Neuro fuzzy logic based self-diagnosis of health parameter using labview

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***Abstract*—** Vital signs monitoring systems are rapidly becoming the core of today's healthcare deliveries. The paradigm has shifted from traditional and manual recording to computer based electronic records and further to handheld devices as versatile and innovative healthcare monitoring systems.Healthcare is impending an acute phase. The age factor increases the ubiquity of incurable diseases. Most of the people are affected by cardiovascular and respiratory diseases but also economically high. Patients have to visit their doctor continuously to get their significant symptoms measured. Due to this patients in inaccessible areas are suffers from proper healthcare. Hence, there is a demand to evolve a system which will help the patients (elderly and rehabilitation after hospitalization) in minimizing continuous visits to the doctor and also assist in timely diagnosis of critical diseases with economically low cost.

This proposed project mainly focuses on developing such a system using Neuro-Fuzzy through adaptive learning system. The simulation results using LABVIEW shows that the performance of the neuro-fuzzy approach is admirable and easy to implement. This proposed system of self-learning continuously reads patient‘s pulse rate or heart beat rate and body temperature and patient related symptoms and create a database according to doctor and standard parameter to continuous monitoring to patient conditions and design alarm and preventive precaution and these values will be shown in graphical user interface monitoring system using labview software and sensors sense the health parameter ECG (AD82320, heart bit rate body temperature(LM35) using arduino microcontroller board.

Keywords- Labview, ECG, LIFA Tool, DSC and Advance signal processing tools, Neuro-fuzzy logic tool.

I. INTRODUCTION

One of the greatest technological shifts in every area of life, especially in daily life activities and healthcare delivery. The use of information and communications combined with medical and engineering technologies enable healthcare researchers to enhance patient monitoring at home, hospital and outdoorsRecently information and communication technologies (ICTs) are predominantly helping patients to improve health care. ICTs help patients in rural and remote areas along with health care professionals and academies in both the private and public sectors. In order to guarantee high quality health care of the patients at a reasonable cost, the health care sector needs new models for information handling and communication techniques to meet out the increasing population. The age factor makes the people more dependent due to deterioration in sensory, motor and cognitive physiological health capacities and becomes severe if they are sustained by pathological circumstances that are usual in the elderly patients. Hence there is an urgent need to provide convenient home atmosphere solutions for the elderly patients and enable them to play part in our society. Patients have to visit their doctor continuously to get their significant symptoms measured. Continuous monitoring of significant symptoms is crucial as they are essential indicators of one‘s physical well-being. The significant symptoms include pulse rate, blood pressure and body temperature. Commonly, it was a practice to get these significant symptoms measured when visiting the doctor. The ready for use devices in the market allow patients to measure these symptoms on a routine basis conveniently from their home and modify their diet and exercise as required to manage their symptoms in balance and hence to monitor their own health at an affordable cost. Physicians can access this data from their computers through wireless network and can analyze their patients‘ symptoms at their own time. These devices benefits both patients and physicians. If anomalies are noticed, they can roster a consultation with their patients. This paper focuses on the development of a reliable, low cost, non-invasive and non-intrusive symptom signs monitor that analyses the information acquired from measuring instruments to diagnose if an individual is within a ―normal‖ range. Neural Fuzzy Systems creates fuzzy rule and membership functions (MFs) for complicated systems for which the fuzzy may fail, limit itself to less number of rules. Whereas, the neural networks are able to adapt to the input changes until the output closely reaches the desired value which increases the reliability of the system. Hence a combination of fuzzy logic (FL) and adaptive nature of neural network is applied for detecting the health status of an individual. The neuro-fuzzy systems can handle any type of information, adjust to the imprecise data and are self-learning. The patient is checked for significant symptoms with the use of portable pulseoxymeter, thermometer and blood pressure monitor and the measured parameters are given as input to the proposed system. If the output represents that the patient is abnormal then the necessary medications are prescribed by the physician.

