Premature Infant Apnea Detector And Recovery Stimulator [PIADARS]

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Abstract- Apnea is respiratory disorder. In Greek apnea literally means "without breath", In general apnea can be defined as respiratory pause for a period of more than 20 seconds or interruption in airflow or respiratory pause accomplished by brachycardia, this condition is found to be more common in premature babies. Our project's main aim is to develop a system which can monitor the pulse rate, temperature and respiratory signals (contraction and expansion of lungs which is been obtained as the bio-signal) of premature infants and to detect the apnea to activate the stimulator to make the infant recover immediately from the disorder. At the same time alarm is turned on to alert infant carer. This detection process is done by obtaining respiratory signals from infant non invasively. The bio signals from the infant are acquired and analyzed using LabVIEW setup (both software and hardware), which will ease in cost, availability, accuracy and implement. If the acquired bio signal is found to be abnormal (or) apnea, then the stimulation is activated, which consist of stepper motor setup with stimulation tools such as soft brush. In the stimulator model, stepper motor is programmed to have to and fro motion. So, that the brush has contact with the body of the infant, to stimulate for recovery. The brushes are positioned to the region, where the body is rightly sensitive to stimulator.

Keywords – Apnea, brachycardia, bio-signal, premature, stimulator

I. INTRODUCTION

Apnea of prematurity is defined as respiratory pauses for a period of more than 20 seconds or interruption in airflow and these respiratory pauses is accompanied by brachycardia, central cyanosis or O_2 saturation < 85% in neonatal i.e. babies born at less than 37 week gestation and with no underlying disorders causing apnea. About 25% of preterm infants have apnea of prematurity, which usually begins 2 to 3 days after birth and rarely on the first day, apnea that develops after 14 days of birth signify a serious illness i.e. more severity is observed in the healthy infants than apnea of prematurity

II. LITERATURE SURVEY

In 2007, Al-Abed, Mohammad, Behbehani, Khosrow, Burk, John, R., Lucas, Edgar, A., Manry and Michael developed "Cross correlation and scatter plots of the heart rate variability and R-peak Envelope as features in the detection of obstructive sleep apnea". This paper Cross correlation and scatter plots of the heart rate variability andR-peak Envelope as features in the detection of obstructive sleep [1].In 2011, Chienchang hsu and Ping-ta shih proposed a paper on "An intelligent sleep apnea detection system". This paper addresses to adjust the transmission power so that each service maintains its signal to interference ratio and used in power control and rate management in multimedia CDMA cellular systems [3].In 2010, Lauren Jean, Laiho, Clague, Robert Crockett developed "A Standoff Approach to Monitoring Infant Apnea". This paper deals with overnight testing on adults with apnea were done using the measurement of the co2 level [5].In 2010, Swain, N.K., Anderson, J.A., Ajit Singh, Swain, M., Fulton,M., Garrett,J. and Tucker,O proposed a paper on "Remote data acquisition, control and analysis using labVIEW front panel and real time engine". In this paper it deals with the Real-time ECG transmitting system schematic is used. It contains electronic and software components. The electronic component covers two aspects. The first ensures the acquisition and transmission of the signal using Acquisition Card DAQmx, or Digital

Multimeter (DMM); the second shall receive the signals on the server side using LabVIEW applications [9].In 2010, Varady, P., Micsik,T., Benedek,S and Benyo,Z developed a paper "A novel method for the detection of apnea and hypopnea events in respiration signals". This use sophisticatedly pre-processed signals. The development of the networks was based on training sets from the polysomnographic records of nine different patients [12].

III. METHODOLOGY

The overall block diagram consists of a signal conditioning unit, a data acquisition unit, a personal computer, a driver circuit, a stepper motor and a stimulator. It explains the detection of apnea and the process of stimulation when apnea occurs. It also consists of many sensors like temperature sensor, respirator sensor and a pulse rate sensor. It is explained in Figure 3.1. And the method is explained in Fig.3.2 .The different blocks of the overall block diagram are explained below.

