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An Indigenous Device Used to Monitor Respiration Rate

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ABSTRACT

The objective of the proposed work is to introduce a real time solution that will be suitable for various environmental conditions and to design a device for underdeveloped regions which easily measures the respiration rate. The device tends to calculate patients breathe by detecting the difference in the temperature whenever the patient inhales and exhales via the mask with the help of thermistor. The feature of this method comprise two alarms produced by a piezoelectric speaker which goes off when the patient stops breathing and another alarm indicates when the battery is low. This idea is also implemented and analyzed using Lab VIEW. Therefore we aim for developing low-cost, thermistor based respiration monitor that can be easy to use, non-invasive and comparatively reliable.

Keywords: Respiratory Rate, Thermistor, LabVIEW

1. INTRODUCTION

Vital signs plays an important role in measuring one's most basic function and one among the vital signs is the respiration rate. The respiration rate is number of breaths a person takes per minute. The breath rate is usually measured when a person is at rest and just involves counting the number of breaths per minute or else by counting the number of times the chest rises. Normal respiration rate for an adult person at rest ranges between 15 to 20 breaths per minute. Respiration rate over 25 breaths per minute or fewer than 12 breaths per minute (when at rest) may be considered abnormal. Recent trends for monitoring respiration rate includes Chest force sensor (to detect force produced by chest), Impedance pneumograph (uses skin electrode to calculate transthoracic impedance) and Pulse Oximetry (measures O_2 saturation in blood).There exists many other commercial device to monitor respiration rate , that uses motion or force sensors to determine respiration rate.

The main theme of this project is to design a respiratory monitor for low-resource environments. The device calculates patient's breathing rate by detecting changes in temperature of the air that the patient breathes, where the temperature sensor will be placed in the oxygen mask. The hot air that a person expires changes the resistance of thermistor which in turn proportionally changes the voltage of thermistor. From the obtained voltage the different respiratory conditions can be monitored. The features of this device will include alarms generated by a piezoelectric speaker which indicates condition of a person's respiration.

One advantage is that it will be built as a standalone device with small size and lightweight. The main purpose of this project is to develop a low-cost and user friendly system as well as a device that meets the social relevance. This device allows the patients to measure their own vital sign and provide the health care professionals with the facility to monitor the patient's health conditions quickly and easily.

Respiration: Exchange of gases between alveoli and blood which occurs by simple diffusion is called as respiration. There have been two types of respiration internal and external respiration.

Internal Respiration: The progression of breaking up of food particles in the presence of oxygen to generate energy at the acellular level. Internal Respiration is an active process, as it requires energy. It is a chemical process.

External Respiration: This involves a sequence of taking in oxygen and giving out carbon-dioxide. External Respiration is a physical process which consists of inhalation, exhalation as well as relaxation. Thus it is a mechanical process.

Previous work: It has been stated that by using PPG signal obtained with the help of IR sensor contains some respiratory information (Binu, 2015). Temperature fluctuations are being measured during the breathing phases using thermistor which is inserted into the nasal cannula. The resistance of the thermistor is decreased as the local temperature is being increased during expiration and the resistance increases during inspiration. The thermistor is connected to the voltage divider circuit and the output voltage is connected to pulse board to record the temperature fluctuation. Other methods performed for measuring the respiration rate includes 1) TMP100, a digital temperature sensor that helped us to observe a small difference in the degree of hotness in the air breathed by a person during process of inspiration and expiration, 2) Respiratory belt transducers also helped us in measuring the change in circumference of the chest, 3) Thoracic expansion which includes sensor was placed on the thorax in order to measure the respiration rate, 4) Battery powered wearable sensor which is used for detecting the sound generated by the turbulence occurring in the respiratory system were analyzed , 6) MEMS based capacitive pressure sensor which is used to measure the respiration rate was studied.

System design:

Temperature Measurement: A Thermistor is a component similar to resistor but this is built with semiconductor process that makes it highly sensitive to changes in temperature. Thermistor SMD0603 NTC which is shown in the Fig.1 is used for this project whose resistance is dependent on temperature, based on this fact a respiratory monitor is designed. The thermistor is being fixed inside a standard mask i.e. it is directly placed in front of the patient's mouth. As the patient inhales/exhales, the hot air changes the resistance of the thermistor as a result the voltage across the thermistor will also change proportionally. Hence it would be possible to use voltage as an indirect measurement of breathing.

Analog Comparator: The breathing rate could be determined by using an analog comparator to compare the actual voltage and the voltage taken as reference to find the error value. From various literary surveys we came to know that breathing signal will be approximately similar to the sine wave with the DC offset, hence we decided to pick out the reference voltage to be at a DC offset. As the obtained signal is similar to the sine wave with DC offset and thus the average value of the signal will also be DC.Thus the obtained output is being amplified.

Amplification Process: Since the change in voltage for any kind of thermistor is too small, henceforth for getting considerable change in voltage operational amplifier with high pass filter is being designed.An Op Amp to be decided might amplifies the minimum changes in the voltage and thus output of this circuit can be given to the microcontroller for further processing.