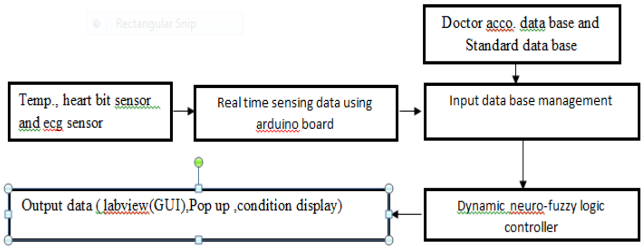

Fig.01 Basic block diagram of Neuro fuzzy logic based self diagnosis of health parameter using labview

1.1 Classification of Patient MonitoringSystems

Patient monitoring systems (PMS) are classified into various categories according to their operation. Remote health monitoring systems (RHMS) refer to those with remote access or systems which can send data to/or from a remote location. The function of this type of system ranges from a single to multiple parameters which cover a variety of symptoms and physical signs and can be utilized in individual homes as well as hospitals. Mobile health monitoring systems (MHMS) refer to smartphones, personal digital assistants (PDAs) and pocket personal computer (PPC) based systems which are used as the main processing station or in some cases as the main working module. RHMS and MHMS are considered to be more convenient and cost effective than traditional, institutional care, since they enable patients to remain in their usual environment whilst receiving professional healthcare services [15]. Wearable health monitoring systems (WHMS) refer to wearable devices or biosensors, consisting of WHMS, RHMS and/or MHMS that can be worn by patients. Smart health monitoring systems (SHMS) are often referred to as advanced technology or a new approach to healthcare monitoring, including vital signs monitoring systems (VSMS). They usually consist of smart devices or a so-called 'smart' approach to address healthcare issues. Vital signs include heart rate (pulse) (HR), blood pressure (BP), electrocardiography (ECG), oxygen saturation (SpO_2), body or tympanic (ear) temperature (Temp. or T) and respiratory rate (RR).

1.2 NI LabView

The NI LabVIEW stands for National Instrument Laboratory Virtual Engineering Workbench. LabVIEW offers a graphical coding to create an application. It offers a platform for designing a system virtually. It is also called as "G" which refers that coding is to be done in a graph form. LabVIEW programs are called as virtual instruments because it creates the hardware design/model on software platform. LabVIEW can be categorized into two main programming: Data flow programming and Graphical programming. The components of LabVIEW consist of namely acquisition, analysis and display. The three major aspects are required to complete a VI are,

- Front panel (GUI)
- Block diagram (Graphical programming)
- Colour code data connector

Controls are inputs: they allow a user to supply information to the VI. Indicators are outputs: they indicate, or display, the results based on the inputs given to the VI.The back panel, which is a block diagram,contains the graphical source code. All of the objects placed on the front panel will appear on the back panel as terminals. The back panel also contains structures and functions which perform operations on controls and supply data to indicators.The LabVIEW files are not any text files but they use an extension called Virtual Instrument file or VI file. This VI is only executable in LabVIEW only.

1.3NEURO-FUZZY SYSTEMS

Neuro-fuzzy systems are one of the most efficient hybrid soft computing techniques which combines the capabilities of neural networks with fuzzy systems. Thus it enables to acquire knowledge from experimental data. Because of its accuracy and interpretability, neuro-fuzzy systems have shown a great potential of success when applied in the medical field. The neuro-fuzzy systems are based on TSK fuzzy rules and have the structure of an MLFNN neural network with five layers. Each layer computes a fuzzy operation: Layer 1 is the fuzzification layer (Ai , Bi). Here each input is presented to each neuron and its output is the membership value of the input presented. There may be many neurons are available as fuzzy sets in its space for each input variable. Layer 2 is the conjunction layer (T). Here every neuron determines the conjunction of the antecedents of every rule. The neurons are proportional to the rules. Layer 3 is the normalization layer (N). Here each neuron determines the relative firing strength of the rule. Layer 4 is the inference layer. It determines the consequent value for each rule weighting the consequent function. Layer 5 is the defuzzification layer. It computes the overall output of all the rules by summing the individual consequents from the previous layer. The architecture of the system is presented in Figure 1. The advantage is that the system has a neural network that can adjust its weights to a set of data in a way such that the output of the network approaches optimally the experimental output. Hence the system simultaneously gains the advantages of fuzzy logic and the advantages of the neural networks.