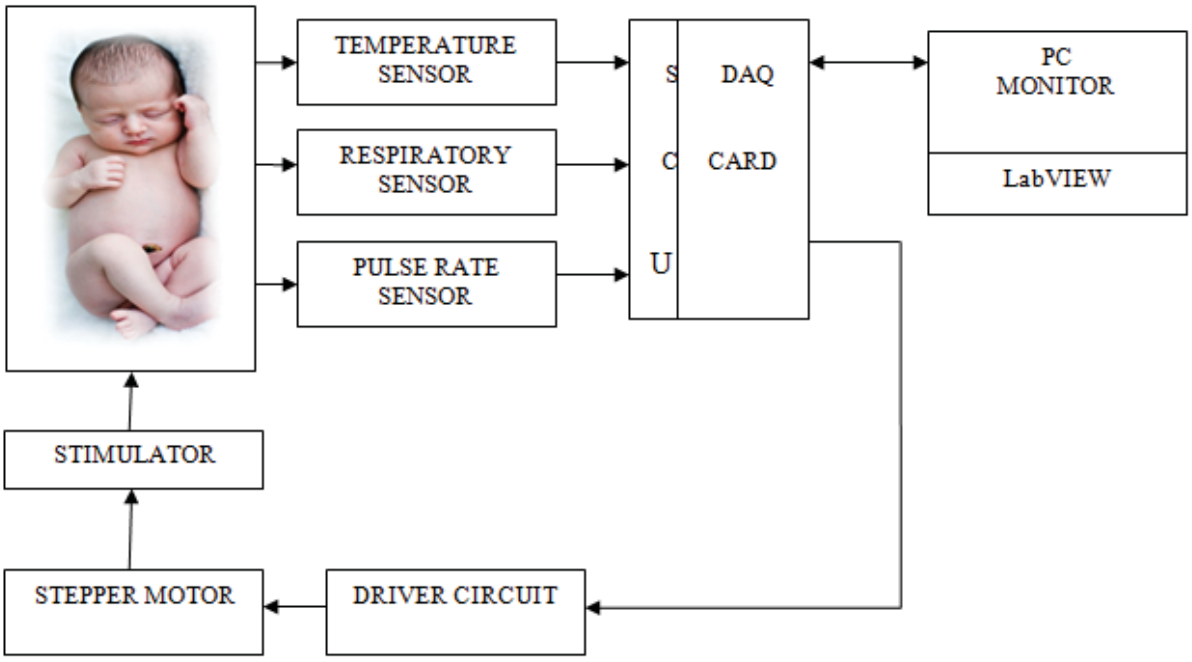
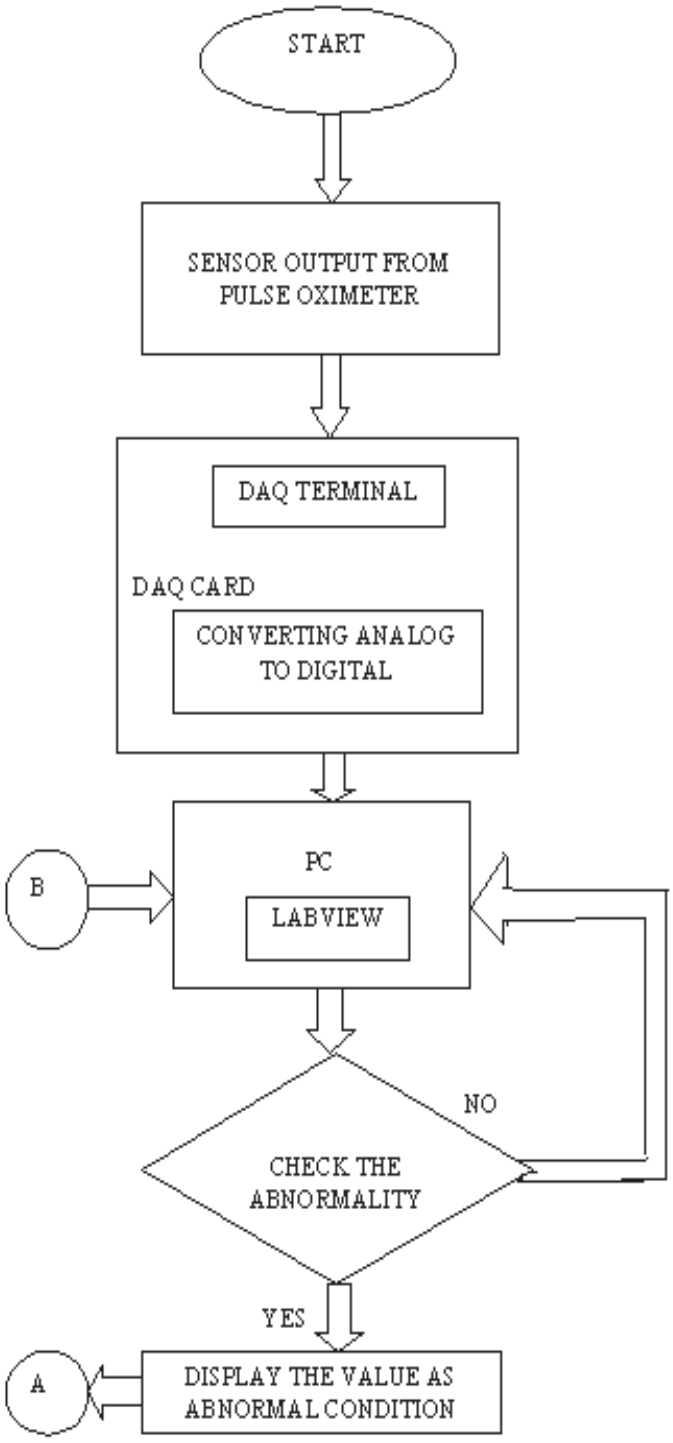


