Tracheal disease diagnosis using breathe signal processing

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Abstract—**Breathtestsarethenon-invasivemethodsforclinicaldiagnosisoftherespiratorydiseases.The respiratorysoundsignalcanbeprocessedusingseveraltechniquesfor diagnosticinformation.Computerizedanalysiscanfacilitatethedete ctionofchangesinrespiratorysoundandstoring.Thismayhelpinthed iagnosisofrespiratorydisordersandtreatmentforapatientssufferin gfromvariousrespiratorydiseases.Thispaperisintendedtodescribe thepotentialapplicationsofbreathepressureandsoundsignalsmeas uredusingacousticsensorfromnostrilsindiagnosingrespiratorydise asesusingfeatureextractionandpatternrecognition.**

Keywords—**Breathesoundsignals,Featureextraction,Patternrecognition.**

I. INTRODUCTION

Research,productdevelopment,andnewapplicationsofbreathsi gnalprocessinghavealladvanceddramaticallyinthepastdecade.I thas,potentially, twogreatadvantagesoverothermeanstheyare,completenon-invasivenessandvirtuallylimitlessrepeatabilitywith respecttofrequency,access,andcost.Mostofthepulmonarydisea sescausesbreathedisorders.Characterizingofbreathe soundsignalshelpsinthediagnosisofbreathedisorder.Diagnosis ofbreathedisorderbybreathesignalprocessingisasubjectiveproc ess.Thelimitationofitcanbeovercomebyusingdigitalsignalproc essingtechniques[3],[4].Thequantificationandanalysisofnoisef reebreathesoundsignalwillbehelpfulforbetterdiagnosis.Artifact suppressionisneededforautomaticdiagnosisofbreathedisorder. Recordingof breathesoundsignalandsignalprocessingtechniquesare neededforautomaticdiagnosisofbreathedisorder.Artifactsuppre ssionisdoneusingfrequencydomainandadaptivefilteringtechni queandthecharacterizationofrespiratorysoundsignalisdoneusi ngspectralanalysisandpowerdensityspectrum.

II. PROCESS

Eachandeverypersonhastheirownbreathepattern.Thepressurev ariationfromeachpersonisdifferentbutliesinacertainrangeforth enormalpersonsandthepersonswhohavebreatheproblems. Theacousticsensorisplacednearthenostrils;anacousticsensorisc apableofsensingboththepressureandsoundvariations.Acommo nsymptominalltherespiratorydiseasepatientsisshortnessofbrea th.Thepressurevariationsandthesoundfromthenostrilisrecorde dusingthecombinationofacousticsensorandaUSBsoundcard,a USB soundcard is an internalcomputerexpansion card whichfacilitatestheinputandoutputtoandfromacomputerunderc ontrolofcomputerprograms. Adatabaseofbreathesignalpatternsweretakenfromtenrandomly selectedsubjects,foreachseparatebreathingdisorder.Abreathes oundrecorderinstrumentwasusedforrecordingthebreathingsou ndsignal.Amicrophonebaseddevelopedsensorwasusedforrecor dingbreathesignalsofnormalanddiseasedpersons.Twosignalsw eretakenintoaccountonesignalwithbreathingandotherissignalw ithoutbreathing.Fromthisanaveragepatternandfrequencyforeac htimeinstantisobtainedandtherespectedvaluesisstoredinthedat abase.Thebreathsignalvaluescalculatedfrompatientsatrealtime isthencomparedwiththeaveragecalculatedvaluesfromthedatab aseandtherespecteddecisionisgiveninthedisplayunit.
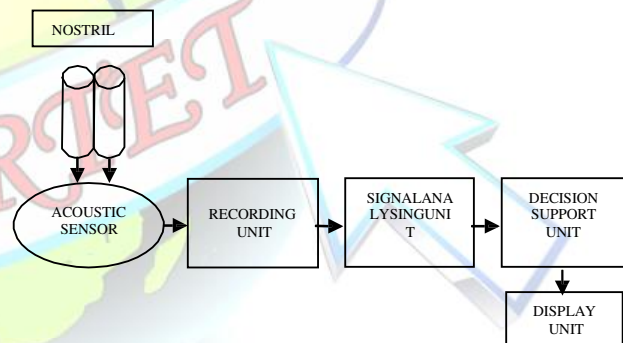

Fig.1Block diagram

A. Acousticsensor

Asensorisusedtomeasure(sense)anenvironmentandconvertthisi nformationintoadigitaloranalogdatasignalthatcanbeinterpreted byacomputeroranobserver.Anacoustic wave sensorisanelectronicdevice thatcan measuresoundandpressurelevels.Itproduceselectricalchargesa saresult ofmechanicalstress.Thesignalis then recordedin thecomputerusingtheUSBsoundcard.