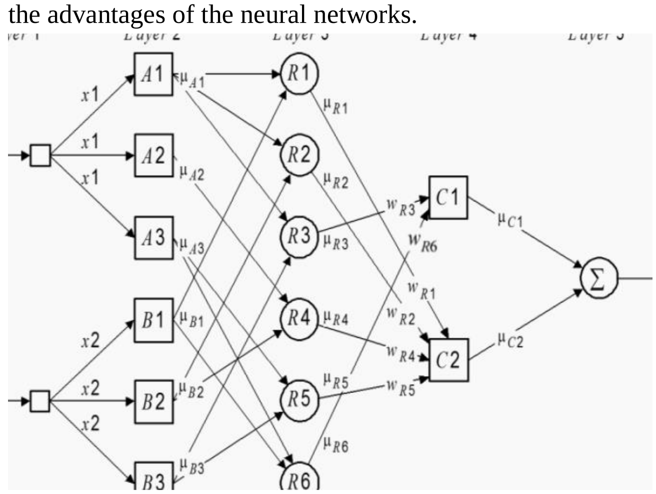

Fig.2 Architecture of Neuro- Fuzzy System

II. LITERATURE SURVEY

Research in Biomedical Engineering and Computational Intelligence is providing mechanisms to help people with some disabilities to perform simple tasks of day-to-day. Studies in this area are justified by the fact that approximately 15% of the World population has some type of disability. Because of physical disability, a significant portion of society has some personal limitations, therefore also for the professional and social life.

Mohanraj T et.al proposed a “Patient Monitoring System Using LabVIEW”. In this project, This monitoringsystem assists the doctor in carrying out medical tests and also provides patient-doctor interaction, when the doctor cannot be physically present near the patient. The proposed system uses a variety of sensors to monitor human body parameters like Temperature, Heartbeat rate, ECG and GSR. These sensors are integrated together and their output is made available to the doctor in graphical form**.** This LabVIEW front panel is published over the web server with both access and control permissions with a unique IP address. The doctor can make use of this IP address to access the monitoring system. This system is also capable of providing visual image/video to the doctor. The entire front panel is then published in the web server through the Web Publishing Tool in LabVIEW. The Web Publishing Tool automatically generates a unique IP address, through the remote Front panel can be accessed.[1].

Mohammed Abo-Zahhad**,**et al. proposed"An Efficient Technique for Compressing ECG Signals Using QRS Detection, Estimation, and 2D DWT Coefficients Thresholding" In the proposed method, , an efficient electrocardiogram (ECG) signals compression technique based on QRS detection, estimation, and 2D DWT coefficients thresholding. Firstly, the original ECG signal is preprocessed by detecting QRS complex, then the difference between the preprocessed ECG signal and the estimated QRS-complex waveform is estimated. 2D approaches utilize the fact that ECG signals generally show redundancy between adjacent beats and between adjacent samples. The error signal is cut and aligned to form a 2-D matrix, then the 2-D matrix is wavelet transformed and the resulting wavelet coefficients are segmented into groups and thresholded. There are two grouping techniques proposed to segment the DWT coefficients. The threshold level of each group of coefficients is calculated based on entropy of coefficients. The ECG signal is first bandpass filtered to reduce noise and differentiated to emphasize the large slope of the *R* wave; it is then squared to further exploit the high-frequency content of the QRS complex [2]

K. D. Johnson et al. proposed a methodology"Patients’ Vital Signs and the Length of Time between the Monitoring of Vital Signs during Times of Emergency DepartmentCrowding,"Vital signs or physiological parameters are the critical factors to determine an individual’s health status. For centuries, vital signs measurement has been the very first assessment, which includes counting the number of pulses in one minute and checking forehead palpation for body temperature manually. The monitoring of vital signs has been an important and critical procedure to gain information about the health status of patients in any given scenario. There have been continuous improvement and enhancement of the vital signs collection equipment, transmission protocols andgraphical presentation to the clinician in an informative and easy to understand approach. Often, vital signs are considered important in the early detection of health related issues only if they are collected and presented accurately [36].

