



Respiratory Signal Processing & Monitoring In LabVIEW Platform Using Arduino & Sensor DAQ

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Abstract -- Respiratory signal is the common interpretation technique for the measurement of respiration system. Now a day's respiration signal and respiration rate are widely used for the diagnosing clinical application because many people are suffered from the heart and lung disease. This paper leads to developing a respiratory signal processing and monitoring in LabVIEW software using Arduino and sensor DAQ 6009. It provides efficient and economical system for the measurement of respiratory system. The monitoring parameter are acquired through the Spirometer sensor and displayed on the LabVIEW front panel and Arduino Serial Monitor.

Index terms – Respiratory, LabVIEW, Arduino, Spirometer, Signal processing.

I. INTRODUCTION

Respiratory system is a vital parameter in the human body. Respiratory rate and its analysis allow the measurement and analysis of the lung functioning and the detecting different cardiac disorders. Different parameters are derived from the respiratory flow rate which is measured by the spirometer. With each breathing cycle oxygen travels through the lung and exhale carbon dioxide through the nose. Spirometer measured the flow of air inhale and exhale during the breathing cycle via mouth. When the breathing cycle is normal the respiration signal looks like as shown in the Figure 1.



Fig.1. Normal respiration signal [1]

The airflow is measured through the certain transducers. Airflow signal allows the to measure and representation of the lung volume which shows the exhale and inhale ratio during the breathing. When the respiration cycle is too slow, too fast or in irregular rhythm, it is known as cardiac disorder or abnormal respiratory disease. The proposed system of detecting respiration signal is non inventive method. Now a days many methods are used for the respiratory signal measurement and analysis. For the signal detecting we used spirometer sensor for the detecting respiratory signal from the patient. The spirometer is connected to the patient mouth for measuring different parameters like maximum and minimum inhale and exhale ratio. Respiratory signal is used for the diagnosing different disease like Asthma, ischemic heart disease. Obstructive Sleep Apnea, Chronic pulmonary disease, lung cancer, coronary heart disease [2]. This research offers the different contribution like portable respiration monitoring system under the DAQ 6009, spirometer and Arduino Uno. The measured data was stored and analyze through the computer system.

II. SYSTEM ARCHITECTURE

In this research for signal processing we require Spirometer sensor, DAQ 6009, Arduino Uno Board, Power Supply, Nose clips, Bacterial filter, Mouthpieces. LabVIEW software, Arduino IDE software. The functionality and working of every parts are described below.

A. Spirometer Sensor [3]



Fig. 2. Vernier Spirometer

The spirometer can be used for the measurements of air flow and lung volume. The sensor has detachable flow head for the easy sterilization process. This sensor is also used for the forced vital capacity, forced expiratory volume and tidal volume during the breathing cycle. The manufacture of this spirometer is Vernier and its products are used for the educational and research purpose. Data collected from the spirometer via Arduino UNO board or the DAQ 6009 and data analysis in the LabVIEW software. Air flow is measured directly and volume is calculated by the flow rate. Specification of the Vernier Spirometer are as shown in Table 1.

Table 1. Spirometer Specification

Flow rate	± 10 L/s
Dead space	93 mL
Nominal output	128 mV/[L/s]
Detachable flow head	Dimensions: 80.5 mm (diameter) \times 101.5 mm (length) Mass: 80 g Construction: Clear acrylic plastic
Handle	Dimensions: 127 mm \times 23 mm \times 35 mm Mass: 85 g Construction: Black ABS plastic
Cable length	1.5 meters
Stored calibration	Slope: 7.8 (L/s)/V Intercept: -17.55 L/s

B. DAQ 6009[4]

Data acquisition (DAQ) is the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure, and sound with a computer. Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Data acquisition system converts analog waveforms into digital values for processing.