Figure.3.1 Over all block diagram

3.1 FLOWCHART

The temperature, respiratory rate and the pulse rate is been acquired from the sensor and the reference value is been compared with the actual value based on the Table 7.1. When the reference value is not met then the abnormality is been showed and the simulator is switched on based on the condition.


START
SENSOR OUTPUT FROM PULSE OXIMETER
DAQ TERMINAL
DAQ CARD
CONVERTING ANALOG TO DIGITAL
B
PC
LABVIEW
NO
CHECK THE ABNORMALITY
YES
A
DISPLAY THE VALUE AS ABNORMAL CONDITION

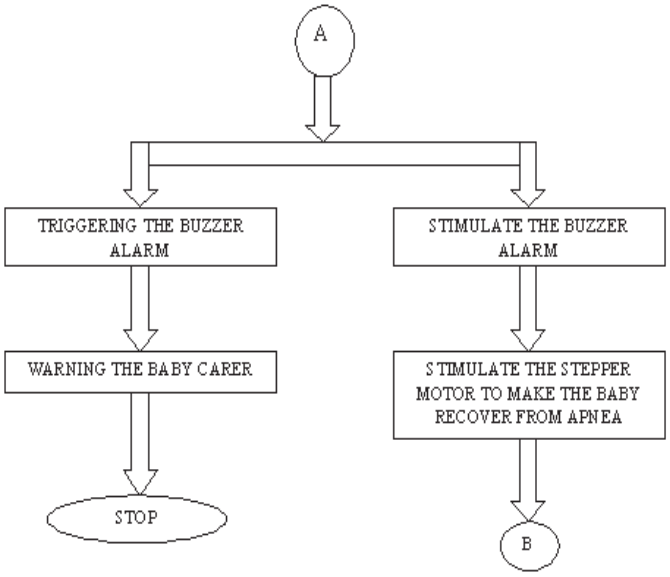


Figure 3.2 Flow chart of overall operation

3.2 SENSOR

To measure the temperature of the infant the most important thing is to take an accurate temperature, because a fever is one of the key indicators of a potentially serious infection in the first months of your baby's life. Here the temperature used is Disc Type Negative Temperature coefficient Thermistors. Temperature sensor is used to sense the body temperature of infant in the incubator. The output of the temperature sensor is given to the amplifier to amplify the weak signals. The amplified signal is passed to the analog to digital converter. The analog to digital converter converts the analog signal to the digital signal. The digital signals are given to the PC where it is compared with the reference value that is already stored in the PC. It is only used for monitoring purpose [10]. The front panel s shown in Fig.3.3.

