VISVESVARAYA TECHNOLOGICAL UNIVERSITY

MINI PROJECT REPORT ON

"DETECTION OF SLEEP APNEA IN INFANT"

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The mini project report has been approved as it satisfies the academic requirements in respect of mini project work prescribed for the said degree.

Project Guide HOD ECE

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External Viva

Name of Examiner Signature with Date

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TABLE OF CONTENTS

ABSTRACT

CHAPTER 1

INTRODUCTION……8

CHAPTER 2

LITERATUREREVIEW……11

2.1 PROJECTS TO BE DISCUSSED…….11

CHAPTER 3

EXISTING SYSTEM AND PROBLEM STATEMENT……12

3.1 PROBLEMSTATEMENT……12

3.2 EXISTING SYSTEM ……...12

CHAPTER 4

PROPOSED SYSTEMS ……..14

4.1 CIRCUIT DIAGRAM……14

4.2 BLOCK DIAGRAM……..14

4.3 WORKING……..15

CHAPTER 5

HARDWARE AND SOFTWARE SPECIFICATION……17

5.1 HARDWARE SPECIFICATION…….17

5.1.1 XILINX SPARTAN 6……17

5.1.2 BREATHING DETECTING SENSOR…….19

5.1.3 MICROPHONE……..19

5.2 SOFTWARE SPECIFICATIONS……..22

5.2.1 MATLAB…….22

5.2.2 KAISER WINDOW……..23

5.2.3 HAMMING WINDOW…….24

5.2.4 FIR 1……25

5.2.5 HILBERT FFT ……28

5.2.6 FFT……...30

CHAPTER 6

RESULTS AND DISCUSSION……32

CHAPTER 7

APPLICATIONS AND ADVANTAGES…….33

7.1 APPLICATIONS…….33

7.2 ADVANTAGES……..33

CHAPTER 8

FUTURE SCOPE……34

CHAPTER 9

CONCLUSION…….36

REFERENCES…….38

APPENDIX……..39

LIST OF FIGURES

SL No	FIGURE No	FIGURE DESCRIPTION	Page No
1	4.1	CIRCUIT DIAGRAM	14
2	5.1.1	XILINX SPARTAN 6 BOARD	18
3	5.1.3	MICROPHONE	22
4	5.2.2	KAISER WINDOW	24
5	5.2.3	HAMMING WINDOW	25
6	5.2.4	FIR 1	27
7	5.2.5	HILBERT FFT	29
8	5.2.6	FFT	31

ABSTRACT

Sleep apnea is where individuals delay while breathing in their sleep; this can be of incredible worry for infants and untimely babies. Current observing systems either require physical connection to a client or might be temperamental. This project is intended to build up a device that can precisely detect breathing through sound and issue proper alerts upon its end. The device delivered is intended to be an independent device and in this manner was created as an installed systems project on a Xilinx Spartan 6 FPGA.

CHAPTER 01

INTRODUCTION

This project is a breath identification framework; the particular aim of this project is to be able to identify the breathing of a newborn child. By being able to identify breathing you can see when it stops and for to what extent, this is significant due sleep apnea. Sleep apnea is where individuals stop their breathing while sleeping. This can conceivably be perilous, particularly for baby and untimely children where it is called apnea of prematurity in the event that they are under 37 weeks and apnea of infancy in the event that they are more established than 37 weeks.

Apnea occasions are delegated suspension of breathing at any rate 20 seconds or more. There is additionally a potential connection between sleep apnea and sudden infant death syndrome, however it is discussed.

This can be of extraordinary worry for newborn children and premature infants. Flow checking frameworks either require physical connection to a client or might be unreliable.Various screens as of now exist, some utilization joined electrical leads on the body to decide breathing and heart thumps, while others are vibration sensors that distinguish development of the child. Screens depending upon sensors appended to the body can be bulky and development sensors are not constantly exact.

At the point when the breathing stops and starts while sleeping that condition is called as sleep apnea .it is related with wheezing .at the point when the upper aviation route bore is limited to a basic degree/esteem that condition is known as wheezing. Hypopnea is a condition of absence of breathing during sleep. At the point when the narrowing turns out to be too more it prompts

blockage of aviation route that subsequent in apnea. At the point when the end of wind stream endures atleast for ten seconds that outcomes in apnea and it is related with diminishing oxygen level of the patient .

Sorts of sleep apnea:

 Obstructive Sleep Apnea (OSA) - brought about by breakdown of the upper respiratory aviation route.

 Central Sleep Apnea (CSA), - brought about by a missing or repressed respiratory drive.

At the point when the apnea isn't dealt with, it influences daytime working. The usefulness of the monitoring framework is upgraded by counting additional highlights like, discovery of internal heat level, giving alarm signal when the breathing rate is not as much as that of threshold esteem, cautions nurture when the patient neglects to inhale through remote presentation monitor. All the sensors are connected to the controller.

Fundamentally controller process the information/signal, and transmits that to LCD and zig-honey bee, which are utilized as a showing and monitoring system.In this paper , it manages the obstructive sleep apnea condition happens at the point when the muscle relax during sleep, which will in general breakdown of delicate tissue at the rear of the throat.

To this end a project was embarked to manufacture something that worked better without requiring direct contact with the body. Breath investigation is a wide subject and is for the most part past the basic recognition of a solitary breath to incorporate portrayal. Obviously these frameworks likewise utilize propelled procedures, for example, neural nets and hereditary

calculations. For clear reasons such propelled frameworks are unfeasible for reduced, versatile frameworks and in this way were fairly restricted in helping the undertaking.

This venture is intended to build up a device that can precisely distinguish breathing through sound and issue suitable alerts upon its discontinuance. The gadget created is intended to be an independent gadget and hence was created as an implanted frameworks venture on a Xilinx Spartan 6 FPGA

CHAPTER 02

LITERATURE REVIEW

2.1 PROJECTS TO BE DISCUSSED

This project is a continuation of a task that has been progressing in Cal Poly's BMED office with help from Raytheon. The underlying stage was to explore potential strategies for breath discovery, that brought about a proposal of sound location and CO2 checking. Sound checking was sought after with accentuation on an application inside an emergency clinic.

Such a boisterous domain would require uncommon thought and a technique to utilize two mouthpieces to distinguish breathing and offset foundation clamor by differential sound. An answer using a universally useful PC was additionally sought after. In the present emphasis an inserted framework sound preparing usage is wanted.

The utilization of a solitary amplifier with an illustrative dish to center the sound and help take out was viewed as when this stage venture began. In this stage receivers with allegorical dishes was not the concentration but rather might be valuable in future cycles to enhance this work.

CHAPTER 03

EXISTING SYSTEM AND PROBLEM STATEMENT

3.1 PROBLEM STATEMENT

The present contraptions discovered accessible didn't meet with desires considering the way that perhaps they were too much intruding or not absolutely convincing. For the screen using weight sensors under the sleep cushion, there is an issue with steadfast quality and accuracy. components, for example, resting cushion thickness and thickness could impact how well the sensor can check the breathing of an newborn child.