The National Instruments USB-6009 devices provide eight single-ended analogue input (AI) channels, two analogue output (AO) channels, 12 DIO channels, and a 32-bit counter with a full-speed USB interface. The components of data acquisition systems include: Sensors that convert physical parameters to electrical signals. Signal conditioning circuitry to convert sensor signals into a form that can be converted To digital values, Analog-to-digital converters, which convert conditioned sensor signals to digital values.



Fig.3 DAQ 6009

C. LabVIEW software

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a system-design platform and development environment for a visual programming language from National Instruments. It is a software package developed to build programs with the symbols. LabVIEW is programmed to act as an interface, helping different hardware to communicate with each other. Also, LabVIEW is used for signal processing, data acquisition, signal transmission, signal analysis, instrument control, and industrial automation on a different operating system. Also, LabVIEW has inbuilt support for NI hardware like Sensor DAQ, Compact RIO, LabQuest with a large number of blocks for the hardware.

D. Arduino IDE software

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, and Linux) that is written in the programming language Java. It is also open source software for writing easily code and upload code on the any Arduino board. Also, it supports C and C++ language using special code structuring.

E. Arduino Uno Board [5]

The Arduino uno is an ATmega328 based microcontroller board. It has 6 analog input, 16 MHz ceramic resonator, 14 digital input/output pins, power jack, USB connection, reset button and ICSP header. Arduino UNO is directly connected with the laptop/PC with the USB cable. Also, it works with the 5v power supply. It does not use the FTDI USB to serial driver chip which makes Arduino different from other available board. AT mega 16U2 used for the directly communicate with the computer or laptop. In this research we use Arduino board because it has low cost, low power consumption and inbuilt ADC.

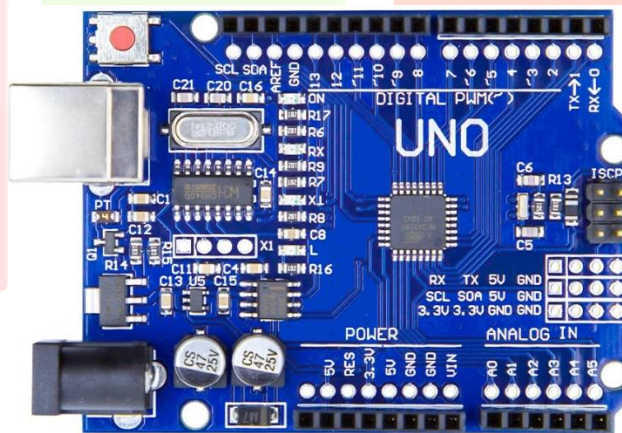


Fig.4 Arduino Uno Board

F. Spirometer Accessories & Power Supply

The nose clip is used for the increase the accuracy of spirometry results by eliminating the escape of air through the nostrils during experiments. The bacterial filter and mouthpieces are used for the prevent infection. For the whole system perform we used 5-volt DC supply which is easily available from the Computer via USB connector.

III. METHADODOLOGY

To extract the respiratory signal, we used here Vernier Spirometer for signal acquisition. Arduino Uno and Sensor DAQ6009 are used for signal converting from analog to digital which are furthered processing in the LabVIEW software. The output is displayed in front panel of the software. Error handling function is used for the error solving and data storage function used for the further diagnosis. This system measures the mechanics of breathing and physical characteristics [8]. Basic block diagram of Respiration signal acquisition and processing shown in the below block diagram figure5. Normal spirometry results are based on the age, height and gender of the patient.

