LOW COST SPIROMETER

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INTRODUCTION:

A spirometer is an apparatus for measuring the volume of air inspired and expired by the lungs. A spirometer measures ventilation, the movement of air into and out of the lungs. The Spirogram will identify two different types of abnormal ventilation patterns, obstructive and restrictive. There are various types of spirometers which use a number of different methods for measurement (pressure transducers, ultrasonic, water gauge). Through a set of medical tests it is used to identify and quantify defects and abnormalities of various lung conditions in human respiratory system. These tests also help in monitoring the response of lungs to medical treatment. With the help of a spirometer, Chronic Obstructive Pulmonary Disease (COPD) can be detected well in advance (American Thoracic Society, 1995a). Monitoring cough and wheezing may not provide an accurate assessment of the severity of asthma in a patient. With the help of the breathing tests conducted using a spirometer, the response and improvement in an asthma patient’s condition during the treatment can be monitored accurately. This improves the quality of treatment by reducing the judgement errors.

A few reasons for conducting spirometric tests can be as follows:

1. Diagnose certain types of lung disease (such as asthma, bronchitis, and emphysema)
2. Find the cause of shortness of breath
3. Measure whether exposure to chemicals at work affects lung function
4. Check lung function before someone has surgery

The rural areas in India don’t have as many medical facilities as those available in the urban areas. Hence, people face a lot of problems in getting treatment or even at times receiving suitable emergency aid. The surveys conducted on this topic with pulmonologists revealed many issues which are faced by them while treating patients who are suffering from pulmonary diseases. These problems persist not only in cities but also in rural areas. The cost of the spirometers used in testing is very high; also, accessibility is a major issue when it comes to remote areas. Thus, the proposed device is aimed mainly at the aforementioned issues.
**OBJECTIVE:**
This project is focusing on development of a spirometer that is low in cost and can be connected with the computer. Also other features include web connection by which the data of the patient can be transmitted to the doctor sitting far away from the patient.

The feature of web connection can be integrated with many other medical devices for other diseases. Also, the use of expensive components that are expensive can be avoided. A well conducted survey brings forth a plethora of choices for cheaper components that can be used in the mass production of devices as well.

**METHODOLOGY:**
The Spirometer has been divided into 2 units. They are:
1) DATA ACQUISITION UNIT
2) CONTROL INTERFACE UNIT

**DATA ACQUISITION UNIT**
The first stage is the Data acquisition block, where the acquisition of air pressure of exhaling and inhaling is done with the help of a mouthpiece, this acquired pressure is then converted to voltage with help of pressure transducer, the output of this being in milli volts is thus given for conditioning which includes amplifying and filtering.

**SENSOR BLOCK**
Sensor Block includes a mouthpiece and a Pressure Transducer.

The mouthpiece is used as an input device for the patient to inhale or exhale in it, such that the difference in the pressure at two ends is given to the Pressure Transducer via two pipes as shown below in Fig 2.2.

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**Fig 1: Block Diagram**

**Fig.2: Mouth Piece with sensor**
The sensor is differential based pressure transducer which converts the pressure coming from the two pipes into voltage. This voltage ranges between 2 to 10milli volts. For the signal to be acceptable by microcontroller it undergoes signal conditioning.

**Signal Conditioning Block**

The signal conditioning circuit will amplify and filter the signal coming from sensor block. Signal conditioning block includes an amplifier that amplifies the output from pressure transducer to the output range of 0.5-5V. This voltage is further sent to a Resistor- Capacitor combination circuit to filter out the very low signals and noise if any. The output from the conditioning circuit is given to the microcontroller which is a part of control and interface unit.

**Control Interface Unit**

The second stage is the control interface which consists of the signal conditioning circuit which will amplify and filter the signal and then give the signal to the microcontroller (Arduino Uno). The microcontroller is used for serially transmitting the input data from the signal conditioning circuit to the software perform some computations and plot the graph. Web connection enables us to transmit the graph and data to the doctor for further analysis. The pictorial view of the complete control interface unit is shown in Fig 2.3

![Control Interface Unit Pictorial view](image)

Fig.2: Control Interface Unit Pictorial view

The setup of the proposed model is as shown above. The main components of the project consist of an amplifier, Arduino uno and the differential pressure transducer.

**CONCLUSION:**

In this project, we had configured and implemented a low cost spirometer with a differential pressure transducer being the heart of the device and tested its feasibility and reliability with a simple experimental setup. On the other hand we obtained the real time graph of mass flow versus volume using a simulation software. Also, we created a website which enables patients to register themselves on it and upload their acquired graphs such that a distantly located doctor can have access to it and give valuable feedbacks. This spirometer is very low cost and when it is produced in bulk it can be made all the more low cost and sold at a lesser price. The software that we have created is not device specific and is an executable file which can be use with any device. As we saw the project to completion we had gotten a
mouth piece 3D printed also built a signal conditioning circuit with LM358 as the amplifier. After multiple hardware tests and simultaneous software simulation of the networks, we propose this particular model of Spirometer. Our proposed device is portable, compact, rugged, very economical and user friendly. The device thus gives you an extra edge over other available devices in the market which are costly, complex and are not that user friendly.

**FUTUREWORK:**

In future our proposed model can be made more efficient. With more advanced technologies coming up, it can be incorporated to make it more accurate. Also, it can be made more hygienic. As it is handy and portable in use it can be made available to many patients in rural areas.

Other feature that can be added and is that it can be made more user friendly so that the whole operation can be made just a click away.

Other important measure that can be taken is to make people learn about how to handle this model especially in rural areas, so as to ensure that the model is properly used and better results can be displayed.