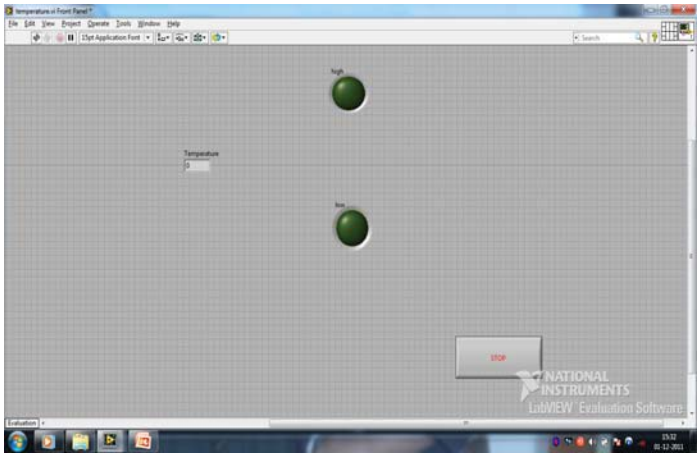


Figure 3.3 Front panel of temperature measurement

Exhalation is generally a passive process to detect apnea. During forced exhalation, as when blowing out a candle, expiratory muscles including the abdominal muscles and internal inter-costal muscles generate abdominal and thoracic pressure, which forces air out of the lungs. The most common method of calculating respiratory rate for babies is impedance pneumography or skin impedance technique because these are the non-invasive techniques than one year, for babies ageing from one to two is 25-35 bpm. This circuit is designed to measure the respiration as shown in Figure 6.11. In this circuit two thermistor is used for the respiration measurement which are connected in the resistor bridge network. The respiratory sensor is used to measure the respiratory rate of the infant, by fixing the

sensor near the nose of the infant. Then the output signal is given to DAQ in which the signal is amplified and converted into square pulses. This count value is taken as respiratory measurement of the baby which is then compared with reference value in the PC. If it does not matches the reference value apnea is detected. Once the apnea is detected, an alarm is induced to alert the carer and at same time infant is stimulated automatically using the soft brush with help of stepper motor. The front panel s shown in Fig.3.4

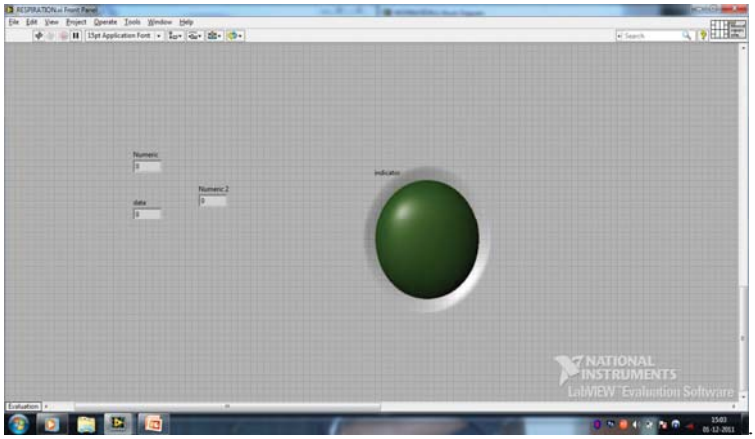


Figure 3.4 Front panel of respiration measurement

Producing an electrocardiogram, or ECG (also abbreviated EKG), is one of the most precise methods of heart rate measurement. Continuous electrocardiographic monitoring of the heart is routinely done in many clinical settings, especially in critical care medicine. Commercial heart rate monitors are also available, consisting of a chest strap with electrodes. Heart rate monitors allow accurate measurements to be taken continuously Pulse of an infant is measured by using pulse rate sensor which is processed by using the similar concept of respiratory sensor. The slight modification is to place the pulse rate sensor in the finger. The front panel s shown in Fig.3.5

