Fuzzy based Expert system for sleep apnea diagnosis

Ms.Jeyalakshmi M.S [#1], Dr.C.R.Rene Robin M.E., Ph.D [*2],

[#1] *Assistant professor, Department of Biomedical Engineering*
Jerusalem college of Engineering,chennai,India
[#2] *Professor, Department of Computer Science and Engineering, Joint Director*
(Approval, Affiliation & Accreditation)
Jerusalem college of Engineering,chennai,India

Abstract — *Reduction and pause of airflow during sleep is the main characteristics of sleep apnea .It is becoming common in children. There are several tests that can be used to confirm the diagnosis. The treatment of sleep apnea can be either surgical or nonsurgical. In this paper a simple way of diagnosis of sleep apnea is devised by analysing the Heart rate variability (HRV) is being devised. A fuzzy based medical expert system is build to treat the sleep apnea using musical therapy is attempted. Further the stress level of sleep apnea patient is also evaluated. This medical Expert system helps the specialist to screen the patient easily for appropriate diagnosis.*

Keywords — *sleep apnea, medical expert system , fuzzy logic , hrv analysis*

I. INTRODUCTION

An APNEA is a episode of time during which breathing stops. In simplified terms, an APNEA occurs when a person stops to breathing for 10 seconds or more. Sleep apnea is a sleep disorder in which breathing is momentarily and continually interrupted during sleep. For people with sleep apnea, the combination of disturbed sleep and oxygen starvation may lead to hypertension, cardiac problems, mood swings and problems related to memory problems. Not everyone who snores has sleep apnea, and not everyone who has sleep apnea snores. This includes difficulties in diagnosing sleep apnea.Sleep apnea can be diagnosed with HRV analysis of Electro cardio gram(ECG).The ecg signal is acquired and HRV analysis both on frequency and time domain is done . A fuzzy expert system which is an important approach to intelligent computing systems is build using the HRV parameter such as rr-mean, rmssd, pnn50,LF/HF in lab view is designed .Musical therapy is given to the sleep apneic patient.

II. LITERATURE SURVEY

G.Acampora et al.[1]   proposed the concept of Evaluating cardiac health using Semantic techniques.

In this work the final result showed that the decreased level of HRV in subjects is stressed highlt and cardiac health of subjects are also calculated .

Task force of European society of cardiology[3] explains the clinical relevance and the standards of measurement and analysis of HRV parameter both in frequency domain and time domain

Deepa annamalai [4]et al,explains ECG signal generation,preprocessing and feature extraction in ECG signals. They also say that using simulation and virtual Instrumentation together in the design environment, allows to work on real-time ECG signals with great accuracy and convenience.

Komal R. Hole,et al [5] explains a rule-based expert system for memory loss disease by using rules and facts was devised . Case-based reasoning is used.this involves comparision of the value with with already saved subjects .

Maitri Patel[9] et al projected a web based expert system for diagnosis of viral infections.It is a rule A rule based expert system.It provide medical consultation along with analysis.It proves that it is more beneficial if it is used through web based applications

Jimmy singla[10] et al gave an expert system to diagnose the lung disease .He also explains various areas computer science,artificial intelligence , expert system.

III. SLEEP APNEA

Sleep apnea is a widespread muddle in which an individual stops in to breathe in sleep. When a person is in sleep the brain sends signals to the muscle centre responsible for breathing to start breathing

When the brain does not transmit the signal to the muscles to start the breathing cycle a breath and there will be no muscle get stimulated .This is termed as Central sleep apnea. This of sleep apnea is not much prevailing.

Obstructive sleep APNEA (OSA) is the frequenctly appearing sleep .In this type the brain sends the signal to the muscles but the muscle will not able to interpret the signal and the will be no muscle get involved in breathing.This is mainly due to the blockage in the air pathway .