Microcontroller Unit: When identifying the number of I/O ports and ADC channels required, the ATMEGA1284P microcontroller as shown in Fig.2 would be favorable and the components might be supplied via the standard AC power supply or 9V battery can be used as a source. The actual calculation of the breathing rate will be performed by taking the samples from ADC. The output from MCU is then displayed using LCD display.

LCD Display: Respiration rate will be determined and displayed as breaths/min on a Liquid Crystal Display as shown in Fig.3.This helps the one who is monitoring the patient to see if the patient is respiring too fast or slow. LCD display will also be powered by battery and a button, which controls the state of ON and OFF of LCD.

Power Source: Since the main objective of this proposal is to develop a respiratory monitor for low resource environment, thus a 9V battery is used which would be easily available. It is planned to design the system such that either power supply or battery source could be used as a power source.

Emergency Indicators: The device is planned to be designed with four different alarms being generated by a piezoelectric speaker. The first alarm aims to indicate when the patient doesn't breath. The second alarm will be the signal when the device is passing on low battery. Other two alarms focuses on indicating the type of breath, either Tachyapnea or Bradyapnea (Karthik Mohan Rao, 2015).

Fig. 1. Temperature Sensor NTC SMD0603

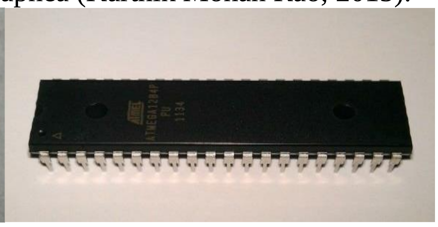

Fig. 2. ATMEGA 1284P (Courtesy:http://baldowl.github .io/ 2012/10/27/bigger-avr-mcuatmega1284p.html)

Fig.3. LCD Display (Courtesy:http://www.piccircuit.co m/s hop/display/107-4x20-lcd-displayyellow-backlight.html)

Working: The temperature sensor NTC SMD0603 was used to obtain the respiratory temperature both inhalation and exhalation. The output voltage of the temperature sensor was in the range of millivolt (mv). Another thermistor was used which measures the external temperature and its output is used as a reference. As shown in Fig.4, the temperature in terms of actual voltage and reference voltage were compared using a comparator and its output voltage was amplified using an amplification circuit. This amplified output was provided as input to Atmega1284p microcontroller. The change in the input voltage was considered as one cycle of breathing and the corresponding respiration rate was calculated.

Detection of respiratory conditions using lab view: LabVIEW which stands for Laboratory Virtual Instrumentation Engineering Workbench, is a graphical computing environment for instrumentation, system design, and signal processing. Unlike text based programming language, LabVIEW uses the data flow programming, where the flow of data determines execution. The flexibility, modular nature and ease to use programming possible with LabVIEW, makes it less complex**.** LabVIEW is a graphical program development application developed by National Instruments for: Interfacing PC with the instruments, Collecting ,storing ,analyzing ,transmitting measured data, Developing program in a graphical environment, Providing an effective user interface (Archita, 2015). In this work LabVIEW is used for processing and analyzing the respiratory signal obtained with the help of thermistor (Roxana Alexander Cernat, Constantin Ungureanu, Ronald Aarts, 2011).

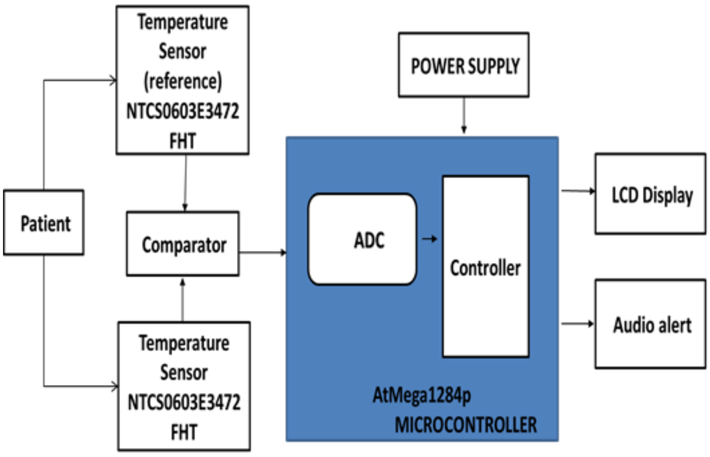

Fig.4. Schematic Diagram of Respiratory Monitor

A. Analysis Module Design: LabVIEW has the capability to connect and interact with a large number of hardware devices and hence the block diagram given in the Fig. 5 is designed in a way that when the hot air falls over the sensor during exhalation and inhalation, the change of output voltage is detected for each respiratory cycle. The change in voltage corresponds to respective change in temperature while breathing; hence the breathing rate is calculated depending upon the change in input. The block diagram comprises of NI-DAQ (USB-6009) through which the respiratory signal is obtained. Here the signal is filtered so that the noise may be removed. It is designed such that whenever the patient breathes, the air that falls over the thermistor induces its resistance to change which leads to change in voltage. The breathing condition is determined in accordance with how fast the voltage changes in a minute, if the breathing rate is greater or less than normal then an indication is provided to show the abnormality (Kiran Balaji, 2014).