Another variable that can impact precision is drawn out strength in the midst of rest. This could be deciphered as though the patient has stopped breathing which would be a false alarm.

Current child relaxing screens use cathode sensors that are connected straightforward to the newborn child and require consistent management to ensure that the child does not become into the wires. An issue could develop if the child is irritated by the sensors and pulls them off their body. These physical associations could moreover achieve bothersome rashes during the zones where they are attached.

3.2 EXISTING SYSTEM

- Polysomnogram. Specialists assess your child's condition during a short-term rest study. ...

- Oximetry. On the off chance that specialists firmly presume obstructive rest apnea, and a full polysomnogram isn't required or accessible, a short-term recording of oxygen levels may help make the analysis. ...
- Electrocardiogram.

A newborn child who has diligent breathing issues during rest may require a short-term rest study. This study is known as a polysomnogram. It outlines your child's cerebrum waves, heartbeat, and breathing during rest. It additionally records arm and leg developments. The rest study will uncover the idea of your baby's breathing issue. It likewise will show the seriousness of the issue. The study requires your child to go through the night at the rest place. A parent or gatekeeper additionally should remain at the rest place with the child.

CHAPTER 04

PROPOSED SYSTEMS

4.1 CIRCUIT DIAGRAM

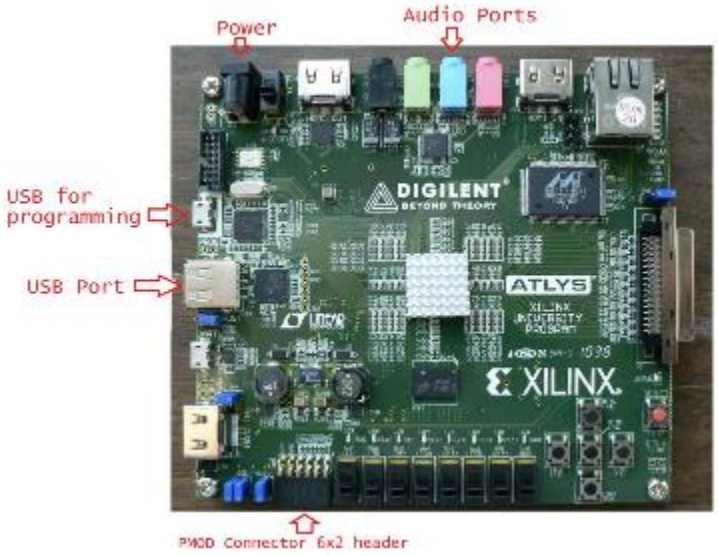
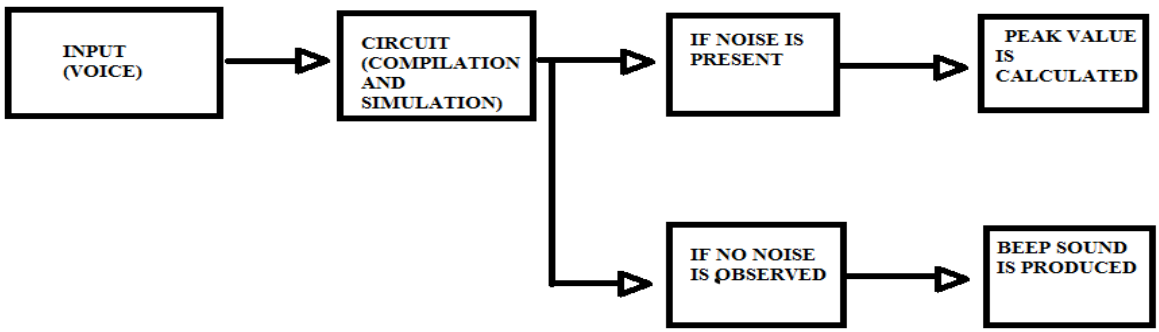
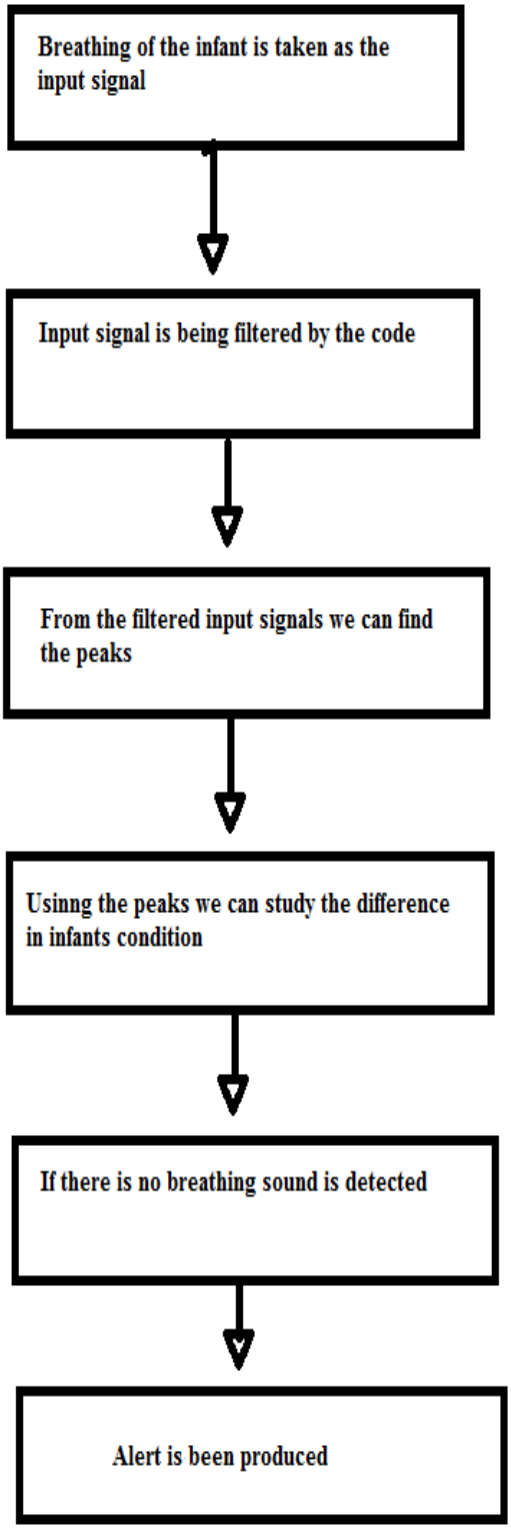


Fig 4.1 : Circuit diagram

4.2 BLOCK DAIGRAM



4.3 WORKING


Breathing of the infant is taken as the input signal
Input signal is being filtered by the code
From the filtered input signals we can find the peaks
Usinng the peaks we can study the difference in infants condition
If there is no breathing sound is detected
Alert is been produced