B. Recordingunit

Hereweusedigitalrecording,digitalrecordingandreproductionc onvertstheanalogsoundsignalspickedupbythemicrophonetoadi gitalformbyaprocessofdigitizationbecausedigitalsignalscanbe easilyinterpretedbycomputerprogramssuchasMATLABfornoi sereductionandArtifactsuppression.

C. SignalAnalysingUnit

TheSignalanalysingunitisusedtoanalysetherecordedsignalandt osuppresstheartifactsusingthecombinationofadaptive andfrequency domain filtering.There arethree

maincomponentsinthecombinationmethodtheyare,theinput orprimarysignal,thenoisesignal(heartsignal&othermuscleartifact)andthefilteredoutputsignal.Inthistechniquetherecordedsignalduringnormalbreathingofnormalpersonordiseasedpatientistheprimaryinputandthesignalrecordedwithnormalbreathing isareferenceinputsignal.breathesoundisconsideredastheprimarysignalforanalysis,apartialoverlapbetweenthebreathesignalandtheheartsignalisprovidedastheprimaryinputfortheadaptivenoisecancellationtechnique.Theheartsoundsignalistakenasthereferenceinputsignalandtheartifactmixedbreathesignalistakenasthe primary input. Thenoisesignalconsistsoftheheartsignalandotherartifactnoises. ToremovethehighfrequencyartifactnoisesFIRfilteringis appliedtoboththesignals.Theoutputisthesignalwhichisdetermined bysubtractingthereferencesignalfromtheprimarysignal.

$$e(n)=b(n)–m(n)$$

Where,b(n)isthebreathsound,m(n)istheheartsoundandotherhighfrequencyartifactnoisesande(n)isthede-noisedbreathsounds[5].

Wealsoobservethesignalpatterns,westudytherelationshipsbetweenvarioussignalpatterns,westudythechangesinsituations andcometoknow about theevents,westudyeventsandthusunderstandthelawbehindtheeventsandusingthelaw,wecanpredictfutureeventsusingpatternrecognition.

D. *DecisionSupportUnit*

Theestimatedmean,frequencyrangeandthewaveformpatternofthede-noisedinputbreathesignalisgiventothedecisionsupportunit.Inthis unittheestimatedvalue iscomparedwiththepreviouslycalculatedandstoredmeandatabasevaluesfromvariouspatientswithvariousbreathediseases.After comparingitthedesired outputis giveninthedisplayunit.

III. ALGORITHMIMPLEMENTATION

Breathesoundsignalsaredifficulttoprocessduetotheinterference oftheheartsoundsandthevarioushighfrequencyartifacts.Thisisremovedbythecombinationalmethodofadaptiveandfrequencydomainfiltering.TheprocessingofthesesignalswasdoneinMATLAB.The IFFTofthesignalswereplottedusingMATLABtoobservethedifferentfrequencyrangesofthesignal.Powerspectrumversesfrequencies,ofthefilteredrespiratorysoundsignalswereplotted.Peakof thewaveformwasfoundatthemaximumvalueofthepowerdensity.Thefrequencyvaluewascalculatedanddependinguponthisfrequenciesfromvarioussubjectsthereferencedatabasevaluesarecalculatedandtheabnormalitiesinbreathesoundsignalsaredecided.

IV. RESULTSANDANALYSIS

Theresultsshownbelowarethesimulationoutputoftheinputsignalsfromvarioussubjectswithoutheartsoundsandothermuscleartifactsfromthecombinationmethodofadaptiveandfrequencydomainfiltering usingMATLABsimulationsoftware. Thewaveformforasampleobtainedfromapersonwhodoesn'thaveanybreatherelatedproblemsusingMATLABisshownbelow,
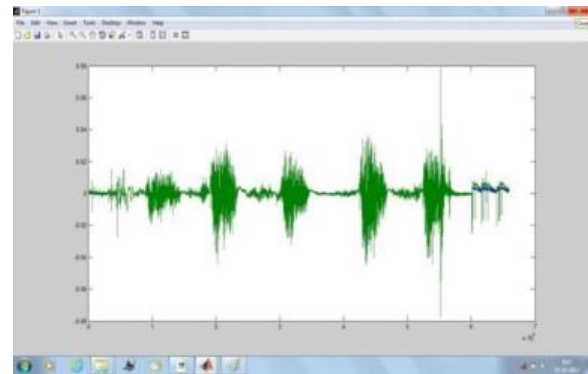

Fig.2Waveformofnormal personwith no breathingproblems

Thefrequencyrangeofanormalpersonwhodoesn'thaveany breatherelatedproblems,isfoundtobeintherangeof(-0.05-0.05)hertz.