SharanbasappaSali, et. Al proposed**“**Health Monitoring System Using Wireless Sensor Network”. the patient during the check up condition. Now a days medical equipments help the patient monitoring; also avoid lot of risk by Doctor‟s in ICU. These medical sensors are tattered on the wrist and finger to monitor the patient’s condition. These medical sensors will sense the condition of patient’s body and collect the data from patient body and send a message via Global System Mobile device to concern person or doctors. These data is communicated via ZeeBee wireless devicethe body condition and for storing electric potentials or (electrodermal) electromyography pursuit such as the skin response.Health care tracking system will monitor the patient continuously and simultaneously transmit the physiological data to the doctors and to other medical staff. Such monitoring, diagnostic device and sensor is used mainly in hospitals and mainly in the examination of patients‟ health condition.The main operation of a blood pressure sensor is the determination of a persons blood flow. Blood movement is the blood capacity that moves along any tissue in a decided interval of time in sequence to show tissue oxygen and nutrients transported in blood.[4]

Joyanta Kumar Roy, et al. proposed “The Wearable Eletronic Rescue System for Home Alone Elderly- Labview&Arduino Evaluation”,The system can detect abnormal condition of heart as well as sudden accidental fall at home. The system has been developed using Arduino Microcontroller and GSM modem. The entire program and evaluation has been developed under LabViewplatform The electrocardiogram (ECG) is the traces of Bio-electric potentials generated by heart and perform further diagnosis. The recorded ECG is often contaminated by several noises such as power line noises, patient –electrode motion artifacts, electrode contact noises, EMG signals of chest muscles and base line wandering. Among these noises, the power line interferences and base line wandering are the most predominant. Therefore proper ECG needs some preprocessing or filtering. These preprocessing modules may be hardware based analog /digital filter circuits or software based filter circuits under Math Lab or Lab View platform.[5]

P M Dafny Paul,et al. proposed “ADAPTIVE NEURO FUZZY CONTROLLED MACHINE HEALTH DIAGNOSIS USING LABVIEW” The artificial neural network (ANN) has the capability of solving the motor monitoring and fault detection problem using an inexpensive, reliable procedure. However, it does not provide heuristic reasoning about the fault detection process. On the other hand, fuzzy logic can easily provide heuristic reasoning, while being difficult to provide exact solutions. By merging the positive features of

ANN and fuzzy logic, a simple noninvasive fault detection technique is developed.[6]

AlexandreBalbinot,et al. proposed a paper "A Neuro-Fuzzy System for Characterization of Arm Movements" The myoelectric signal reflects the electrical activity of skeletal muscles and contains information about the structure and function of the muscles which make different parts of the body move. Advances in engineering have extended electromyography beyond the traditional diagnostic applications to also include applications in diverse areas such as rehabilitation, movement analysis and myoelectric control of prosthesis. This paper aims to study and develop a system that uses myoelectric signals, acquired by surface electrodes, to characterize certain movements of the human arm. The noise was eliminated by using typical filtering procedures such as band-pass filter, band-stop filter and by use of a good quality of equipment with a proper electrode placement. The signal was amplified with a high common mode rejection ratio (CMRR) amplifier (which provides a high common mode rejection ratio of 110 dB). A notch filter (60 Hz) was used to eliminate power line noise. Through a data acquisition board (NI-USB6008 with an acquisition rate of 1 kHz per channel). [7]

J. T. Martin et.al. proposed a paper , "Normal Vital Signs Belie Occult Hypoperfusion in Geriatric Trauma Patients,"vital signs are incorporated in every basic health assessment plan, as the simple measurements of physiological parameters that represent a set of objective data used to determine general parameters of a patient's health and viability. These values influence the medical professional's interpretation of a patient's overall condition and affect the course of treatment for each patient individually. Although vital signs monitoring is one of the most commonly performed task in healthcare, most of the literature has reported that the frequency of obtaining vital signs depends on hospital policy, nursing judgment or physicians' written instruction and is commonly based on the patient's health complaint. For example, acute stroke units have guidelines that require vital signs monitoring every 15 minutes during the acute phases of care and most intensive care units require a minimum of hourly records of vital signs.[8]