- With the help of microphone breathing signal is collected and converted into electrical signal.
- Electric signal is taken as input for the code.
- Code will filter the input signal and takes only the necessary frequency and removes the noise.
- It creates an envelope of the input signal.
- And it will represent the breathing pattern in 2-D graph.
- The peaks of each signal is identified in regular interval of time.
- If breathing pattern is not detected in the filtered input signal.
- Alarm is being produced

CHAPTER 05

HARDWARE AND SOFTWARE SPECIFICATIONS

5.1 Hardware specifications:

5.1.1 Xilinx Spartan 6

The Spartan®-6 family furnishes driving system integration capacities with the least all out cost for high-volume applications. The thirteen-part family conveys extended densitiesrunning from 3,840 to 147,443 logic cells, with a large portion of the power utilization of past Straightforward families, and quicker, progressively far reaching network. Based on a develop 45 nm low-power copper process innovation that conveys the ideal equalization of cost, power, and execution, the Spartan-6 family offers another, progressively productive, double register 6-input lookup table (LUT) rationale and a rich choice of implicit system-level squares.These incorporate 18 Kb (2 x 9 Kb) square RAMs, second era DSP48A1 cuts, SDRAM memory controllers, upgraded blended mode clock the executives squares, SelectIO™ innovation, poweroptimized fast sequential handset squares, PCI Express® good Endpoint squares, propelled system-level power the executives modes, auto-identify setup choices, and upgraded IP security with AES and Device DNA insurance. These highlights give a lowcost programmable option in contrast to custom ASIC items without hardly lifting a finger of utilization. Austere 6 FPGAs offer the best answer for high-volume rationale designs, customer situated DSP designs, and cost-delicate implanted applications. Austere 6 FPGAs are the programmable silicon establishment for Targeted Design Platforms that convey incorporated programming and equipment segments that empower creators to concentrate on advancement when their improvement cycle starts.

It consists of

16 Nos. DIP Switch (Digital Input)

16 Nos. Point LEDs (Logic Output)

2 Nos. of Push Buttons

Two UART(RS232)

12-Bit SPI ADC (2 channel)

12-Bit SPI DAC

Temperature Sensor LM35

5V SPDT Relay

Buzzer (Alarm)

Reset Button | Power-on Indication

JTAG (Program/Debug)

40 Pin and 20 Pin I/O Expansion Connector

On-Board Voltage regulators +5V | +3V3 | +1V2

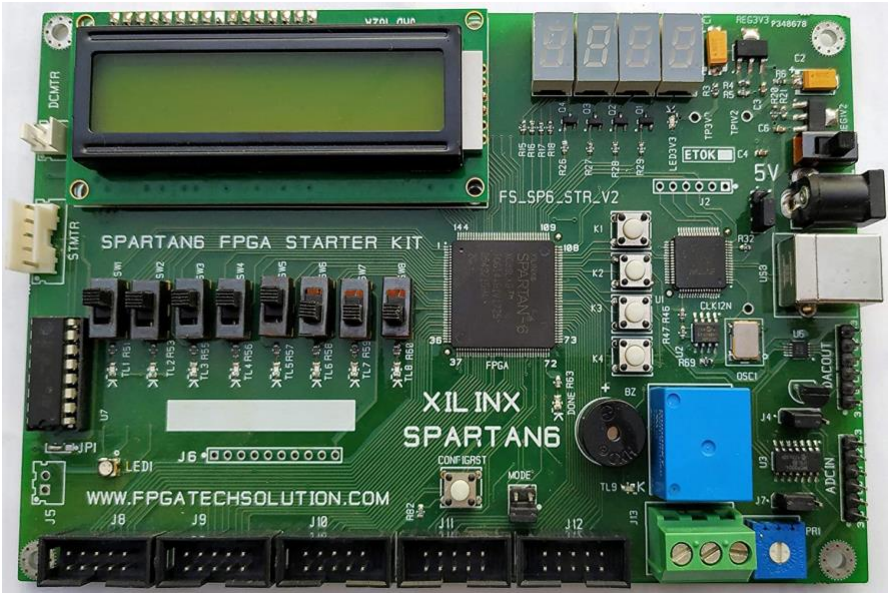


Fig 5.1.1 Xilinx Spartan 6 board

5.1.2 BREATHING DETECTING SENSOR

Sensors are advanced gadgets that are much of the time used to distinguish and react to electrical or optical signs. A Sensor changes over the physical parameter (for instance: temperature, circulatory strain, stickiness, speed, and so on.) into a sign which can be estimated electrically.

A sensor changes over stimuli, for example, heat, light, solid and movement into electrical signs. These signs are gone through an interface that changes over them into a double code and gives this to a PC to be prepared.

Sensors can improve the world through diagnostics in clinical applications; improved execution of vitality sources like energy components and batteries and sun oriented force; improved well being and security and security for individuals; sensors for investigating space and the known college; and improved natural checking.

Each sensor has diverse standard of activity, in light of the sort of physical amount it is estimating. The thought is to make an adjustment in the property/properties of sensor, (for example, obstruction, thickness, shape, temperature and so on) as a component of the physical amount under estimation.

5.1.3MICROPHONE

A microphone is a gadget that translates sound vibrations noticeable all around into electronic signals or copyists them to a chronicle medium. Microphones empower numerous sorts of sound account gadgets for purposes including interchanges of numerous sorts, just as music and discourse recording.

As often as possible, microphones are intended for a given reason. One of the primary contemplations, beside the kind of gadget, is what is being recorded. Directionality of microphones is one such thought in microphone plan. Omnidirectional microphones are fit to recording all sounds in a territory yet poor for concentrating on a solitary subject among foundation commotion. Directional, bidirectional and shotgun microphones are reasonable for interviews. Be that as it may, a similar impact is regularly accomplished with two unidirectional gadgets, for example, cardioids microphones.

The primary electronic microphone was a fluid based instrument that utilized a stomach joined to a current-charged needle in a weakened sulfuric corrosive arrangement. This early microphone couldn't duplicate clear discourse.

From that point forward, there have been and keep on being numerous sorts of microphone innovations, some of which are depicted beneath:

The main feasible stomach microphones utilized a sheet of metal connected to a needle which scribed transmitted vibrations to a foil recording medium. At the point when the needle moved over the foil after the scribing, the procedure was turned around and made an interpretation of back to sounds again through a similar metal stomach.

Carbon microphones were utilized in phones for more than one hundred years. These gadgets utilized the variable electrical obstruction of carbon under tension between metal plates to make an interpretation of airborn sound waves into an electrical sign.

Condenser microphones utilize the shifted electrical accuse of a capacitor of a stomach going about as a one of the plates of a capacitor. The plate is one-sided by a fixed charge, regularly from a battery which likewise intensifies the sign. Capacitance differs with development of the stomach according to different plates giving the way to record the sound in electrical signal.