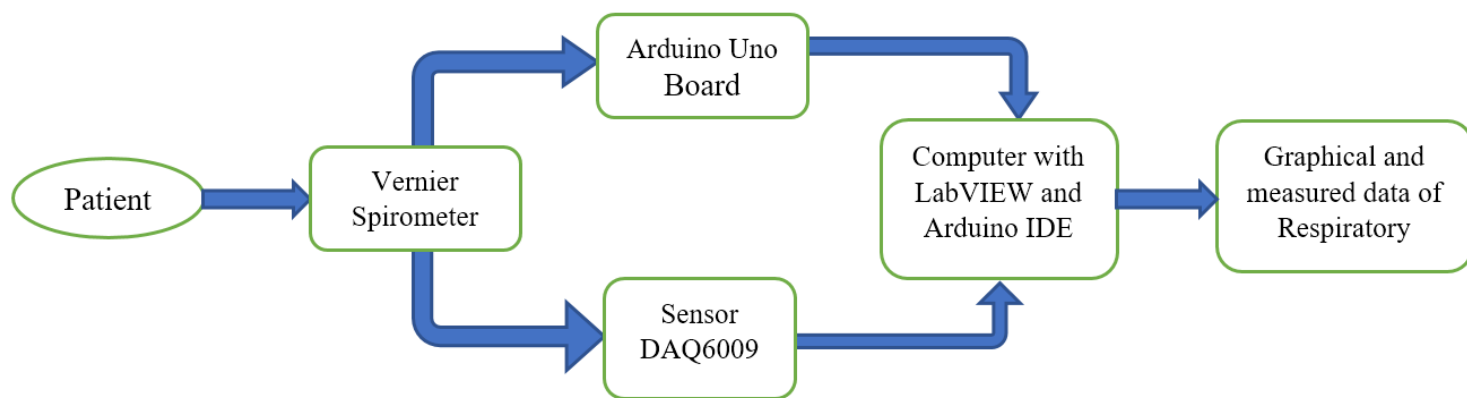


Figure 5. Block diagram of Signal Methodology

IV. EXPERIMENTAL SETUP AND RESULTS

A. Experimental Setup

In this respiratory monitoring system, code is developed in Arduino and for the diagnosing making VI in the LabVIEW. To collect respiratory signal spirometer, connect with the mouth and it is connected to the Sensor DAQ and Arduino board as shown in below figure. The spirometer is connected to mouth via mouthpiece. Spirometer sensor connected to Vernier analog protoboard adapter. Adapter output connected to the Arduino Uno board and Sensor DAQ and then both hardware connected to the computer via USB cable. The sensors are connected to the hardware via suitable pins according to the pin diagram and code design. Power supply is given from the 5 volts output board. The whole respiration monitoring system setup shown in below Figure 6. The procedure of analogue electrical signal obtained from the patient is shown in below Figure 9.