M. A. D. Minor et al. proposed a paper based on Pulse is defined as the palpable rhythmic expansion of an artery produced by the increased volume of blood pushed into the vessel by the beating of the heart. Pulse rate is the number of pulses recorded in one minute. In most clinical circumstances pulse rate is identical (very similar) to heart rate. Critical factors that affect the pulse rate are: age, existing/on-going medical conditions and medication. The duration of pulse monitoring for achieving an accurate reading of pulse is a debatable topic often reported in the literature as 15 sec or 30 sec or longer. [9].

B. Eberle et al.praposed a method based on"Checking the carotid pulse check: diagnostic accuracy of first responders in patients with and without a pulse,"It is reported that counting the pulse for 30 seconds or less is potentially problematic as an irregular pulse may not be detected during this interval. Moreover, the contradictory findings of studies reported on the relationship between the length of pulse assessment and accuracy .[10]

P. A. Bath et al a proposed a methodology"Understanding how information and ICTs can improve health,"Pulse oximeters usually use red and infrared lights to measure SpO2. These devices apply light near to a finger or body part and measure the amount of light received by a sensor under the body part. The difference of the absorbed signal can be mapped to a SpO2 value. This also provides a plethysmographic signal, from which heart rate and further blood flow information can be derived. In the busy medical environment, medical professionals are often loaded with many patient specific tasks and often there is a chance of missing a critical physiological measurement .[11]

T. Frommelt et al. proposed a method based on paper, "Accuracy of Different Devices To Measure Temperature,"The balance between heat generated and heat lost is represented as the body's core (internal) temperature. Core temperature is technically difficult to measure (except by an anal reading which is distressing for the patient) and in most clinical circumstances it is acceptable to approximate core temperature by measurement of peripheral body temperature in the mouth, ear (ear drum = tympanic membrane) or skin. Factors that may not affect the body's core temperature but can contribute to the inaccuracy of these peripheral measurements are consumption of hot or cold fluids, vasoconstriction of the peripheral arteries (e.g. cold hands) or wearing warm clothes. There are several factors that need to be considered in order to have an accurate and reliable peripheral temperature measurement. One study found significant differences in the accuracy and consistency of several commonly used devices for measuring temperature including tympanic, oral disposable, oral electric and temporal artery.[12]

M. A. Cretikos et. al. proposed a method , "Respiratory rate: the neglected vital sign," based on The number of breaths taken in a given time (usually 1 minute) is known as the respiratory rate and among all the vital signs, the respiratory rate, in particular, is often not recorded and/or neglected. This is in spite of the fact that an abnormal respiratory rate has been shown to be an important predictor of serious events such as cardiac arrest and admission to an intensive care unit (ICU).[13]

With the ever growing wireless/mobile based PMS, end-user acceptability is becoming an important aspect in the design of such systems. There is still an open research question to be addressed and the opportunity for research to address a particular question such as: Do wireless/remote/mobile based patient monitoring systems make a difference to the patient's (end-users) well-being? To answer this important question, many researchers have included the views of patients as well as of medical professionals at every stage of the design and development.[14]

T. Schleyeret al."Advancing oral medicine through informatics and information technology: a proposed framework and strategy,"The acceptance of any system in the healthcare industry depends on the user awareness and acceptability. The adaptation of a device within the clinical field is diminished if it is negatively perceived. User-centred design is essential in order to incorporate these perceptions into the product, especially at the earlier stages of the project development. When analysing the user's needs, contextual inquiry and the user's profiling, the designer should consider a number of factors such as task analysis, surveys, interviews and focus groups to address the user acceptability.[15]

P. Kulkarniet. al."mPHASiS: Mobile patient healthcare and sensor information system,"The reliability of monitoring systems is an important and open research question which is often considered as a critical parameter for the acceptability of the system. In the context of reliability and efficiency, the main purpose is to connect the patient monitoring systems to the user within their activity area (range) and model the regular activities. An alert is not triggered when the person is outside the coverage area or a specific range of more than a predefined threshold. Several methods are proposed for determining when an alert/alarm should be triggered.[16]

III.PROBLEM IDENTIFICATION

A number of critical issues considered important in this research are discussed here.