Mixed sleep apnea, occurs when central sleep apnea and obstructive sleep apnea appears in an individual

IV. HRV ANALYSIS

Heart rate is the number of time the heart beats . It articulated as beats per minute (bpm). Heart rate variability (HRV) is a physiological occurrence in which the RR intervals and changes over time is investigated. HRV varies for different orthostatic positions like supine and standing positions. An indirect measurement from the ECG signal is the HRV. HRV analysis gives an effective quantitative marker of the autonomic nervous system (ANS) . of HRV is started from sympathetic and parasympathetic nervous system.

V. FUZZY LOGIC AND FUZZY EXPERT SYSTEM

A. Fuzzy Logic

Fuzzy sets were introduced by Zadeh in the year 1965 . Fuzzy sets are used to represent data under uncertainiies and imprecise es. Fuzzy logic provides an inference mechanism . This inferencing mechanism is similar to the inferencing mechanism of human and hence acan beapplied to knowledgebased systems.

B. Fuzzy Expert System

An expert system sometimes known as knowledge based system.It is a set of software programs that exploit the knowledge stored to solve problems in a specific domain which necessitate human expertise. Fuzzy Expert System (FES) accept the imprecise data and provides an exact output. It provides optimum , precise solution for the given problem . Fuzzy expert system is now becoming common in medical field

Fuzzy expert involves fuzzification of the input variable which are crisp in nature , finalizing the membership function, construction of inference engine ,defuzzification of the output value .In fuzzification process the crisp input which are limited to the domain is converted to fuzzy sets. There are different member ship function

triangular,sinusoidal,sigmidal,gausian The input for the defuzzification process coverts the fuzzy ouput into crisp number .It involves the aggreagation of output fuzzy set.After aggregation the final output is crisp number

VI. FUZZY BASED EXPERT SYSTEM FOR SLEEP APNEA DIAGNOSIS BASED ON EVALUATING STRESS PARAMETER

Sleep apnea is diagnosed based on the HRV features extracted from ECG. Both the frequency domain and time domain analysis was done using LabView.Fig 1 gives the overall architecture of proposed system .
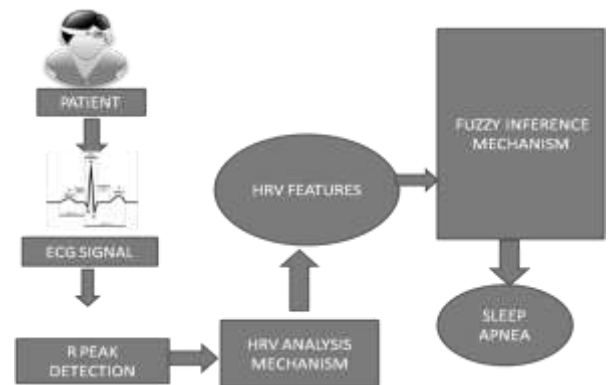

Fig 1.The architecture of the fuzzy expert system

A. HRV Analysis

The ECG signal is acquire from the subject using ECG limb electrodes, EKG sensor, DAQ. ECG is filtered using butterworth,.infinite reponse filter. Filter ecg is analysed for extracting HRV parameter . The time domain methods are done based on the include standard statistical methods.time domain analysis involves calculating standard deviations (SDNN) or density distributions of succeeding RR-intervals. For sleep apnea detection time domain parameters such as mean RR,RMSSD, pNN50 are analyzed . The frequency domain analysis is mainly aimed at identifying fundamental rhythms of heart rate time series . The frequency domain paramtes such as low frequecy(LF) and high frequency(HF), very low frequency(VLF) are obtained as shown in fig 2. HRV varies for different for different position For example HRV values are entirely different for orthostatic positions like supine and standing positions.
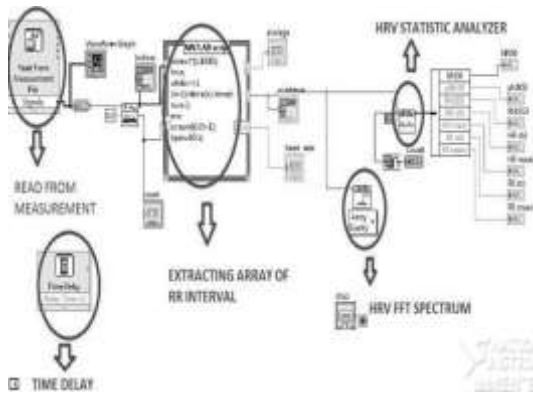
Fig 2.HRV analysis

