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Development of Humidity and Temperature Measurement Instrumentation System using LabVIEW:

T.Bheema lingaiah[1], D.Hanumesh Kumar[2], C.Nagaraja[3], Solomon Woldetsadik[4]

Asst Professor in Department of Biomedical Engineering, Jimma University, Jimma, Ethiopia[1]

Research Scholar, Dept of Instrumentation, Sri Krishnadevaraya University, Anantapur, India[2]

Professor, Dept of Instrumentation, Sri Krishnadevaraya University, Anantapur, India[3]

Lecturer in Department of Biomedical Engineering in Jimma University, Jimma, Ethiopia[4]

ABSTRACT: Respiratory instrumentation nowadays is a common specialty in clinic to corporate hospitals. The instruments viz nebulizer, C-PAP, Bi-PAP, I-PAP, E-PAP and ventilators etc are widely used. In winter humidity levels greatly falls to very minimum levels. Hence the respiratory instrument needs support of humidifiers. Hence the humidity and temperature measurement has a great role in bio medical instrumentation. This paper deals with measurement of temperature and humidity for C-PAP instrument with humidifier.

Keywords: humidity, temperature, C-PAP Instrument, Respiratory Instruments.

I. INTRODUCTION

Humidity is a vital part of everyone's respiratory system and thus an important aspect of proper mechanical ventilation. Optimal humidity is achieved by a healthy individual because the body is able to heat the inspiratory gases to normal body temperature (370C) with 100% relative temperature humidity (Absolute humidity of 44mg/l) before the gases reaches the lungs. When the portion of the airway is bypassed via endotracheal (ETT) or a tracheotomy, a portion of the body's natural humidifier, the nose and the upper airway, are no longer able to add humidity to the gases that are being delivered to the lungs. When this air enters the larynx, the thoracic additional air-conditioning completes the temperature rise to 37ºC and the humidity rise to 100% by the time the air enters the lungs. Decreasing of humidify of inhaled air passing through nasal cavities and also through throat my cause dangerous disease of the lower airways [1-4].

Humidity is one of the important parameters in the atmospheric gases. The natural air can contain humidity and varies from season to season. The humidity and air causes lungs to breathe very naturally and provides support mechanism for oxygenation of blood. In pulse oximeter it has been explained about oxygenation of blood. Some patients may undergo respiratory disorders like asthma bronchitis, obstructive pulmonary diseases, pleurisy etc causes deprived oxygenation. This will cause metabolic stress on the patient. To give relief to the patient the patient may be given respiratory support instrumentation. The respiratory supportive instrumentation may have nebulizers, CPAP (Continuous Positive Air Pressure), EPAP, Bi-PAP, IPAP, APAP, ventilators and oxygen concentration etc. so when patient aided by breathing apparatus may require the following precautions

1. Air must be pure, devoid of bacteria and dust particles.
2. Should contain enough amounts of oxygen and fractional carbon-di-oxide around the Normal air.
3. No contaminated gases are allowed air temperature regulations balanced humidity is required.
4. When patient is given dry air it causes inflammation of lungs, hence dry air must not be applied to the patient.
5. Excess humidity in the air also causes distress on lungs. Hence balanced humidity is required.

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The advanced ventilator instrumentation will have humidity generation, humidity control; where as other respiratory instruments will have humidifiers but divided of measurement and control. Usually the humidifiers are used in cold-dry airy winters. Hence to provide humidified air to the patient, humidifiers are essential. There is a great need for the measurement of humidity and controlling mechanism in respiratory instrumentation.

The humidification control depends upon unique supply to the water. So greater the heat greater the humidity of air, lower the heat lower the humidification. Hence the temperature control influences the humidification control.

II. FUNCTIONAL DESCRIPTION:

The functional block diagram of humidity and temperature instrumentation system is shown in fig 1. It consists of the following functional blocks

1. Humidity Sensor
2. Temperature Sensor
3. Signal Conditioning Unit
4. NI DAQ
5. Personal Computer

The functional approach to the system is described below. The humidity sensed by the humidity sensor is processed by a signal conditioning unit which consists of an instrumentation amplifier and a filter circuit. The output of the humidity signal conditioning unit along with temperature signal conditioning units are applied to NI DAQ which is interfaced to the personal computer. The data obtained by the DAQ is processed by the system programmed in National Instrumentation's LabVIEW.