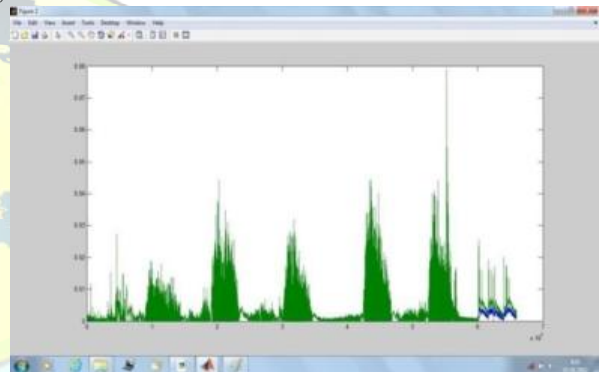TheIFFTwaveformforasampleobtainedfromapersonwhodoesn'thaveanybreatherelatedproblemsusingMATLABisshownbelow,

Fig.3IFFT plotof normalpersonwith no breathingproblems

FromtheIFFTplotthefrequencyrangeofnormalpersonwithnobreathingproblemsisfoundtobeintherangeof(0-0.05)hertz. ThewaveformforasampleobtainedfromapersonwithwheezingprobleminthenormalconditionusingMATLABisshownbelow.
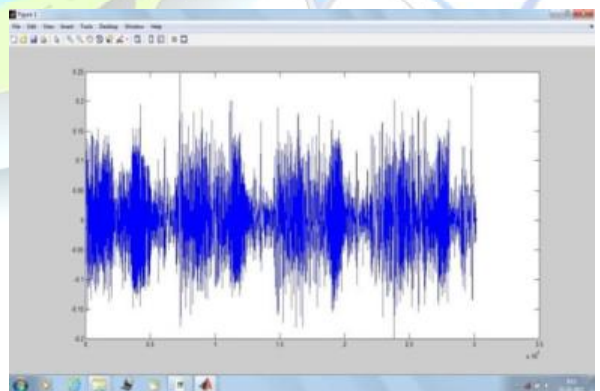

Fig.4Waveformof apersonwithwheezingproblem in normal condition

Thefrequencyrangeforasampleobtainedfromapersonwithwheezinginthenormalconditionisfoundtobeintherangeof(-0.2-0.2)hertz.

TheIFFTwaveformforasampleobtainedfromapersonwhohasw
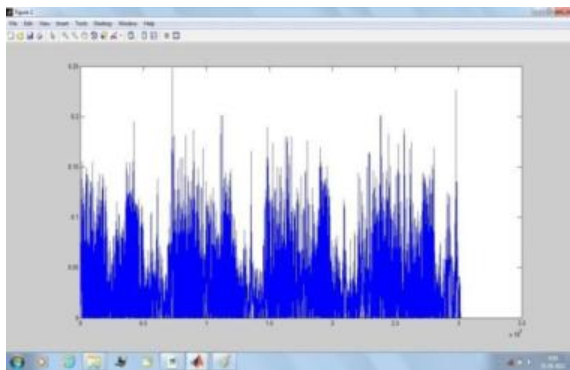heezingprobleminhisnormal
conditionusingMATLABisshownbelow

Fig.5IFFTplotof apersonwithwheezingproblemin normal condition

FromtheIFFTplotthefrequencyrangeofapersonwithwheezingp
robleminnormalconditionisfoundtobeintherange(0-0.2)hertz.
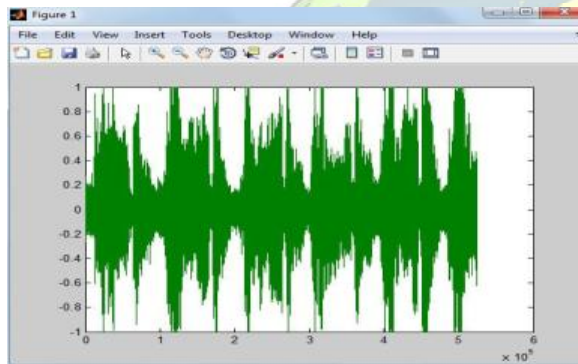Thewaveformforasampleobtainedfromapersonwhohaswheezi
ngproblemduringwheezingusingMATLABisshownbelow,