B. IMPLEMENTATION OF FUZZY EXPERT SYSTEM

The membership function for the input variables means RR,RMSSD, pNN50,LF/HF are created here triangular membership function ,with the linguistic variable small medium and large are created. The membership the output variable depicting the sleep apnea therby the nervous level is being designed .Here linguistic variable is selected as shown .fig.3
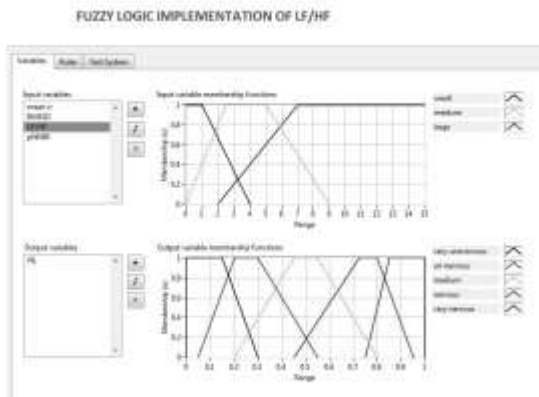

Fig 3.membership function for the input ouput variable

The fuzzy system designed is stored and it is loaded into the LABView by load fuzzy tool available in LABview Fuzzy tool box. Fuzzy rules involes multiple antecedent Hence fuzzy operator such as "and" , "or" is used to obtain an appropiate number that represents the result of the antecedent evaluation.An muliple input and multiple output fuzzy inference is selected

Fuzzy rule base is defined with taking all the input variable .It is in the the of IF – Then Rules for example

If rrmeanis small and rmssd is large and pNN50 is large and LF/HF ratio is low then NL is nervous
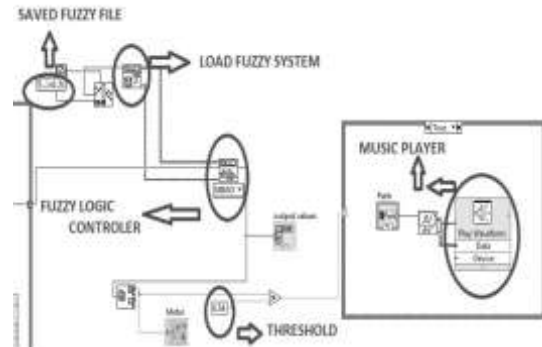

Fig 4.Loading of the fuzzy system into LABView

The ECG is acquired from different subjects of sleep apnea is analyzed using the fuzzy logic. The sleep apnea level was found to be extremely varying based on age. The performance of the subjects higher on age were found to be distinct from the performance of young aged subjects. The mean of RR-interval and pNN50 for apnoeic subjects is very low when compared to normal subjects. And LF/HF for apnea subject is very high when compared to normal subjects. This shows strong correlation between the sleep apnea individual and stressed subject

VII. TABLE I
INPUT AND OUTPUT FUZZY EXPERT

SUBJECTS	MEAN R-R	RMSSD	PNN50	LF/HF
SUB1	0.672	34.15	0	2.711
SUB2	0.667	36.54	0	2.711
SUB3	0.74	58.78	40	2.79
SUB4	0.714	41.41	20	2.676
SUB5	0.83	96.51	20	2.497
SUB6	0.26	92.84	33	1.118
SUB7	0.207	238.11	73.3	0.817
SUB8	0.19	234.28	83.33	0.85
SUB9	0.28	158.28	56.66	0.620
SUB10	0.34	266.98	63.33	0.537

The accuracy of the system can be improvised by using a neuro fuzzy system .In neuro fuzzy system, the fuzzy inference system is designed to learn from the input .Thus improving the accuracy.

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