In the present project the author has made an effort to implement humidity and temperature measurement with CPAP/APAP instruments. The hardware details of the module used for humidity and temperature measurement is described below.

(a) Relative humidity measurement is performed by calibrated humidity sensor SY-HS-220 [5] along with signal processing module shown in fig 4 and 5, which minimizes the system complexity by reducing component count. The humidity sensor module converts relative humidity to voltage with an accuracy of ± 5% RH. The photographic plate shown in fig 4 describes the experimental setup of humidity measurement using the above said module interfaced through NI DAQ 6009 and programming implemented through LabVIEW.

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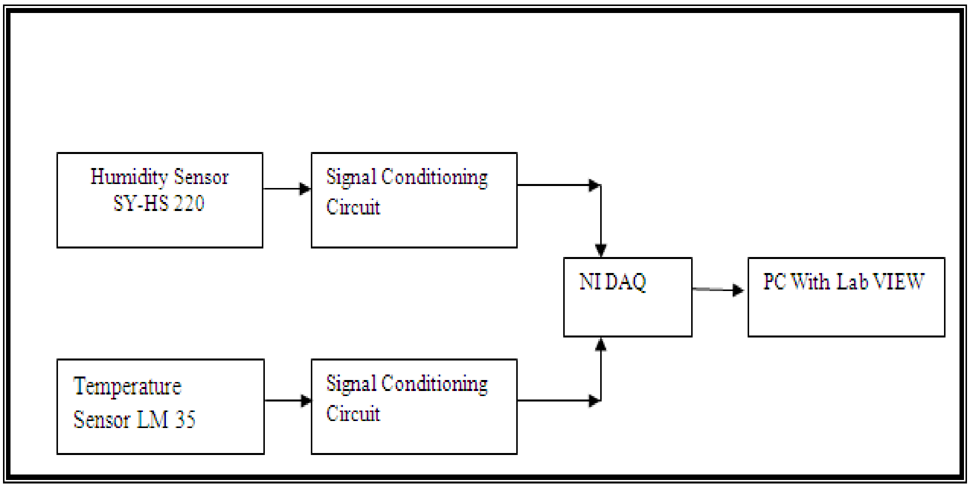

Fig 1: Functional Block Diagram of Humidity and Temperature Measurement System

(b) Temperature measurement is performed by an integrated circuit temperature sensor LM35 [6]. The output voltage of sensor is linearly proportional to temperature with a gradient of 10mV/ºC and able to operate in the range -55ºC to +150ºC with an accuracy of ± 0.5ºC. These make LM35 good choice for patient temperature monitoring. The LM 35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supply, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.10C in air. The centigrade temperature is converted to Fahrenheit temperature and displayed.

The LM 35 is used for creating clinical thermometer. The circuit diagram for temperature measurement using LM 35 is shown in fig 3. This circuit requires current biasing resistor 83 K Ohms. The output of LM 35 is fed to the input of voltage follower built with Lm 308. The output of the voltage follower is applied to the NI DAQ 6009. The programming developed in LabVIEW acquires and converts to Fahrenheit. The data is displayed in the front panel. The block diagrams developed for measuring humidity and temperature are shown in fig 2(a) and 2(b).

(c) Combination of these sensors with data acquisition system has proved to be a better approach for temperature and relative humidity monitoring [7]. The system is able to communicate with the computer with the help NI DAQ. This is really useful because it makes the system portable, powered by the computer itself without the need of an external power plug. Also, this way of powering the system is good for eliminating the possible noise that could be induced to the system by using a power cord, because the battery of a computer provides a quite steady voltage. Also, the use of NI DAQ makes the system connectable to any desktop or laptop computer because it only needs a USB port. This makes a system easy to carry, set-up and use.