Fig.6Waveform of personwithwheezing problemduring wheezing

Thefrequencyrangeofapersonwithwheezingproblemduringwh
eezingisfoundtobeintherangeof(-1.0-1.0)hertz.
TheIFFTwaveformforasampleobtainedfromapersonwhohasw
heezingproblemduringwheezingusingMATLABisshownbelo
w,

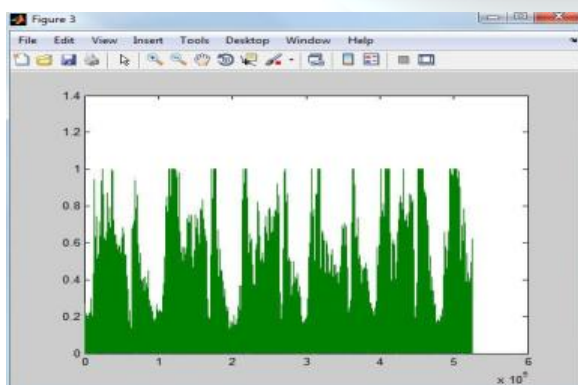Fig.7IFFTwaveformofpersonwith wheezing problemduring wheezing

FromtheIFFTplotthefrequencyrangeofapersonwithwheezingp
roblemduringwheezingisfoundtobeintherangeof(0-1.0)hertz.
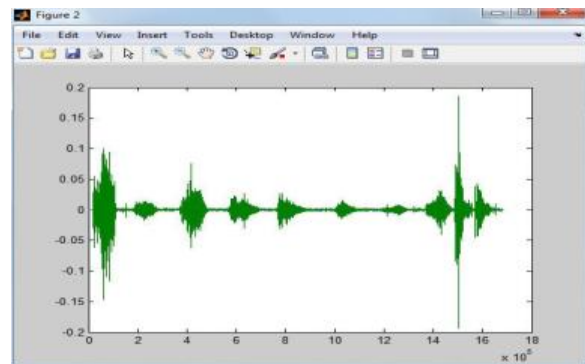Thewaveformforasampleobtainedfromapersonwhohascoldusi
ngMATLABisshownbelow,

Fig.8Waveformof apersonhaving cold

Thefrequencyrangeofapersonwithcoldisfoundtobeintherangeo
f(-0.15-0.1)hertz.
TheIFFTwaveformforasampleobtainedfromapersonwhohasco
ldusingMATLABisshownbelow,
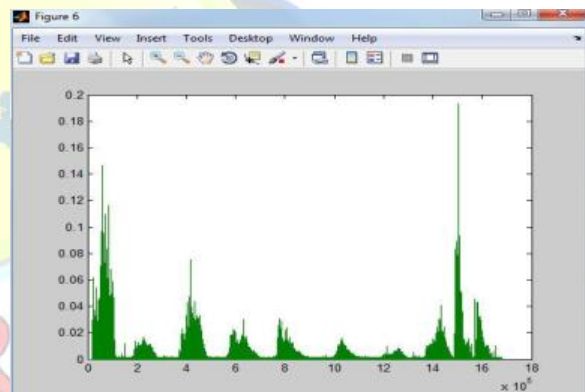

Fig.9IFFT Waveformof aperson havingcold

FromtheIFFTplotthefrequencyrangeofapersonwithcoldisfoun
dtobeintherangeof(0-0.15)hertz.

V. CONCLUSION

Theresultswehaveobtainedareaftereliminatingtheheartsoundan
dtheothermuscleartifacts.BycomparingtheMATLABsimulatio
nresultforthepre-
storedbreathsignalsofawheezingpatientintheirnormalandabnor
malstateswiththesimulationresultobtainedforthepre-
storedbreathsignalofa normalpersonandacold patient,
itisclearlyseenthatthereisaheavyfrequencyvariationinthesignal
sobtainedfromanormalpersoncomparedtothatofawheezingand
coldpatient.Anormalperson'sbreathingfrequencyliesintherang
e(-0.05–
0.05)hertz,awheezingpatientsbreathingfrequencyinnormalcon
ditionliesintherange(-0.2–
0.2)hertzandinsevereconditionliesintherangeof(-1.0–
1.0)hertzandthecoldpatientsbreathingfrequencyliesintherange
of(-0.1-
0.1).Fromthisitisclearthateachrespiratorydiseasepatientshaved
istinctbreathpatternandfrequencyrange.Hence,iftheprocessisfu
rtherrefinedrespiratorydiseasescanbeidentifiednon-
invasivelyandtreatedeffectively.Thiswouldeliminatetheexpens
ive

testsusedfordiagnosingtherespiratorydiseasessuchastheBronc
hitis,Sinusitis,PneumoniaandGastricproblem'setc.

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