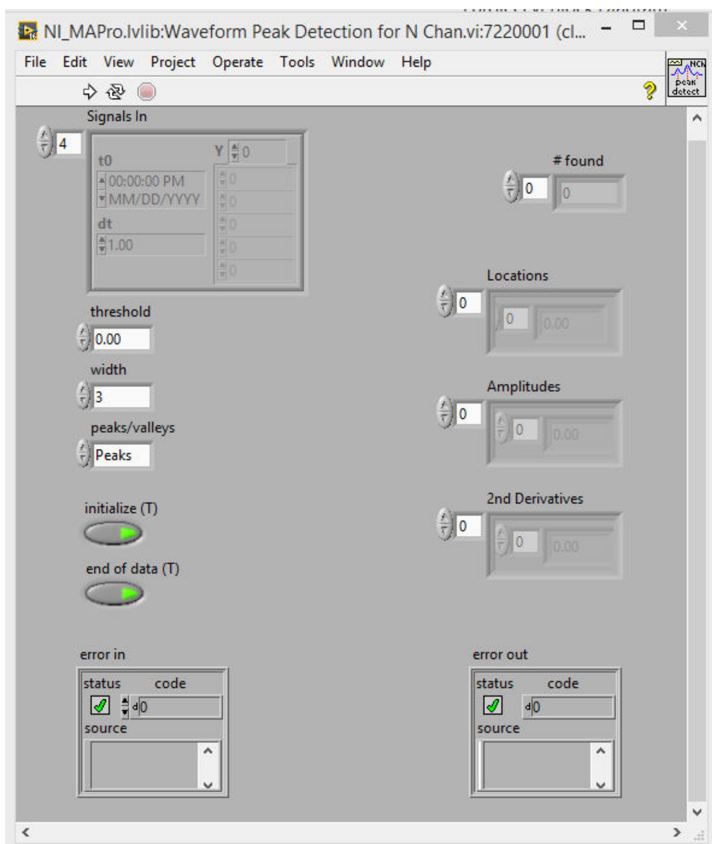


Figure 5.12 Configuration of Peak Detector VI

5.2.6 CONVERT TO DYNAMIC DATA EXPRESS VI

Converts dynamic data into desired data types such as Numeric, Boolean, Waveform and arrays for its use in other VI's.

Configuration:-

- **Input Data Type**

  1D array of scalars - single channel

- **Scalar Data Type**

  Floating point numbers (double).