3.1 Reliability, Efficiency andAcceptability

With the ever growing wireless/mobile based PMS, end-user acceptability is becoming an important aspect in the design of such systems. There is still an open research question to be addressed and the opportunity for research to address a particular question such as: Do wireless/remote/mobile based patient monitoring systems make a difference to the patient's (end-users) well-being? To answer this important question, many researchers have included the views of patients as well as of medical professionals at every stage of the design and development.

3.2 Platform Variability and CostEffectiveness

The software platform is becoming a drawback to the development and implementation of mobile based PMS due to its multiple/different operating systems. The development environments for handsets cover a wide range of operating systems including: Microsoft Windows Mobile, Symbian, Blackberry, Palm OS, Mobile Linux, J2ME, Apple's iOS and the Android platform by Google.

3.3 Energy Usage and BatteryLife

When a device transfers a considerable amount of raw data to the central processing unit of a stationary computer, a large amount of energy is required which is normally supplied by a battery. For example, a blood pressure measurement every 10 minutes requires 35 mA/h (consider data transmission,valve and microcontroller).

IV. METHODOLOGY

Telehealth is one of the emerging areas of today's healthcare for the delivery of health information remotely. The worldwide acceptance of telehealth solutions is due to the use of the internet and related services, being 'online' at all times and the ease of communication anytime and anywhere. Moreover, the need for telehealth is increasing in older adults worldwide, for the purpose of reducing the cost and enhancing the quality of healthcare delivery. After in-depth market analysis, in this research we have collaborated with Medtech Global Limited for the delivery of the advanced healthcare solution called VitelMed.which acts as the base medium forthe proposed research project in order to have an overall integrated system: vital signs collection and monitoring, video conferencing and multiple physical signs interpretation.

Telehealth is often considered as the extension of telemedicine and is defined as: the use of information, computing, electronics and telecommunications technologies to provide healthcare delivery when patient and clinician are separated by a distance.Moreover, it employs advanced telecommunications technologies for the exchange of medical information via the electronic medium for the delivery of healthcare.Telehealth technologies range from simple text messaging and phone calls to advanced remote patient monitoring and to the innovative real-time monitoring of vital signs and video consulting (two-way video conferencing) .It uses the combination of digital video cameras, simple-online questionnaires, medical measurement devices and/orsensors.

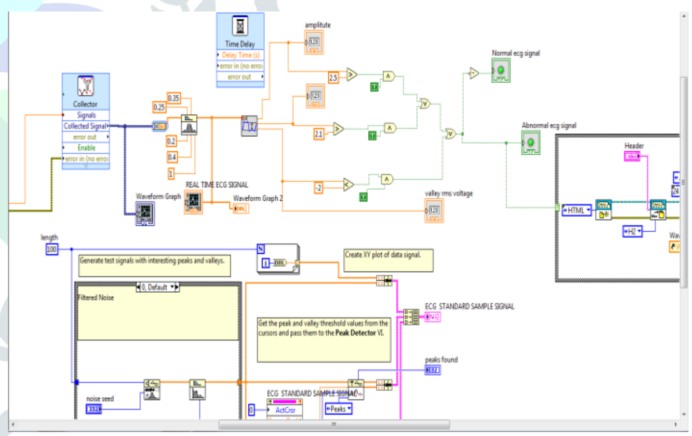

Fig. 3. Labview based block diagram Neuro-Fuzzy Based Self Learning System ForDiagnosis Of Health Parameter

LabVIEW is the Laboratory Virtual Instrumentation Engineering Workbench. LabVIEW is constructed to be used with hardware supported by the National Instruments ni-visa driver. This covers most USB, PCI, and PXI data acquisition devices with analog input. A simulated Ni-visa device is a device created using the arduino microcontroller Simulated Device option in the menu of MAX for the purpose of operating a function or program without hardware.