Electret microphones utilized in mobile phones and PCs are a kind of condenser microphone that utilization an enraptured ferroelectric material.

Precious stone microphones utilize a piezoelectric gem that creates limited quantities of power under pressure of a stomach to give the account signal.

Dynamic microphones utilize a loop suspended in an attractive field that might be joined to different films for expanded recurrence reaction. They use electro-attractive acceptance to deliver the sign. These microphones are appropriate to arrange execution.

Laser microphones utilize the vibrations of surfaces influenced by sound waves to catch sound at separations. The lasers return at various points because of the vibration and these progressions are deciphered and converted into sound waves.

Because of likenesses in work, microphones can work as speakers. For the most part, microphone-inferred speakers are fit to high-recurrence seems like the STC organization's microphone determined super-tweeter. Speakers can likewise work as microphones, despite the fact that they are commonly appropriate for the catch of low frequencies.

Fig 5.1.3: microphone

5.2 SOFTWARE SPECIFICATIONS

5.2.1 MATLAB

MATLAB, short for MATrixLABoratory is a programming bundle explicitly intended for snappy and simple logical counts and I/O. It has truly many worked in capacities for a wide assortment of calculations what's more, numerous tool kits intended for explicit research disciplines, including insights, improvement, arrangement of fractional differential conditions, information examination.

For CME200, you need a strong information on essential MATLAB orders and a few further developed highlights counting two-and three-dimensional illustrations, arrangement of

arithmetical conditions, arrangement of common differential conditions, figurings with frameworks and arrangements of direct frameworks of conditions.

The vast majority of what you need is talked about here, yet in particular, after this instructional exercise you ought to have the option to discover your way around the MATLAB help capacity and program capacities to locate any extra highlights you may need or need to utilize.

Features of MATLAB

- High-Level Language. ...
- Interactive Environment. ...
- Handling Graphics. ...
- Mathematical Functions Library. ...
- Application Program Interface (API) ...
- Toolboxes. ...
- Accessing Data. ...
- Interfacing with Other Language.

5.2.2 KAISER WINDOW

The Kaiser window is an estimation to the prolate spheroidal window, for which the proportion of the mainlobe energy to the sidelobe energy is augmented. For a Kaiser window of a specific length, the parameter β controls the relative sidelobe attenuation. For a given β, the relative sidelobe attenuation is fixed regarding window length. The statement kaiser(n,beta) figures a length n Kaiser window with parameter beta.

As β builds, the relative sidelobe attenuation diminishes and the mainlobe width increments. This screen shot shows how the relative sidelobe attenuation stays around the equivalent for a fixed β parameter as the length is fluctuated.

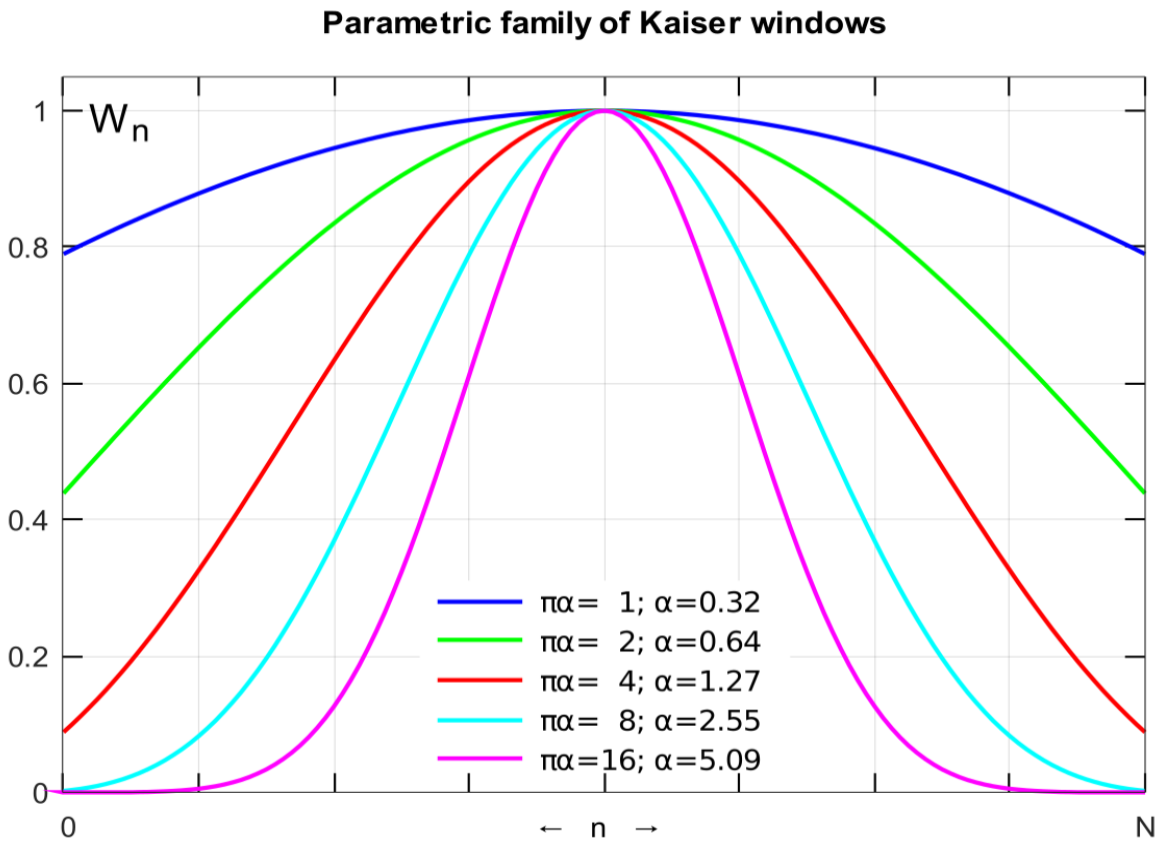


Fig 5.2.2: Kaiser widow

5.2.3 HAMMING WINDOW

The Hamming window is a shape framed by utilizing a raised cosine with non-zero endpoints, improved to limit the closest side projection. Parameters: M : int. Number of focuses in the output window. On the off chance that zero or less, an unfilled array is returned.

The hamming window lessens this wave, giving you a progressively precise thought of the first sign's recurrence range. ... With what I think about sound and snappy research, apparently Hamming Window is here to limit the sign side flap (undesirable radiation). In this manner improving the quality or music of the sound.