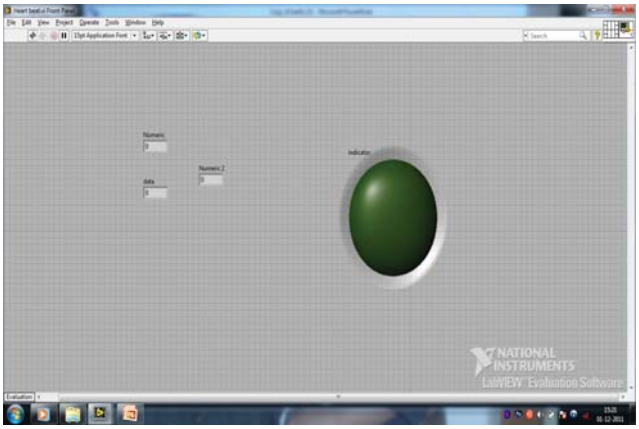


Figure 3.5 Front panel of the pulse rate measurement

3.3 DAQ CARD

Data acquisition (DAQ) card is used to acquire an electrical or physical phenomenon such as voltage, current, temperature, pressure, or sound. PC-based data acquisition uses a combination of modular hardware and flexible software (LabVIEW) to transform standard computer into a user- defined measurement or control system.

3.4 PC MONITOR

The PC monitor consists of LabVIEW software. The reference value of the infants bio-signals is stored in the PC through LabVIEW which is then compared with the acquired bio-signals of the infant through DAQ.

When the abnormality is detected the initiating signal to the driver circuit to drive the stepper motor is given through the DAQ [9].

3.5 STIMULATOR

The stimulator consists of a rod to which soft brushes are connected at both the ends. When stepper motor rotates thus setup also rotates to stimulate the infant [11].

3.6 STEPPER MOTOR

Stepper motors operate much differently from normal DC motors, which simply spin when voltage is applied to their terminals. Stepper motors, on the other hand, effectively have multiple "toothed" electromagnets arranged around a central metal gear, as shown at right. To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. When the gear's teeth are thus aligned to the first electromagnet, they are slightly offset from the next electromagnet. So when the next electromagnet is turned ON and the first is turned off the gear rotates slightly to align with the next one and from there the process is repeated. A stepper motor (or step motor) is a brushless, electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely without any feedback mechanism (see open-loop controller), as long as the motor is carefully sized to the application. Stepper motor is used to stimulate the baby when apnea is detected using stimulation tool such as a soft brush [7]. The front panel s shown in Fig.3.6

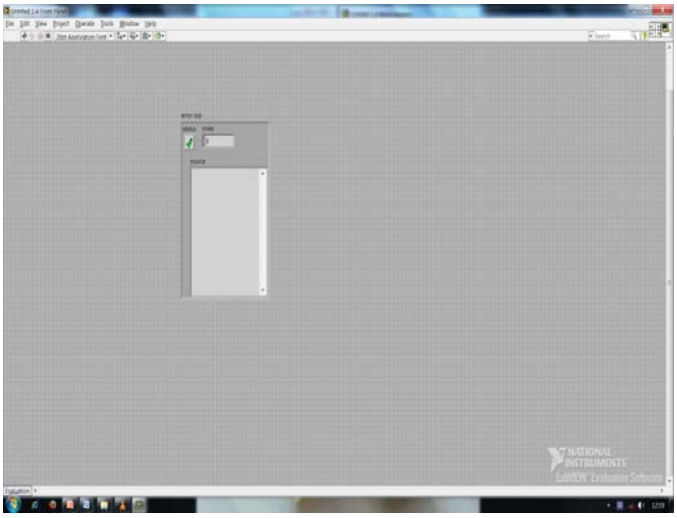


Figure 3.6 Front panel of stepper motor

IV.PERFORMANCE ANALYSIS

Table 4.1 Condition of the baby based on the acquired signal

Acquired signal from the sensor	Infants bio-signal value	Indicator condition	Condition of the baby
1.Respiratory rate	<60 & >80 bpm		Abnormal
	60 – 80 bpm		Normal
2.Temperature value	<85.5°F & >105°F		Abnormal
	85.5°F to 105°F		Normal
3.Pulse rate	<90 & >150 ppm		Abnormal
	90-150 ppm		Normal

V. CONCLUSION AND FUTURE WORK

The project mainly aims on developing detection and simulation system for premature infant deduced with apnea. Initially there was only detection and monitoring system. With the help of mechanical setup the project has been extended to simulation system. The project was started out with sensing unit which senses the bio signals from the infant which is then acquired by the Data Acquisition Card (DAQ). These signals are then compared with the reference value in the PC, which isinterfaced with the DAQ. When the abnormality is detected the alarm is induced which alerts the carer and the stimulation tools stimulates the infant with the help of the stepper motor.