- **Start Time**

  Now

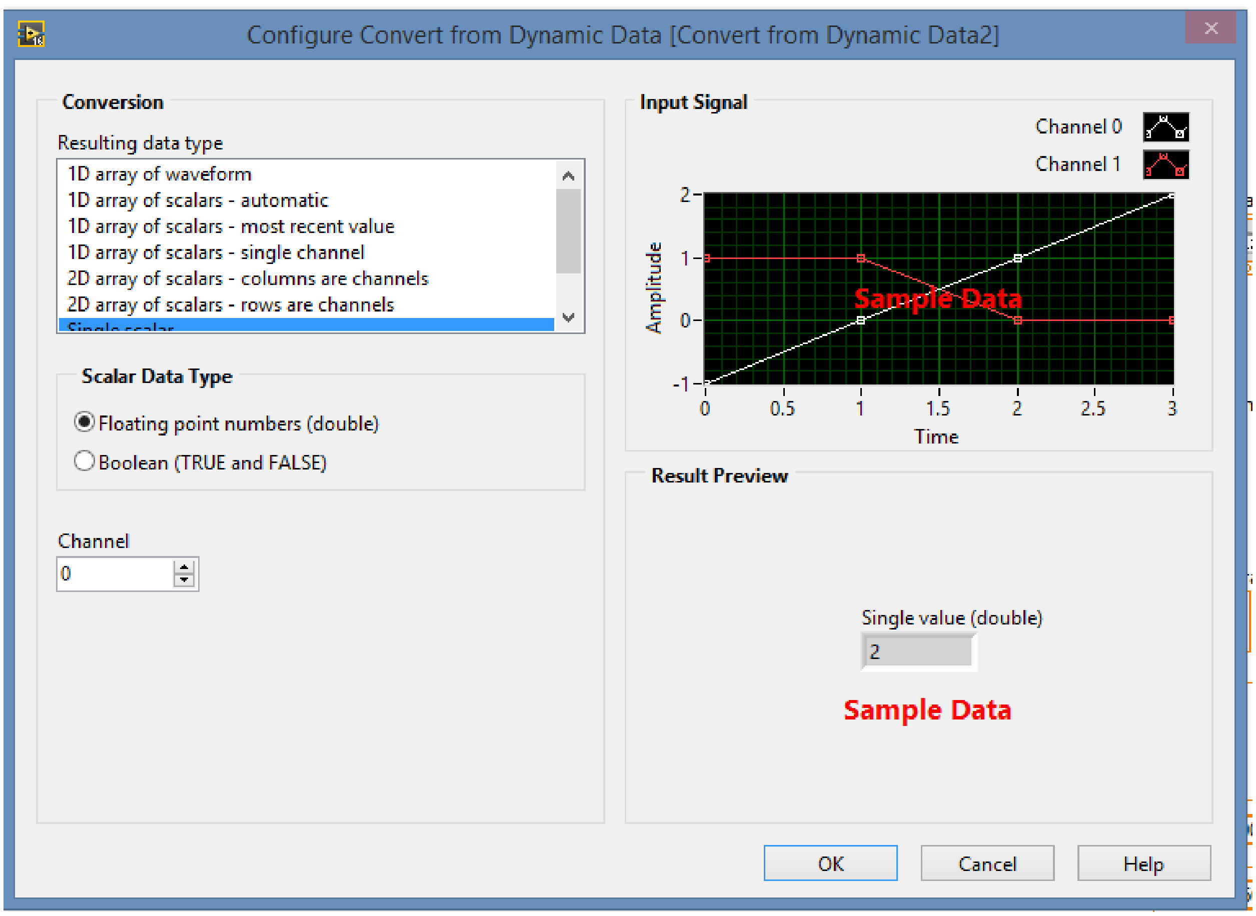


Figure 5.13 Configuration of Convert from Dynamic Data

5.2.7 CONVERT FROM DYNAMIC DATA

Converts dynamic data into desired data types such as Numeric, Boolean, Waveform and arrays for its use in other VI's.

Configuration:-

Resulting Data Type

Single scalar

Scalar Data Type

Floating point numbers (double)

Signal Value (Double)