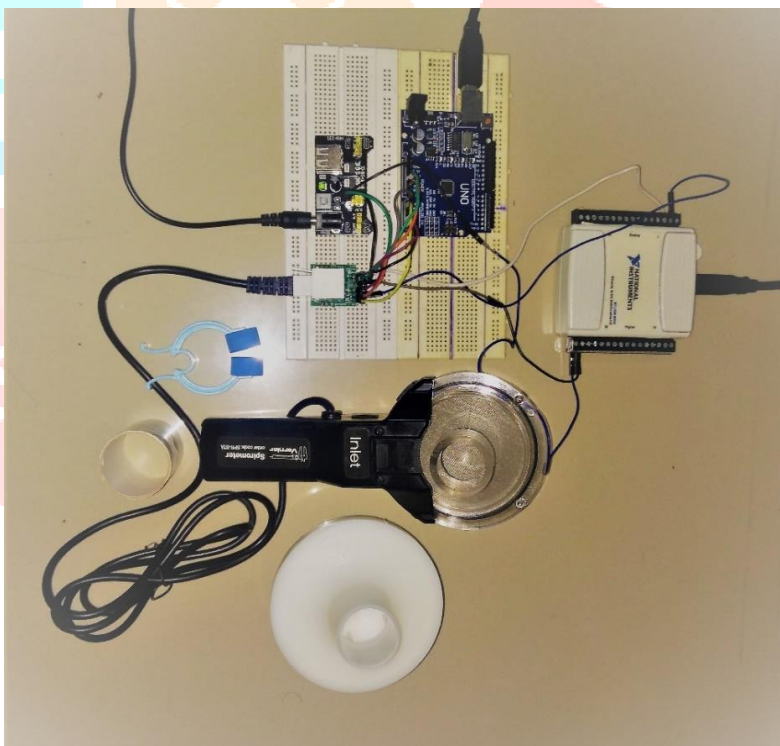


Fig 6. Respiratory monitoring system setup



Figure 9. Signal obtained from the patient

B. LabVIEW Block Diagram

Here, is the block diagram of the LabVIEW software which is used for the monitoring Respiratory signal from the patient. The digital output of the signal transfer through the USB cable from the DAQ6009. The block diagram is also called as the signal conditioning flow.

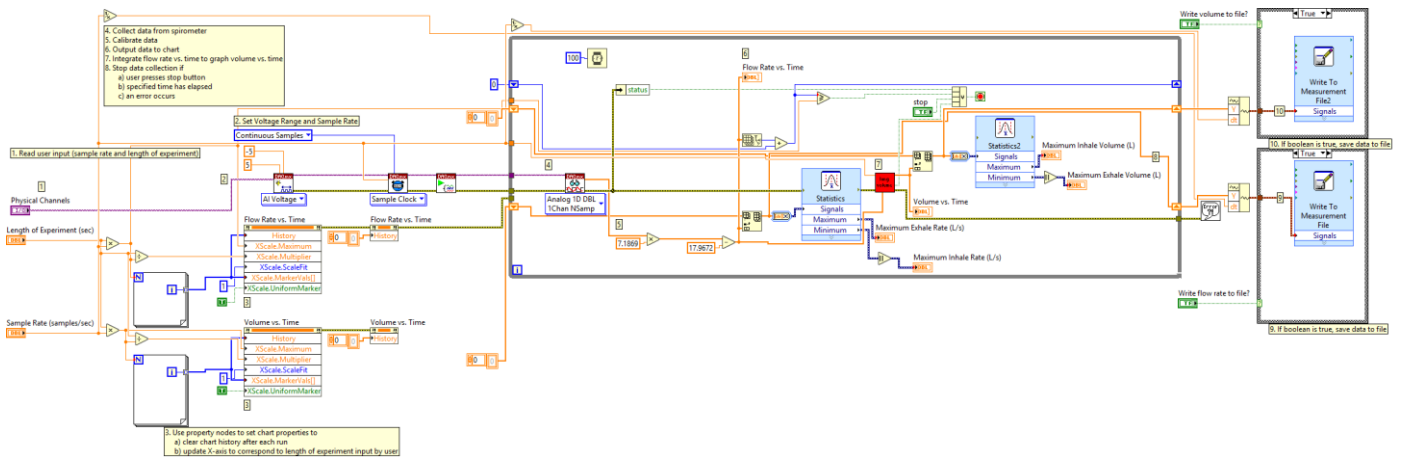


Fig.10 Block Diagram of System

C. Monitoring and processing of Respiratory Signal

This system is able to generate the result shown in Fig.11, which shows the result of ECG signal. Also, by using Arduino we get the maximum and minimum respiration ratio graph in the Arduino IDE software. This graphical data shown in the Arduino serial Plotter and digital data measured in the Arduino Serial Monitor. On the other side analog output is shown in the LabVIEW front panel. The data collected from the LabVIEW software can be tabulated and it is useful for the further diagnosis and all data are stored in computer. Below figure is the graphical presentation of both DAQ6009 and Arduino Uno hardware.