The future enhancement of the project can be done by positioning the stimulation tool automatically in the sensory regions of the infant. Fully automating the system will be concentrated in the future. The extension and future work of the project lies with the application in real time project.

REFERENCES

[1] Al-Abed, Mohammad, Behbehani, Khosrow , Burk, John,R., Lucas, Edgar, A., Manry and Michael.(2005) , "Cross correlation and scatter plots of the heart rate variability and R-peak Envelope as features in the detection of obstructive sleep apnea" , Engineering in Medicine and Biology Society, 27th Annual International Conference of the IEEE , University of Texas, Arlington, USA, pp. 3488-3491.

[2] Behal, A., Feemster, M., Dawson,D and Mangal,A. (2010) ," Sensor less rotor velocity tracking control of the permanent magnet stepper motor Control Applications" in Proc. of the IEEE International Conference, Gif-sur-Yvette, France, pp.150-155

[3] Chienchang hsu and Ping-ta shih (2010) 'An intelligent sleep apnea detection system', in Proc. of the 9th International Conference on Machine Learning and Cybernetics, Qingdao,11-14 July,Taipei,Taiwan,Vol.6, pp.3230-3233.

[4] Jiann Der Lee, Shu Yen Wan and In-Kai Hung (2001) 'Design and implementation of PC based multimedia biosignal integration system', in Proc. of UKACC Control Mini Symposia, Vol.9, No.8, pp.1299-1311.

[5] Lauren Jean, Laiho, Clague and Robert Crockett (2010) 'A Standoff Approach to Monitoring Infant Apnea', in Proc. Of 32nd Annual International Conference of IEEE, engineering in Medicine and Biology Society, Canada, pp.213-216.

[6] Leverich,M.K., Silberberg,J.L. and Weininger,S.(2000) 'Design and development of a multi-channel signal-acquisition system for recording an apnea waveform database', in Proc. of IEEE Thirteenth Symposium, Computer - Based Medical Systems, pp.213-216.

[7] Shinjo, N., Buist, L. and Subramanian, C.S. (2010) 'Stepper motor control with PC based data acquisition tool kit', in Proc. of IEEE Transactions, Nuclear Science, pp.245-254.

[8] Swain, N.K., Anderson, J.A., Ajit Singh, Swain, M., Fulton, M., Garrett, J and Tucker, O. (2003) 'Remote data acquisition, control and analysis using LabVIEW front panel and real time engine', in Proc. of IEEE, School of Engineering Technology Technology and Science, South California State University , Orangeburg, SC, USA, pp.1-6.

[9] Swain, N.K., Anderson, J.A., Ajit Singh, Swain,M., Fulton,M., Garrett. And Tucker. (2010) 'Remote data acquisition, control and analysis using lab VIEW front panel and real time engine' , School of Engineering Technology & Science, South Carolina State University, Orangeburg, SC, USA, pp.1-6 .

[10] Tolgadundar, Atila Yilmaz and Omer caglar (2011) 'Sleep apnea detection for pre-phase diagnosis using third level holter recording device', in Proc. of IEEE 19th Signal Processing and Communication Applications Conference, Antalya, June 2011, pp.865-868.

[11] Turley, P., Wright, M., and San Antonio, T.X.(2007) 'Developing engine test software in LabVIEW', in Proc. of IEEE Autotescon, pp.575-579.

[12] Varady, P., Micsik,T., Benedek,S and Benyo,Z.(2010) ' A novel method for the detection of apnea and hypopnea events in respiration signals', in Proc. of Biomedical Engineering, IEEE Transactions, Vol .49, pp. 936 – 942

[13] Yang Mengda and Zhu Min (2010) 'A research of a new technique on hardware implementation of control algorithm of high-subdivision for stepper motor', in Proc. of IEEE international conference, Belgium, pp.115-12.