The advanced ventilator instrumentation will have humidity generation, humidity control; where as other respiratory instruments will have humidifiers but divided of measurement and control. Usually the humidifiers are used in cold-dry airy winters. Hence to provide humidified air to the patient, humidifiers are essential. There is a great need for the measurement of humidity and controlling mechanism in respiratory instrumentation.

In this paper humidity measurement is made by incorporating humidity sensor in the humidifier supported CPAP instrument, temperature measurement is explained, and the application of both is also mentioned.

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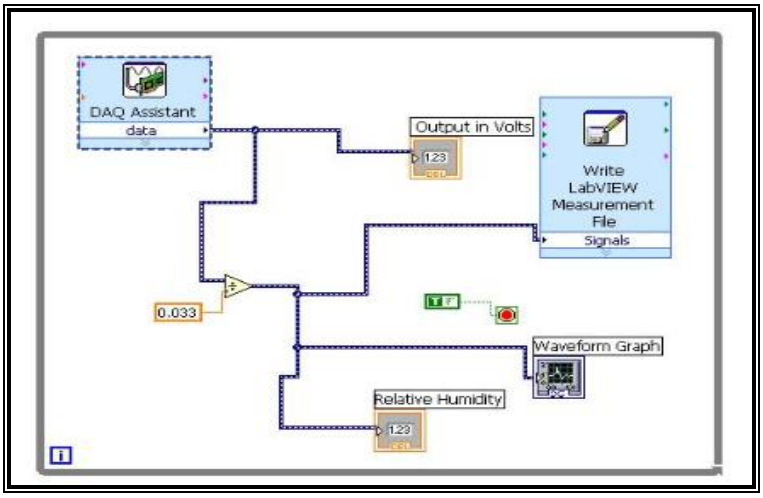

Fig 2(a): VI Block diagram of Humidity Measurement

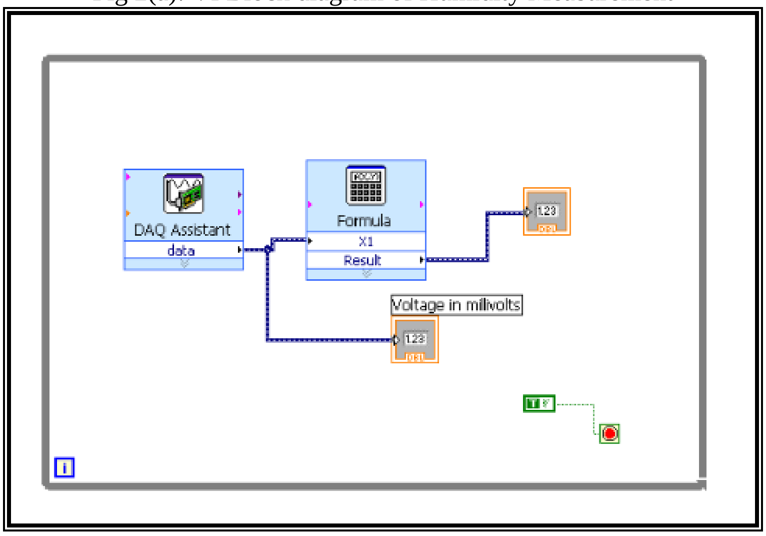

Fig 2(b): VI Block Diagram of Temperature Measurement

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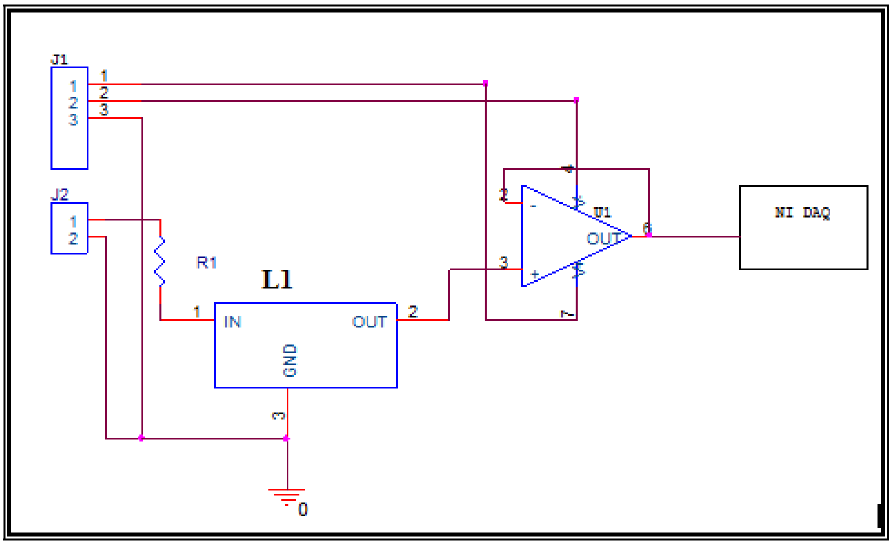