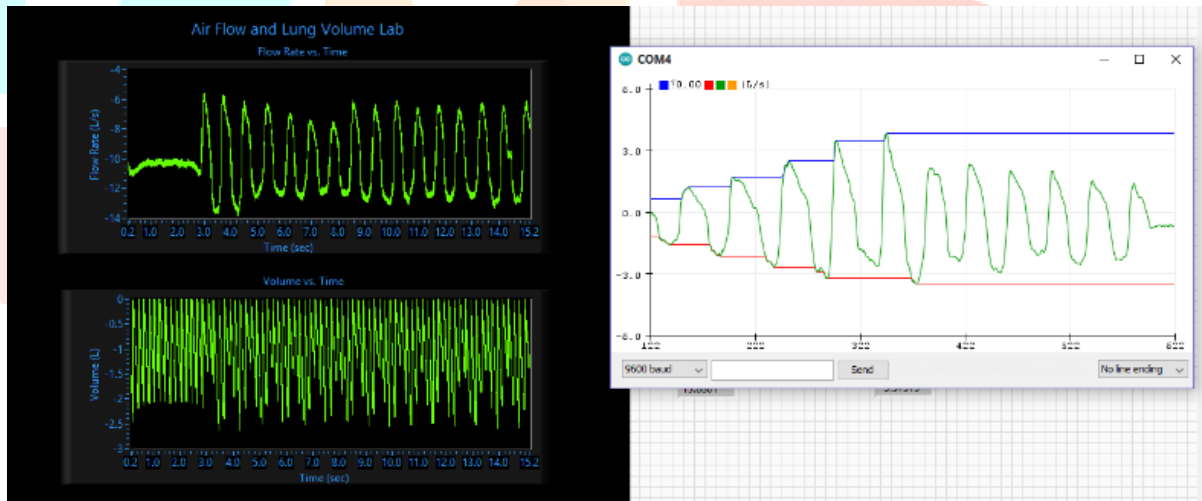


Fig. 11 Sensor DAQ 6009 and Arduino hardware acquired signal.

The proposed system is functioning well once all the hardware connected properly. The whole system is very reliable, portable and cost effective.

V. CONCLUSION AND FUTURE WORK

In this paper, the low-cost real time respiratory signal monitoring and processing system was proposed and implemented. Also, this system provides less power consumption compared to traditional technology and useful for the internal village area. The hardware we used here are commercially available and the software programming are described here. The proposed system could be modified and add more functions like ECG, Temperature, pulse rate, Analysis for cardiac disorder etc...

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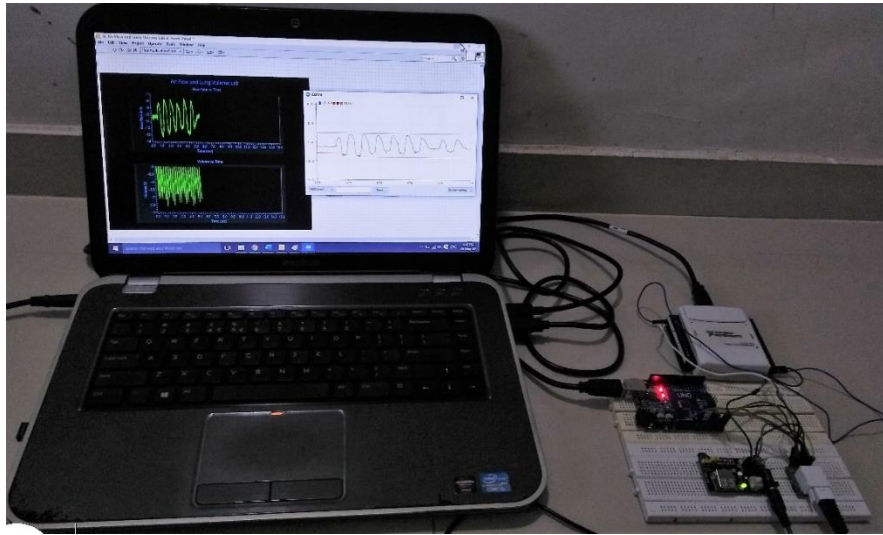


Fig.12 Experimental setup

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