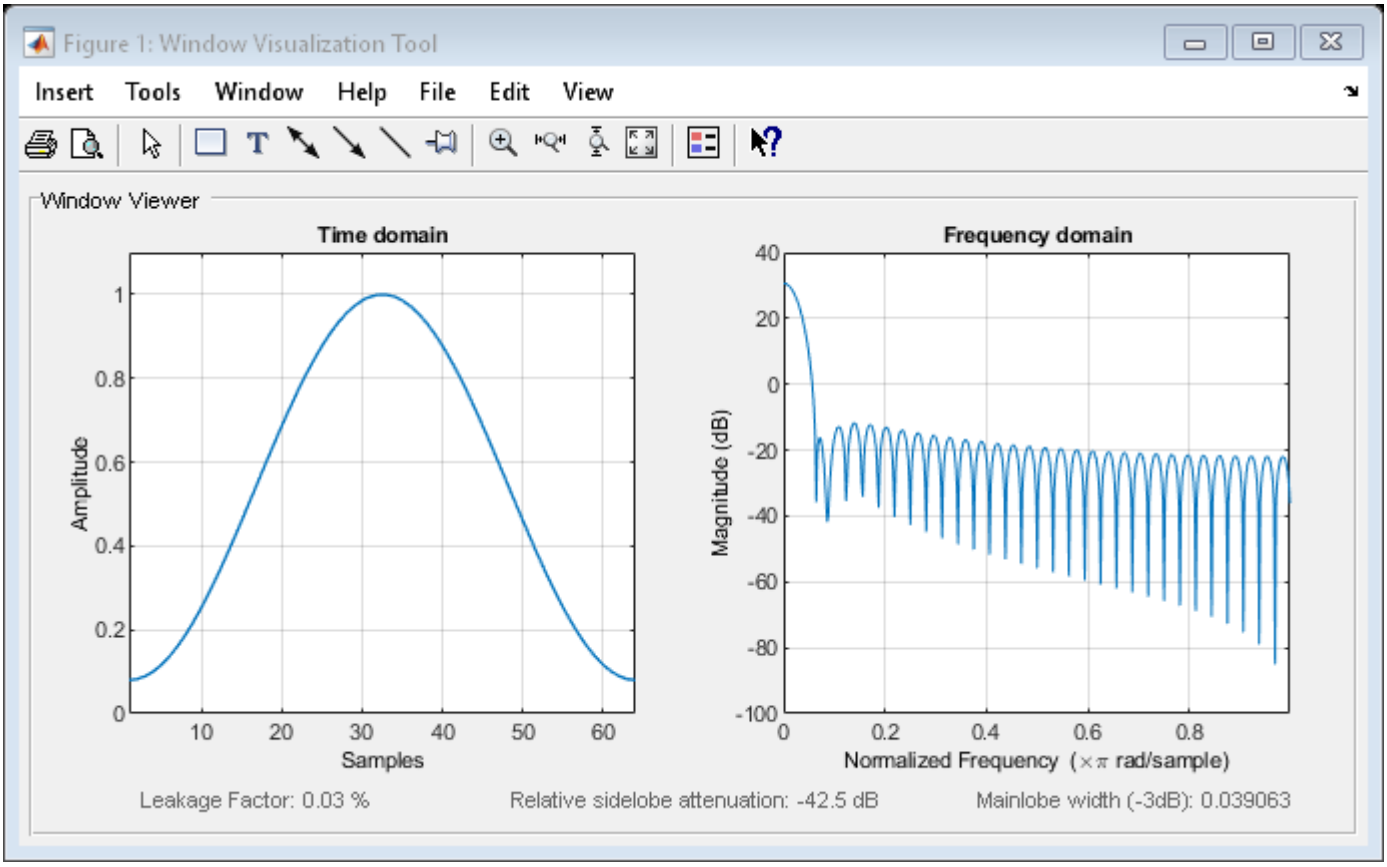


Fig 5.2.3 : Hamming window

The convolution spreads the true frequency to frequency bins around it. By using a window function other than the rectangular one there is less of the sidelobes compared to the main lobe, so less artificial long-distance spread making the result cleaner and better suited for frequency-selective analysis.

5.2.4 FIR 1

A FIR filter can be portrayed by the accompanying information/output relation

$$y[n]=\sum_{k=0}^{N} b[k]x[n-k]$$

As should be obvious high order FIR filter implies N to be huge and low order implies N to be little. Note that a large portion of those coefficients can be set 0 however the last one at x[n−N] would in any case make a high order filter (explicitly a filter with an unadulterated postponement).

The deferral related with FIR filters (of symmetric impulse reaction types) is legitimately identified with the order N of the filter.

A FIR low-pass filter is a numerical algorithm and its cutoff frequency is standardized to be among 0 and π radians mathematically and somewhere in the range of 0 and 1 for programming, for example, MATLAB. At the point when you need to locate the physical cutoff frequency of such a FIR filter , you ought to consider the physical inspecting rate and relate it through

$$f_c=\frac{\omega_c F_s}{2\pi}$$

where ωc is the cutoff frequency (in radians per test) of the scientific filter, and fc is the physical cutoff frequency in Hertz.

Impulse reaction of the FIR filter is straightforwardly accessible in the coefficients b[k] as been clarified. At the point when you are managing an IIR filter or a LTI filter which doesn't forces a LCCDE expression, at that point handy calculation of the impulse reaction that should be possible in various manners.

The most straightforward could be to make a sign that characterizes the unit impulse as delta = [1, zeros(1,L-1)] then the L purposes of the impulse reaction can be figured legitimately by h = filter(b,a,delta) . Note that on the off chance that impulse reaction h[n] doesn't rot sufficiently quick, at that point you should expand the length L.