Fig 3: Circuit diagram of Clinical thermometer using LM 35

Fig 4: Experimental setup of Humidity Measurement

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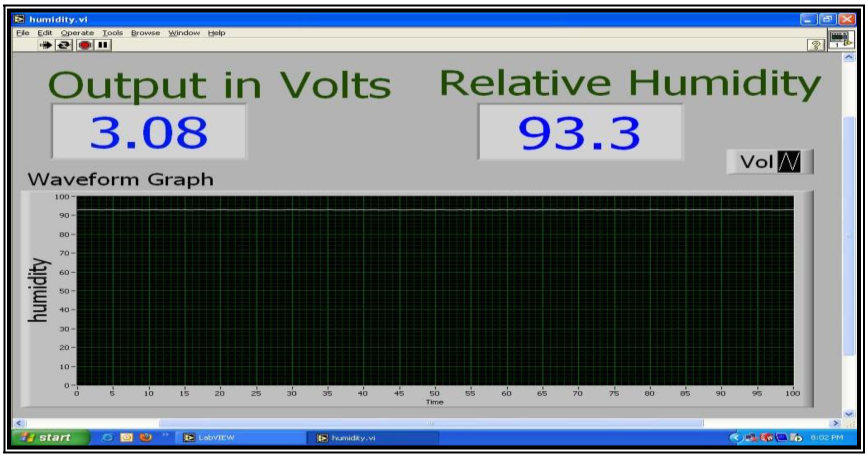

Fig 5: Front panel for humidity measurement

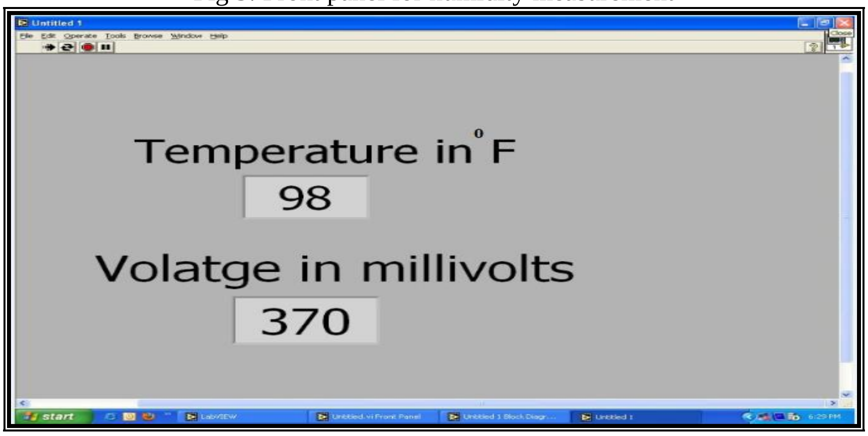

Fig 6: Front panel of Temperature measurement

III. RESULTS AND DISCUSSIONS:

The humidity and temperature modules which have been procured from the market and have been tested against performance and calibration. The unit has got full satisfactory performance against the standard instrumentation. Hence the present module is implemented in the CPAP system. The CPAP instrument EVO 804-APAP is used in the present study. The clinical thermometer constructed using LM 35 has resulted in good performance. Figures 5 show the developed front panel displaying the relative humidity and its corresponding voltages, and fig 6 shows the front panel displaying temperature in Fahrenheit and its corresponding voltage.

