Lung Function Assessment using Flex Sensor

Udhaya Suriya T S[1], Arun N[2], Karthick K[3], Karthik Kumar G[4]

[1]Professor, Department of Biomedical Engineering,

[2,3,4]Student, Department of Biomedical Engineering,

Adhiyamaan College of Engineering, Hosur, Tamilnadu, India

Abstract- Inspired and expired lung volumes are measured for detecting, characterizing and quantifying lung disease using spirometry. Most of the old age people and infants will not able to exhale the gas forcefully into the spirometer. In order to overcome this difficulty, Lung Function Assessment using Flex Sensor has been implemented. This may help to measure Forced Vital Capacity (FVC)and Slow Vital Capacity (SVC) of the lung volume. This method is very cost effective and can be easily affordable.

Keywords: PFT, flex sensor, spirometry, FVC, SVC.

I. INTRODUCTION

In humans, the main muscle of respiration that drives breathing is the diaphragm and intercostal muscle in the chest wall.The obstructive lung diseases are categorized by airway obstruction such as Asthma, chronic, bronchitis, emphysemabronchiectasis and chronic obstructive pulmonary disease (COPD). This restricts the amount of air that enters into alveoli because of constriction of the bronchial tree, due to inflammation[6]. It is diagnosed with the help of pulmonary function tests performed by spirometer.

In a pulmonary function test, patient is allowed to sit comfortably in a chair and breathe into a mouthpiece that is connected to an instrument called a spirometer[1]. The spirometer measures the volume and the rate of air that you breathe in and out over a period of time. When standing, some numbers might be slightly different. In some tests require forced inhalation or exhalation after a deep breath. Sometimes, the patient will be asked to inhale a variety of gas or a medicine to see how it changes the test results.

Though this procedure is an effective, it has some drawbacks that the patient may have shortness of breath or shaky for few moment after performing the test[4]. Measurement of absolute lung volumes, residual volume, functional residual capacity and total lung capacity are technically more challenging, which limits their use in clinical practice.

The role of lung volume measurements in the assessment of disease severity, functional disability, course of disease and response to treatment remains to be determined in infants, as well as in children and adults. It is also not applicable for those who had a recent heart attack or some other heart problems[5].This test may cause problems for those had surgeries on eye, chest and abdominal area.

Here comes a sensor technology to overcome the above limitations which is non-invasive and just stick over the chest to measure the lung volume. It is done by sensing module that senses the change in resistance whenever deflection occurs[2].

II. DESIGN OF EQUIPMENT

The design of equipment model consists of three modules for sensing, power anddisplay. They are discussed below.

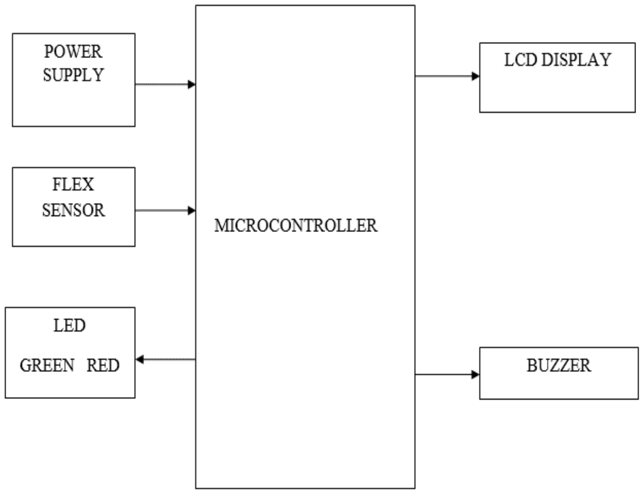

Fig. 2.1 Block Diagram

A. Sensing Module

The sensing module consist of flex sensor which measures the amount of breathing[3]. Typically the sensor is stick over the chest and resistance of sensor element is varied by movement of chest wall during expansion and contraction of breathing. The resistance is directly proportional to the amount of bend.

B. Power Supply Module

Normally this circuit requires 230V power supply which is fed in step-down transformer convert it to 12V AC. The obtained voltage is then rectified and given for microcontroller, LCD display, and buzzer and LED lights.

C. Display Module

The display module consists of 16x2 LCD display which is used to show the lung volume. It shows both the numerical value and also indicates whether the result is normal or abnormal.

III. WORKING

Microcontroller is the heart of the circuit which is of atmega 328p type it gets powered by means of power supply. The flex sensor which acts as a main part since it acquire the changing signal from chest. According to changes in resistance, the voltage drop occurs is proportional to the volume of chest. The LCD display and Buzzer shows the output and alarm during normal and abnormal conditions respectively.

IV. RESULTS

Due to the changes in the chest wall, the sensor shows the result in the display (800-900cm^3) and also indicates the condition of patient (normal or abnormal). The result is shown in fig. 2

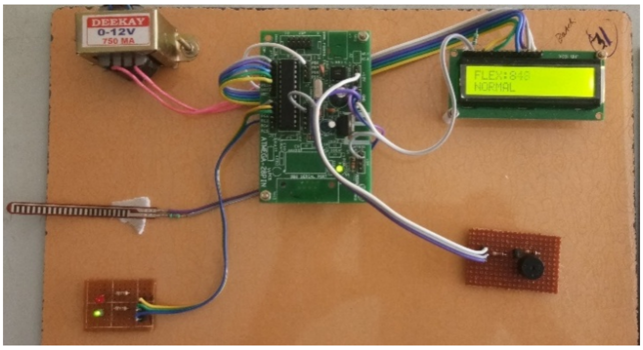

Fig. 4.1 Result

V. CONCLUSION

In this project, the technology has been enhanced to measure the lung volume which includes forced vital capacity (FVC) and slow vital capacity (SVC) without making any disturbance to the patient. This is also cost efficient compared to conventional spirometer and reduces the effort made by patient. It can also be integrated into miniaturized wearable device and just stick over the patient, it won't make any irritation to the patient. Future work is to adding an ultrasound sensor for measuring the fluid accumulation in the lung whenever the sensor measures any abnormalities.

REFERENCES

[1] Dima Damen, James Dodd, Sion Hannuna, Charles Sharp, Massimo Camplani, and Jason Viner "Remote, Depth-based Lung Function Assessment" vol. 64, December 01, 2016.

[2] Puja Dhepekar, Yashwant G. Adhav, "Wireless robotic hand for remote operations using flex sensor",March 16, 2017.

[3] Takahiko Mori, Yuya Tanaka, Misaki Mito, "Proposal of bioinstrumentation using flex sensor for amputated upper limb" November 06, 2014.

[4] C. William Carspecken, Carlos Arteta and Gari D. Clifford, "TeleSpiro: A low-cost mobile spirometer for resource-limited settings" February 14, 2013.

A. Web Resources

[5] https://www.ncbi.nlm.nih.gov/pubmed/14295711

[6] http://www.sensorwiki.org/doku.php/sensors/flexion