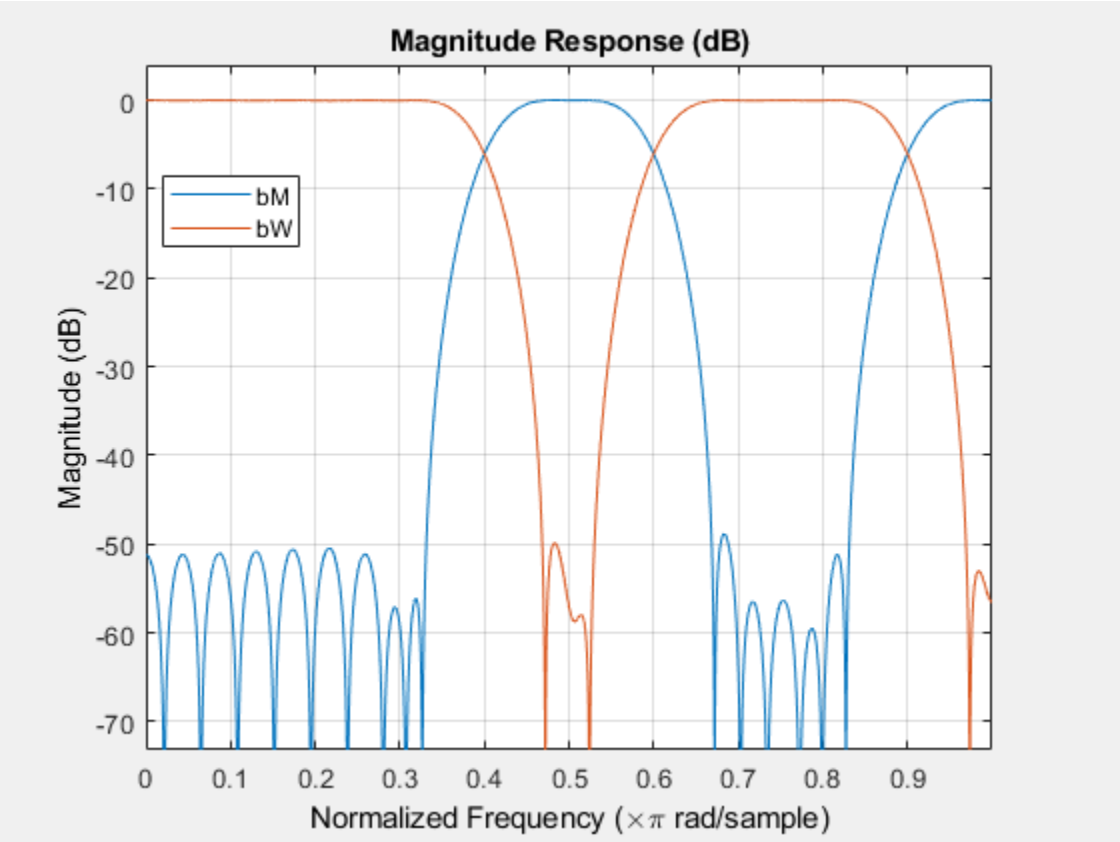


Fig 5.2.4 fir 1

Function File: *b* = fir1 *(n, w)*

Function File: *b* = fir1 *(n, w, type)*

Function File: *b* = fir1 *(n, w, type, window)*

Function File: *b* = fir1 *(n, w, type, window, noscale)*

The filter type can be indicated with one of the accompanying strings: "low", "high", "stop", "pass", "bandpass", "DC-0", or "DC-1". The default is "low" is w is a scalar, "pass" if w is a couple, or "DC-0" if w is a vector with multiple components.

A discretionary forming window can be given as a vector with length n+1. If not indicated, a Hamming window of length n+1 is utilized.

With the choice "noscale", the filter coefficients are not standardized. The default is to standardize the filter with the end goal that the greatness reaction of the focal point of the first passband is 1.

To apply the filter, utilize the arrival vector b with the filter work, for instance y = filter (b, 1, x).rease the length L.

5.2.5 HILBERT FFT

The HILBERT work outputs an arrangement that has every intermittent term stage moved by 90 degrees. This change has the fascinating property that the correlation between an arrangement and its own Hilbert change is mathematically zero.

This routine is written in the IDL language. Its source code can be found in the record hilbert.pro in the lib subdirectory of the IDL dissemination..

Result = HILBERT(*X* [, *D*])

X :A n-component gliding point or complex-esteemed vector.

D :A FLAG for rotation direction. Set D = +1 for a positive turn (the default). Set D = 1 for a negative revolution.

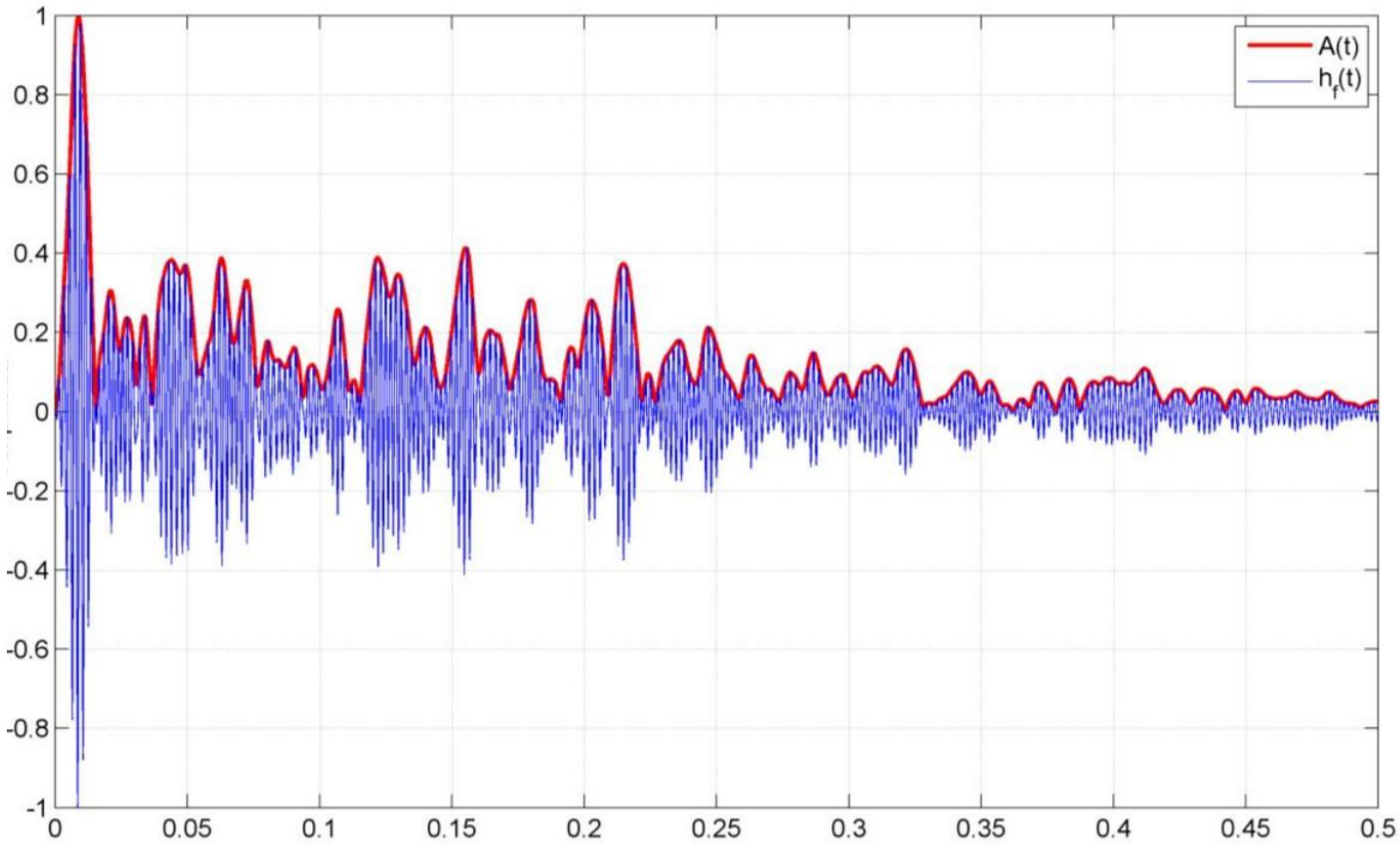


Fig 5.2.5 Hilbert fft

Executing a Hilbert change empowers us to make an explanatory sign dependent on some unique genuine esteemed sign.