Sl no	Date	Standard Instrument Relative Humidity (%) (Ambient)	Measured with SY-HS 220 Module used with CPAP
1	OCT 3RD 2012	57	62
2	OCT 4TH 2012	61	66
3	OCT 5TH 2012	62	67
4	OCT 6TH 2012	69	76
	OCT 12TH 2012	61	68

Table 1 (a): Measurement of Relative Humidity with CPAP

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Sl no	Date	Standard Instrument Relative Humidity (%) (Ambient)	Measured with SY-HS 220 Module used with CPAP
1	OCT 7TH 2012	87	90
2	OCT 8TH 2012	85	89
3	OCT 20TH 2012	83	88
4	OCT 23RD 2012	83	89
5	OCT 31ST 2012	80	87

Table 1 (b): Measurement of Relative Humidity with CPAP Without humidifier

Sl no	Date	Standard Instrument Relative Humidity (%) (Ambient)	Measured with SY-HS 220 Module used with CPAP
1	JAN 12TH 2013	50	92
2	JAN 13TH 2013	39	93
3	JAN 14TH 2013	37	93
4	JAN 15TH 2013	33	92
5	JAN 16TH 2013	48	91

Table 1(c): Measurement of Relative Humidity with CPAP with humidifier

IV CONCLUSION

From the above measurements of humidity and temperature it is clear that there is very close agreement between the designed instrument and already available standard instruments, which validates the measurements made by our system. The humidity data in RH% and Temperature in Fahrenheit was continuously monitored for the certain time interval for a patient. Thus the author could get the humidity recordings using CPAP instrument where the humidity sensor incorporated in the mask. The clinical thermometer using LM 35 is successfully created on LabVIEW platform. The front panel's displaying the humidity and temperature is shown in figures 5 and 6. The presented system can be useful for studying behaviour of humidity and temperature during respiration even at home.

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BIOGRAPHY

T.Bheema Lingaiah is an Asst Professor in Department of Biomedical Engineering in Jimma University, Jimma Ethiopia. He completed M.Sc (Instrumentation) from Sri Krishnadevaraya University in 1996. He is pursuing Ph.D in

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the field of Bio-medical Instrumentation. His areas of interest are in Biomedical Instrumentation, Microcontroller based instrumentation, Virtual Instrumentation, Analytical Instrumentation, control systems and automation.

D. Hanumesh Kumar completed M.Sc (Electronics and Instrumentation) from Sri Krishnadevaraya University in 2010. He is doing Ph.D in Instrumentation. His areas of interest are in Microcontroller based instrumentation, Virtual Instrumentation, Analytical Instrumentation, control systems and automation.

Prof.C.Nagaraja ,Professor and Head of the Department of Instrumentation Sri krishnadevaraya University. He joined the faculty of Instrumentation & USIC in 1993,Sri Krishnadevaraya University as assistant Professor. He did his M.Sc Instrumentation from the same university in the year 1990. He completed his M.Phil in Medical Instrumentation 1992. Continued in the faculty of instrumentation as Teaching assistant and joined as Assistant Professor. He completed his PhD on PC based Photo acoustic Instrumentation. He is member of board of studies. His specialization is Bio-Medical instrumentation. He is Fellow Member of Institute of Electronics and communication engineers (New Delhi). He completed UGC a major research project on " Design and development of Microcontroller based low cost pulse oxmeter". Under his guiding 2 M.Phils and 2 PhDs awarded. He has organized 3 National workshops and attend 3 National symposium conducted by Instrument society of India. He was the resource person for several workshops and seminars in instrumentation organized by Sri Krishnadevaraya University. He is life member of Instrument society of India, Bangalore. He has published nearly 20 papers in national and international journals in Instrumentation. His areas of specializations are: 1. Bio-medical instrumentation, Analytical Instrumentation, Microcontroller based application development. Industry oriented Product design.

Solomon Woldetsadik is working as a lecturer in Department of Biomedical Engineering, in Jimma University, Jimma. He completed his master's degree in Control Engineering in Addis Ababa University.