2

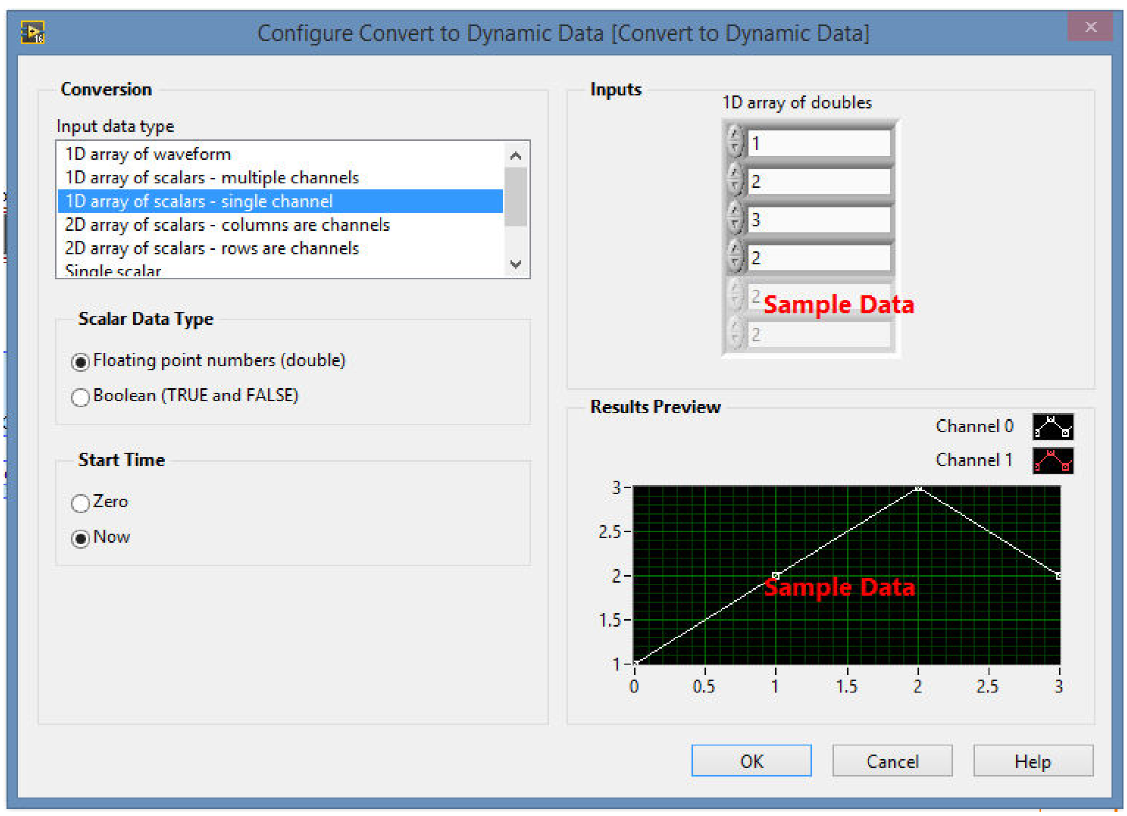


Figure 5.14 Configuration of Convert to dynamic data

5.2.8 MATHEMATICAL BLOCKS

- **Division**

  It is used to divide signal values by a specified constant.

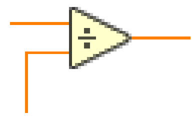


Figure 5.15 Division Operator

- **Multiplication**

  It is used to divide signal values by a specified constant.

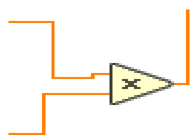


Figure 5.16 Multiplier`

5.2.9 RELATIONAL BLOCKS

- **Greater than**

  It is used to check weather a given value is greater than a certain constant. It returns a Boolean value.

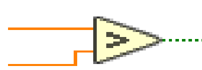


Figure 5.17 Greater than operator

- **Less than equal to**

  It is used to check weather a given value is less than or equal to a certain constant.

  It returns a Boolean value.

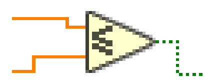


Figure 5.18 Less than or equal to operator

- **Greater than equal to**

  It is used to check weather a given value is greater than or equal to a certain constant.

  It returns a Boolean value.

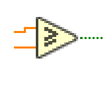


Figure 5.19 Greater than or equal to operator

- **Logical AND**

  It returns the logical and. It returns a Boolean value.

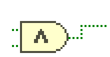


Figure 5.20 Logical AND gate

Table 5.1 Truth Table for Logical AND

A	B	RESULT
0	0	0
0	1	0
1	0	0
1	1	1

- **Equals to**

  It is used to check weather a given value is equal to a certain constant. It returns a Boolean value.

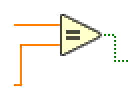


Figure 5.21 Equals operator

Basic configuration of ExpressVI

1. **Transform settings**

   Transform type: We have selected transform type as UWT

   Wavelet: we have selected db06.

   Levels: we have selected the value 8.

2. **Threshold settings**

   We have checked the soft threshold box.

   Threshold holding rule is set to minimax

   Rescaling method is set to single level

   Option for approximation is set to none

3. Data type and display mode

Data type is set to waveform.

5.3 WEB PUBLISHING TOOL

This tool is used to embed VI front panel generated images and create HTML documents. The front window with the resultant waveforms, heart rate and indicators is send to the client computer via LabVIEW web publishing tool.

We have followed the following procedure to create LabVIEW web server and start it to display the HTML page:-

- First go to Tools in the menu bar then select option from the dropdown menu.
- A window will pop up; now select web servers from the category.
- Then check on allow access under visible VI and allow viewing and controlling under browser access, then click on OK.
- Now again go to Tools in the menu bar and select web publishing tool in the dropdown menu.
- A window will pop up.