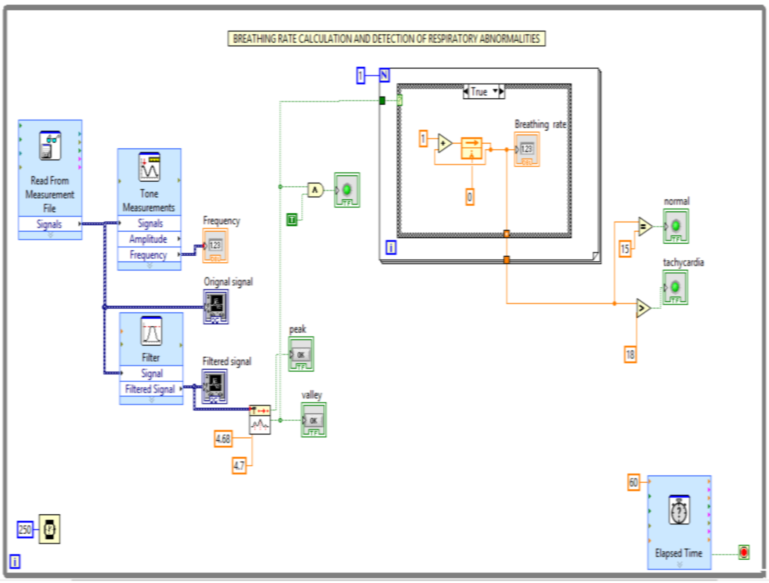

Fig.5.Block Diagram for Detection of Respiratory Rate Using Lab VIEW

B. Output and Results: The waveform as shown in Fig. 6obtained via DAQ from thermistor indicates the respiration processes of inhalation and exhalation. The noisy signal is processed using LabVIEW such that the noises are filtered and added with certain conditions to obtain the abnormalities from breath of different patients. The conditions are set for elapsed time of 60 seconds.

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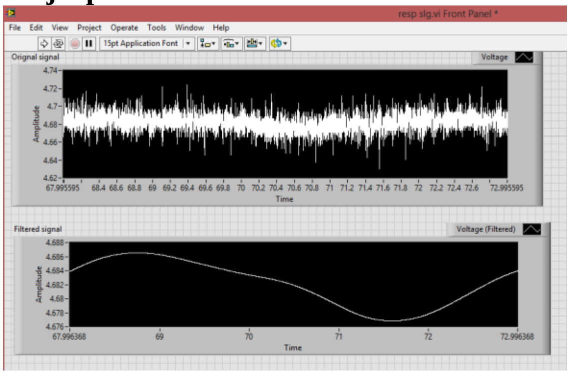

Fig.6.Noise Free Respiratory Waveform

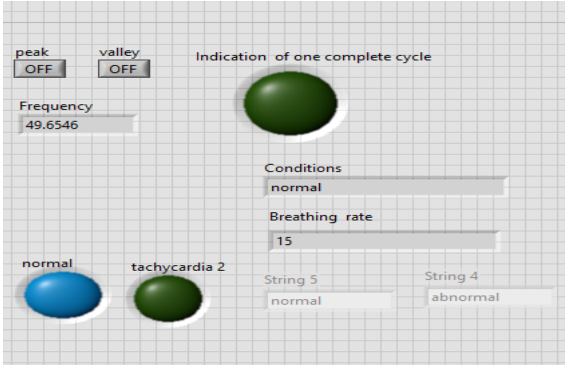

Fig.7.Determination of Breathing Rate

3. RESULT AND CONCLUSION

Respiratory monitor which measures the respiration rate of the patient is designed and it displays the value in LCD. The two alarms have been used to indicate the abnormalities and for checking the condition of battery/power source among the alarms one indicates when the patient is not breathing referred to as apneatic condition while the other indicates when the battery power is low. Thus a device is designed which is of low-cost, easy to use and reliable as shown in screen shot Fig. 7.

Future work: The developed device has been considered for further development such that to produce a miniaturized device which sends the data through a wireless communication to the corresponding physician for further analysis ,so that it could reach even the low resource environments.

REFERENCES

Archita, Human Body Respiration Measurement Using Digital Temperature Sensor with I2C Interface, International Journal of Scientific and Research Publications, 03(03), 2013, 1-8

Binu E, Shivaani Varsha N, Real Time Monitoring of Respiratory Parameters Using a Wireless Portable System, 3(1), 2015, 283-287

Karthik Mohan Rao, Sudarshan BG, Design and Development of Real Time Respiratory Rate Monitor Using Non-invasive Biosensor, International Journal of Research in Engineering and Technology, 04(06), 2015, 437-442

Kiran Balaji PS, Anand Jatti, PPG Signal for Extraction of Respiratory Activity and HR Monitoring of CHF Patients, International Journal of Advanced Research in Computer Science and Software Engineering, 4(1), 2014, 659-666

Roxana Alexander Cernat, Constantin Ungureanu, Ronald Aarts, Real-Time Extraction of the Respiratory Rate From Photoplethysmographic Signals Using Wearable Devices, 46(6), 2011, 523-539.