IV. RESULT

Lab view continuously compares the sensed value with the predefined database critical safety values and then gives the alert indication signal accordingly to the heartbeat rate and medical parameter of the person. Any deviation from the reference or set value can be indicated by an alert pop up.

The evaluation of the proposed system has been directed towards three primary aspects. These are:

Utility as a remote and wireless vital signs recording and monitoring – is reflected in the sensitivity and specificity of the proposed system – that is, whether it generates an alarm or prompt in response to an adverse condition in the patient, and the rate of false alarms. Moreover, identified problems should be correctly classified. Results pertaining to this aspect are presented in thissection.

Usefulness for physical signs interpretation – the usefulness of the system as an aid to interpreting multiple physical signs.

Precise enough to predict falls risk – precision of the falls risk assessment is somewhat difficult to determine due to the fact that the patients who were identified as having a low, medium or high risk of falls cannot be tested in a real-time hospital environment due to the project time constraints. Such a project would require at least several months (possible longer depend on the falls incident rate) of patient monitoring with respect tofalls.

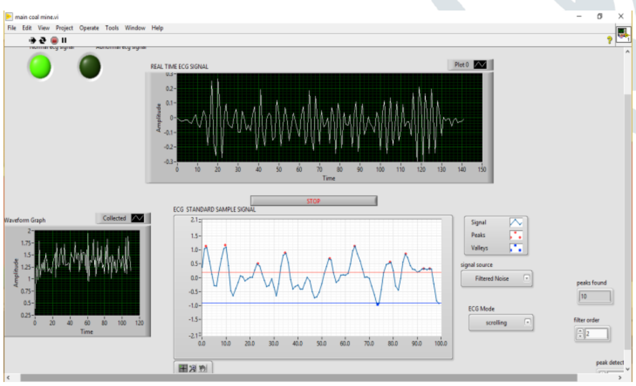

Fig.4; ECG signal at Normal Health Condition

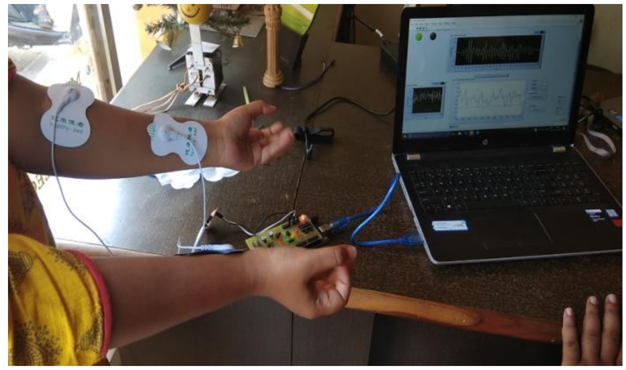

Fig.5. Hardware Set up to execute Neuro-Fuzzy Based Self Learning System For Diagnosis Of Health Parameter

IV. CONCLUSION

Neuro-Fuzzy logic based vital signs monitoring systems mimic the expert's behavior by executing a sequence of smart/intelligent algorithms which interpret vital signs in a meaningful manner fast and accuratelyThese wearable physiological sensors available on the market consists of wearable devices, such as wrist devices, ear-lobe sensors, finger sensors, arm bands, chest belts, waist belts, etc. In the latter case, the distributed biosensors are capable of wirelessly communicating their measurements and thus constitute a body area network, which can be formed through Bluetooth-enabled devices. Basic signal conditioning operations such as filtering, amplifying, and normalisingeven basic feature extraction - are usually performed by dedicated hardware.

Handling the communication with the on-body-distributed biosensors,which involves collecting physiological measurements and voice recordings, communication synchronization, sending control signals for adjusting sensors' parameters, e.g., sample rate, accuracy and receiving sensor statusdata.

The majority of systems used today have adopted the generalised monitoring model based on either set threshold ranges or standard deviation changes which are implemented specifically for certain age groups

The aim of the proposed paper is to provide multiple combinations of extracted parameters in order to help clinicians with detection and estimation of health conditions or with early 'diagnosis'. Physical signs are classified as priority-2-warnings and priority-1-alarms. Priority 2 warnings are generated when the vital sign(s) changes.

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