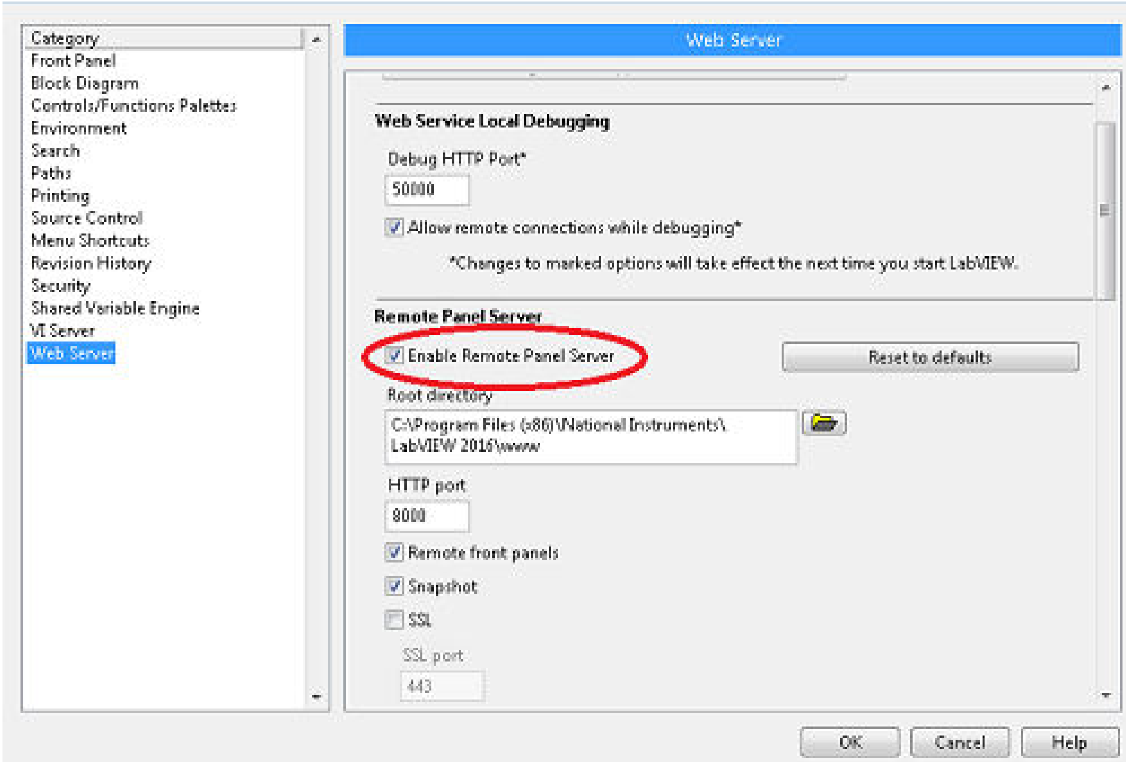


Figure 5.22 Web Server

- Now select the VI that is to be shared on the client computer in the VI name.
- Viewing mode can be embedded, snapshot or monitor. We select embedded.
- Now click on next to select the html output, enter the document title and HTML content for the web page, then click on next.
- After this click on save to disk.
- A pop up will appear showing the Url of the HTML page created.
- Now click on connect to start the service.
- On the client computer paste the same Url to control the front panel.
- Note that supported browser is Internet explorer.