What's more, in the comms world we can utilize the expository sign to effectively and precisely register the momentary size of the first genuine esteemed sign. That procedure is utilized in AM demodulation.

The arrival esteem is a complex-esteemed vector with a similar size as the information vector.

HILBERT creates the quick Fourier change utilizing the FFT capacity, and movements the first 50% of the change items by 90 degrees and the second half by - 90 degrees.

The steady components in the change are not changed.

Point moving is practiced by duplicating or partitioning by the unpredictable number, I = (0.0000, 1.0000).

The moved vector is then submitted to FFT for change back to the "time" space and the output is separated by the number components in the vector to address

5.2.6 FFT [FAST FOURIER TRANSFORM]

FFT is an algorithm that registers the DFT [discrete fouriertransform] and IDFT [inverse discrete fourier transform]

Fourier examination changes over a sign from its unique area (frequently time or space) to a portrayal in the frequency space and the other way around.

The DFT is acquired by decaying an arrangement of qualities into parts of various frequencies.[1] This activity is helpful in numerous fields, yet registering it legitimately from the definition is regularly too delayed to possibly be down to earth.

A FFT quickly processes such changes by factorizing the DFT framework into a result of meager (generally zero) factors.

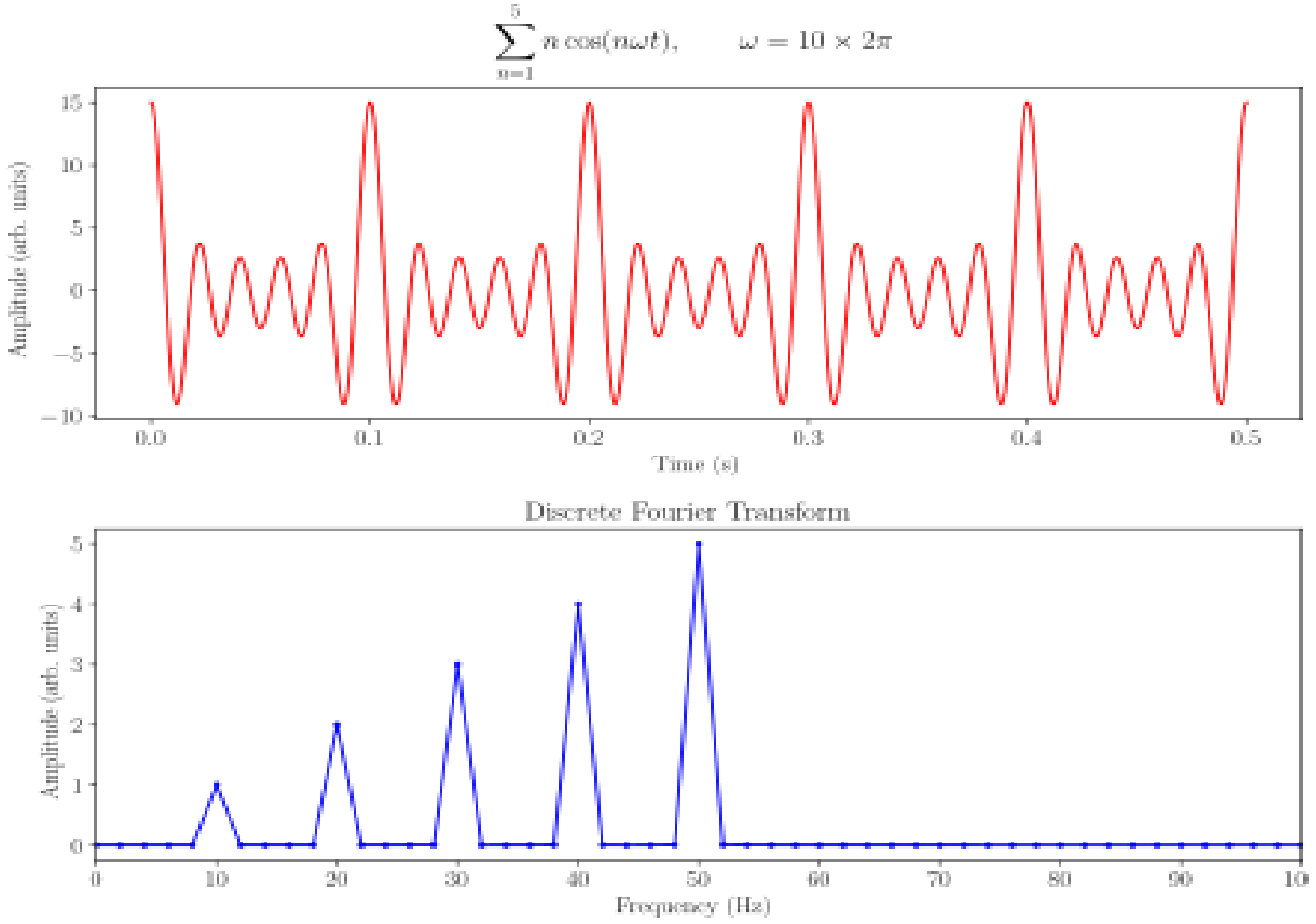


Fig 5.2.6:fft

CHAPTER 06

RESULT AND DISCUSSION

We have successfully completed the first review of Mini Project.We have installed Matlab and we are working on the code. We are learning about the code and trying to get the required output, taking the help of our lab teachers as we are facing some issues in getting the desired output.We have completed the report work and the presentation of how much we have done, for our second review.

CHAPTER 07

APPLICATIONS AND ADVANTAGES

7.1 APPLICATIONS :

- Sleep apnea can be diagnosed
- Any defect in the body can be predicted by studying the breathing patterns.
- Breathing rate can also be calculated

7.2 ADVANTAGES :

Using this circuit we can diagnose sleep apnea. We can treat and improve the health by:

- Better sleep
- Lower risk of heart problems and stroke
- Reduced risk of depression
- Lower risk of mortality
- Better management of diabetes
- Lower risk of cancer

CHAPTER 08

FUTURE SCOPE

Observing systems are accessible and specialists are accessible in any case, there is no correspondence that relates patient's status furthermore, specialists .Thus this system successfully limits the correspondence issue among patients and specialists. Some extra territories can be incorporated to investigate in future explore by adding different sensors to the system, for example, galvanic skin reaction, ECG, altimeter and so on working together with specialists for future client contemplates.

In the current study, reasonable technique is for human services checking gadgets for sleep study has been proposed and tried on summed up PC based system with predetermined number of subjects. In this manner, future scope of work primarily lies in the execution of compact committed, installed system and testing into bigger database. Future scope additionally incorporates further approval in home condition and expanding the continuous versatile strategy to purpose of-care applications, for example, adaptively modifying the CPAP gadget, from the yield of order model. The other future scopes are recorded underneath.