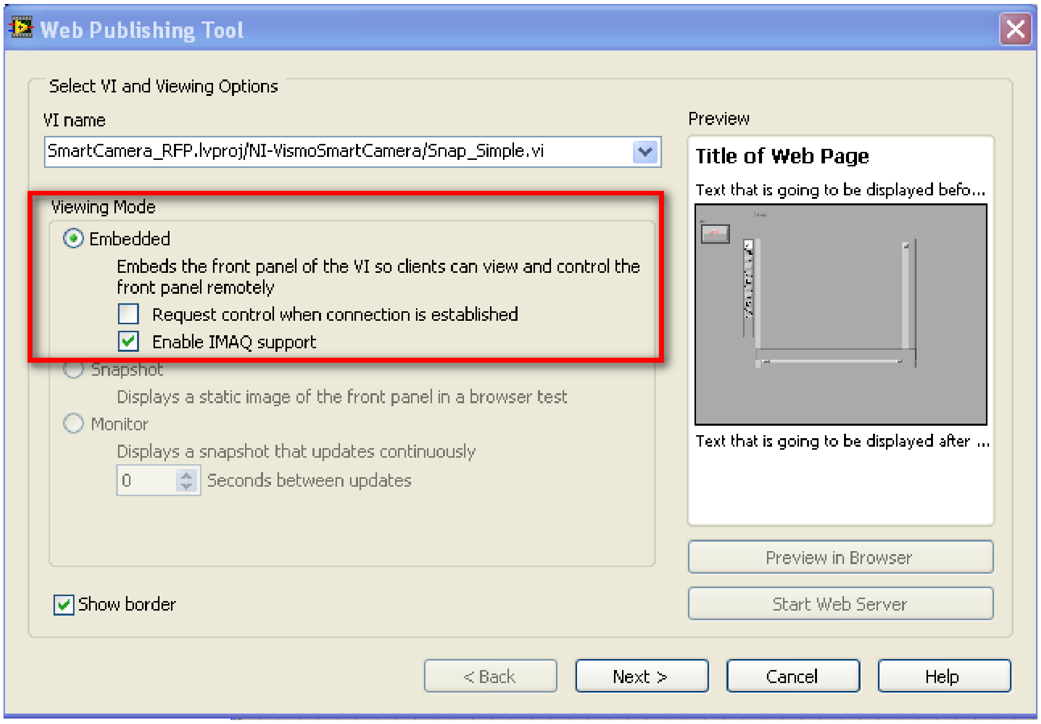


Figure 5.23 Web Publishing Tool

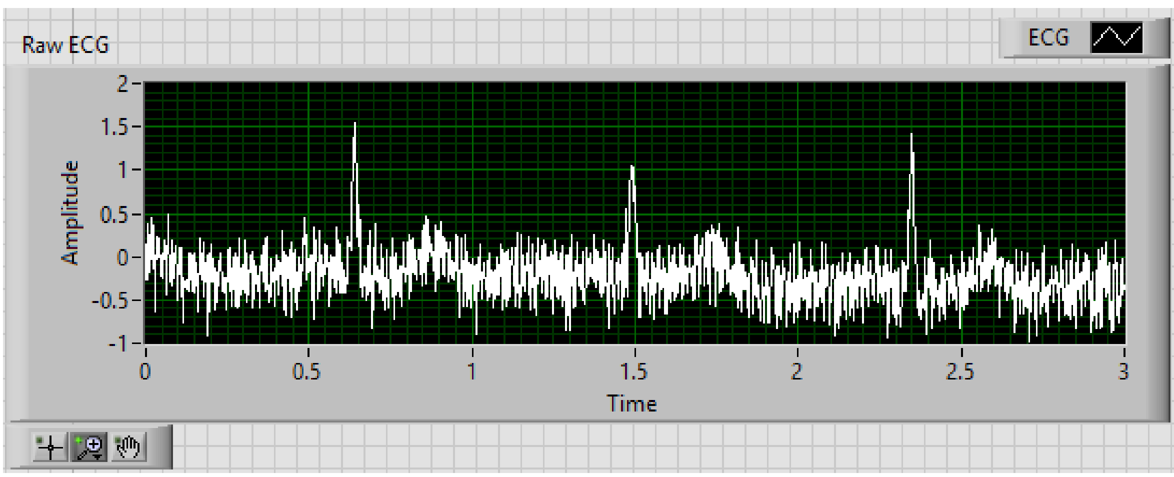
CHAPTER 6

RESULT

6.1 GRAPHS

6.1.1 Raw ECG signal acquisition

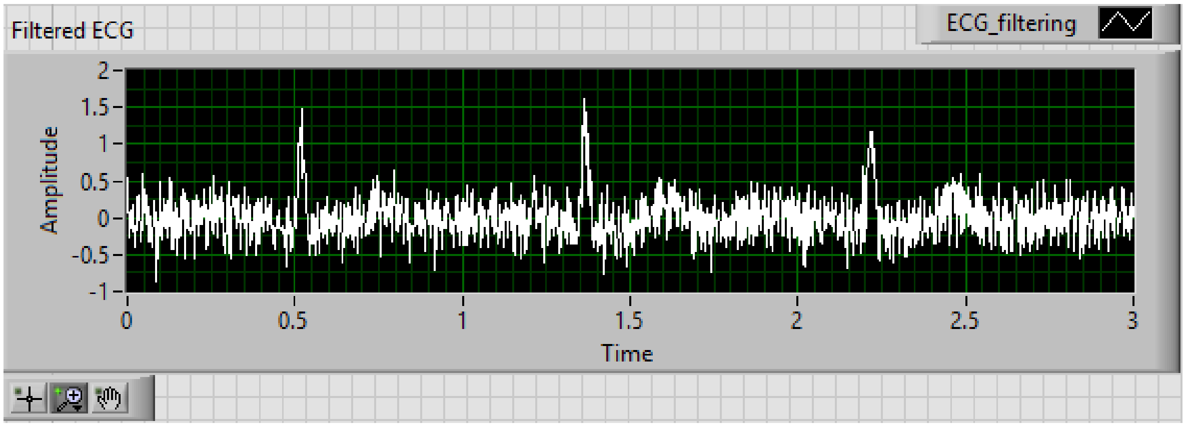
Raw ECG signal as shown in the Graph 6.1 is acquired from the Simulate ECG ExpressVI and whiteband noise is added to it.



Graph 6.1 Raw ECG signal

6.1.2 Removal of baseline wandering

Simulated ECG contains baseline wandering, in order to remove it we have used Biosignal Filtering VI which is a highpass FIR filter.Filtered ECG signal is shown in the Graph 6.2 below.



Graph 6.2 Filtered ECG signal

6.1.3 Removal of wideband noise

After filtering the simulated ECG signal, there is still some wideband noise that is present in the filtered signal. Wideband noise is removed from using Wavelet Denoise ExpressVI and the denoised ECG signal is shown in the Graph 6.3 below.

Graph 6.3 Denoised ECG signal

6.2 SCREEN SHOTS

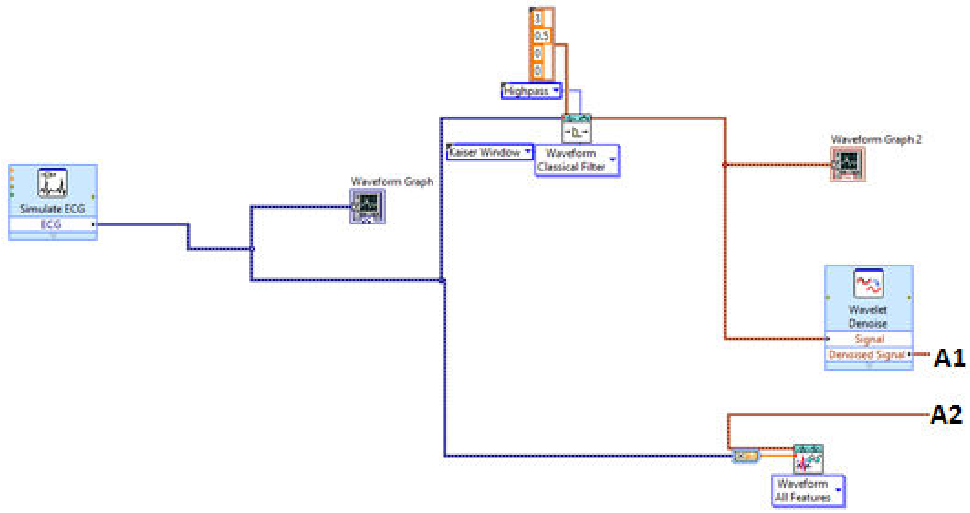


Figure 6.1 Block Diagram Of Telemedicine System -Part 1

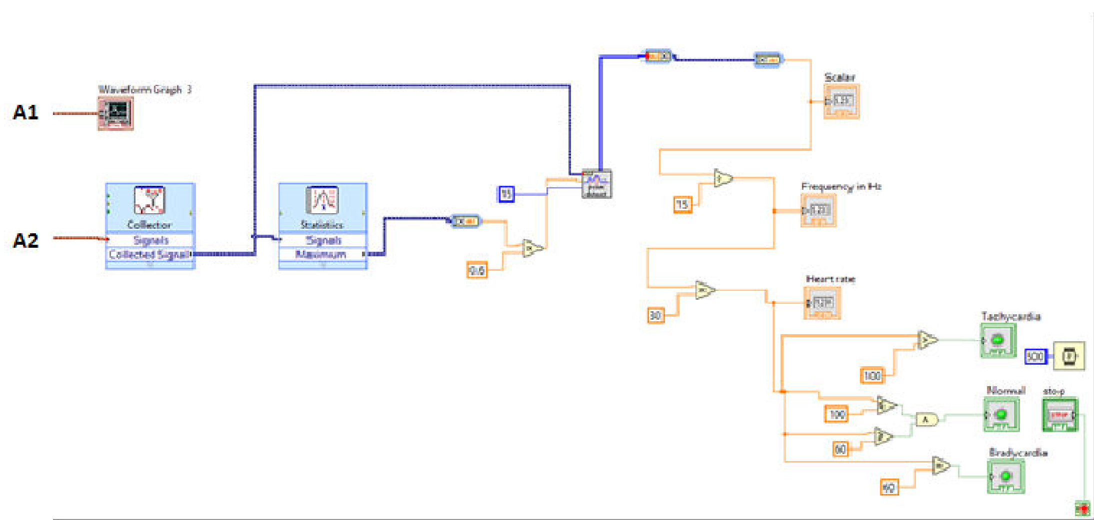


Figure 6.2 Block diagram of Telemedicine system – Part 2

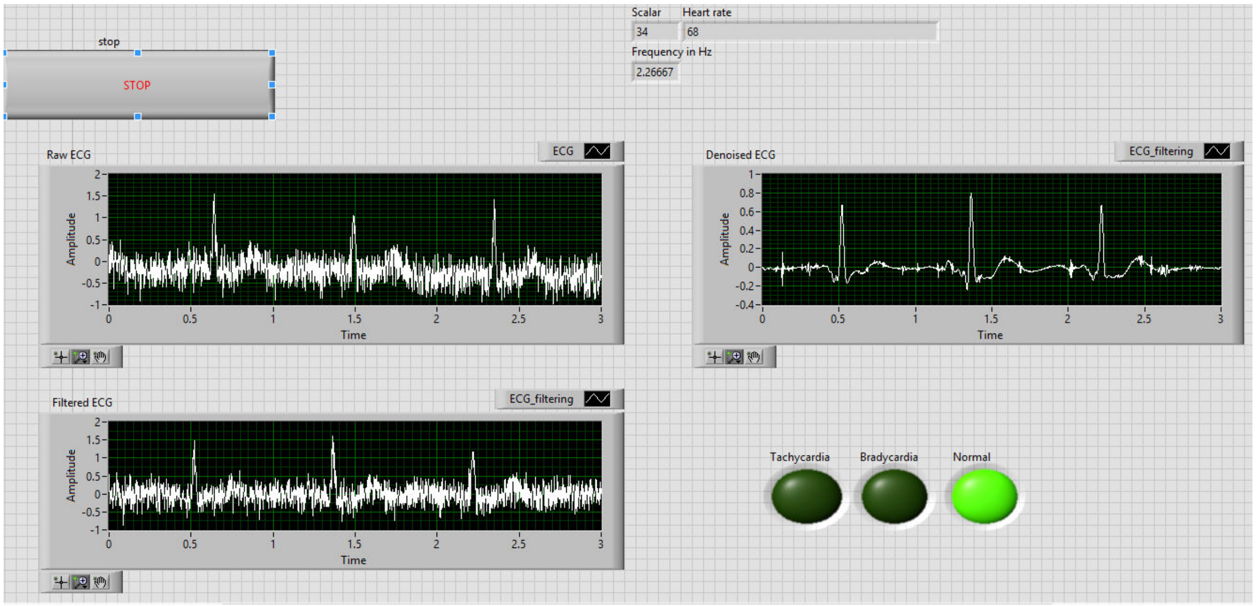


Figure 6.3 ECG Signal Analysis

Figure 6.4 LED Indicators

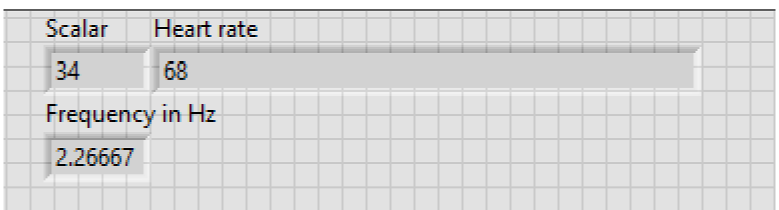


Figure 6.5 Numeric Indicator

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

- We have successfully implemented a single channel Telemedicine system for Rural Health Care.
- We have learned LabVIEW programming and got ourselves acquainted with LabVIEW software.
- We have learned various digital signal processing techniques which helped us process the raw ECG signal.

7.2 FUTURE SCOPE

For now we are implementing single channel Telemedicine system to measure heart. Further we can improve it by implementing a multichannel channel telemedicine will features such as EMG, etc. Through LabVIEW we can establish an entire health care platform where the advice from any specialist can easily be accessed.

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