 In the current work of sleep arranging utilizing single channel estimation of EEG signal has been performed utilizing C4-A1 terminal. Accordingly, choice of ideal anode for better execution stays as a potential future expansion.

 As another future scope, the choices of the sleep stage order model and attributes wave grouping can be consolidated together to improve the presentation of programmed sleep arranging.

 The reaction of the thermistor to distinguish hypopnea occasions was seen as poor. Alterations in the sign molding circuit of the thermistor might be done to improve the symptomatic capacity.

 It has been seen that brief term hypopnea occasions which did not produce critical follow in sufficiency decrease of procured breath signal have been treated as expected breath. It may be because of the constraint of single channel recording. Accordingly, the SpO2 as well as feelings of excitement in EEG can be consolidated to recognize the occasion.

 In the work it has been discovered that SVM based classifier performs well. Be that as it may, advancement of different classifiers and highlight choice methods should be possible for all the more precisely.

CHAPTER 09

CONCLUSION

This system presents following features: a) Easy to use. b) Low cost. c) Works in genuine time. d) Wearable. e) Light weight system, f) Non intrusive. This system changes physiological information to the specialist .This system recognizes whether the patient is discovering trouble in breathing or not all that that it is useful in recognizing and checking sleep apnea condition. This system constantly recognizes and screens the breathing rate and internal heat level of the patient. It imparts an alarm sign of the patient condition. It additionally shows the patient's status on the checking system, on LCD and furthermore cautions the specialist by sending SMS through GSM. Checking systems are accessible and specialists are accessible be that as it may, there is no correspondence that relates patient's status also, specialists .Thus this system viably limits the correspondence issue among patients and specialists. Some extra regions can be incorporated to investigate in future inquire about by adding different sensors to the system, for example, galvanic skin reaction, ECG, altimeter and so on teaming up with specialists for future client considers.

Sleep aggravation in individuals has gotten one of the normal issues as of late. Among various sleep unsettling influences, sleep apnea is the most widely recognized one. Clinical trial of sleep apnea is exorbitant, awkward, tedious and besides shortage of sleep facility has made an interest for reasonable locally situated wellbeing observing gadgets, which will be ease, agreeable, and convenient and conservative in size. Present examination planned to discover appropriate systems for this sort of wellbeing checking gadgets of sleep study.

In the work, all the significant destinations of these gadgets has been tended to, for example assessment of sleep quality through EEG signal, location of apnea and hypopnea occasions

progressively and on-line for different applications which have developed in ongoing time, and distinguishing proof of apnea type, which has a significant job in treatment methodology.

Past works in the significant field of utilization have been inspected completely and different parts of such methodologies are improved in the work, so as to meet the current day prerequisites. A synopsis of these headways over the past methodologies are introduced here.

REFERENCE

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APPENDIX

Code

```
close all, clear all

%% Variables

low_stop = 300;

high_stop = 1000;

WindowEnvelope = 0.1; % Length of envelope averaging filter window

(seconds)

MaximaWindow = 2.4; % Length of window to find local maxima

(seconds)

DownSamp = 200; % Frequency to downsampe envelope to (Hz)

Threshold = 0.2; % Percentage of mean maxima value that a breath must be above

Fs = 8000; % Sampling Frequency

nbits = 8; % Bits of Precision When Sampling

WindowTime = 5; % Length of recorded time processed in eachvbatch (seconds)

%% Initialize

BreathCountTotal = 0;

y = audiorecorder(Fs,nbits,1);

meanbreath = 0;

%% Create Bandpass Filter
```

```
F=[(low_stop-100) low_stophigh_stop (high_stop+100)]; % band limits

A=[0 1 0]; % band type: 0='stop', 1='pass'

dev=[0.0001 10^(0.1/20)-1 0.0001]; % ripple/attenuation spec

[M,Wn,beta,typ]= kaiserord(F,A,dev,Fs); % window parameters

b = fir1(M,Wn,typ,kaiser(M+1,beta),'noscale'); % filter design

%% Initialize

loopcount = 0;

EXIT = 1;

BreathTotal = [];

%% Initial Recoding

signal = zeros(1,Fs*WindowTime);

record(y)

while EXIT == 1

%% Counter

loopcount = loopcount + 5;

%% Filter Signal

signal_f = fftfilt(b,signal);

%% Find Envelope

signal_h = hilbert(signal_f); % Hilbert Transform

envelope = sqrt(signal_h.*conj(signal_h));

envelope_f =filter(ones(1,round(Fs*WindowEnvelope))/round(Fs*.1),1,envelope);
```

```
envelope_fDS = downsample(envelope_f,round(Fs*(1/DownSamp)));

%% Find Local Maxima

windowsize = DownSamp * MaximaWindow / 4;

BreathCount = 0;

Breath = [];

for ix = 1:length(envelope_fDS) - windowsize

maxima = max(envelope_fDS(ix:ix+windowsize));

ifloopcount< 2 % Ignore first 2 loops

elseifloopcount< 100 % Use next 100 loops to get breaththreshold

if maxima == envelope_fDS(ix+windowsize/2)

BreathCount = BreathCount + 1;

Breath(BreathCount) = ix + windowsize/2;

end

else % Begin using and updating threshold

if (maxima == envelope_fDS(ix+windowsize/2)) && maxima >(Threshold * meanbreath)

BreathCount = BreathCount + 1;

Breath(BreathCount) = ix + windowsize/2;

end

end

end

BreathTotal = cat(2,BreathTotal,envelope_fDS(Breath));
```

```
meanbreath = mean(BreathTotal);

ifisempty(Breath) &&loopcount> 100 == 1

fori = 1:10

beep

pause(.1)

end

EXIT = 0;

end

%% Keep Recording

stop(y)

signal_new = getaudiodata(y,'double');

record(y)

signal(1:(end-length(signal_new)))=signal((1+length(signal_new)):end);

signal((end-length(signal_new)+1):end) = signal_new;

clearsignal_new

%% Plot

figure(1)

subplot(2,1,1)

signalplot = signal;

time1 = (0:length(signalplot)-1) / (Fs/4);

refresh
```

```
plot(time1,signalplot)
title('Raw Signal')
xlabel('Time (seconds)')
ylabel('Intensity')
subplot(2,1,2)
envelopeplot = envelope_fDS;
time = (0:length(envelopeplot)-1) / (DownSamp/4);
plot(time,envelopeplot)
hold on
plot(Breath/(DownSamp/4),envelope_fDS(Breath),'rx','MarkerSize',16,'linewidth',4)
title('Envelope of Breath Signal w/ Breath Markers')
xlabel('time (sec)')
ylabel('Arbitrary Units')
hold off
pause(0.1)
end
```