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Smart Spirometer for Real Time Breath Monitoring and Analysis Using Air Pressure Sensor

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Abstract— Spirometers are used to measure lung capacity and the response of the lungs and chest during physical therapy. Current spirometers possible concerning business are high-priced. Due to this high cost, many physicians undertaking in underdeveloped countries like India, cannot produce Spirometry supplies. Thus, the growth of a low-cost trustworthy spirometer would admit these physicians to evaluate their patient's pulmonary well-being. All these factors experienced to the growth of a device that addresses cost issues in addition to mechanics accuracy. A calculating-located made smaller spirometer plan is Designed expected realized that would use a stable-state pressure sensor. An original of Computer located Spirometer method has happened earned which would engage a complete-state alone traffic pressure sensor. A loyal parallel signal procurement and deal with channel have happened created and tested in addition to the dependable-state pressure sensor. Spirometry is the method to measure the flow and book of air recording and leaving the alveoli. A spirometer is used to conduct a set of medical tests that help to identify and quantify defects and abnormalities of various lung conditions in the human respiratory system. These tests also help monitor the lungs' response to medical treatment. With the help of a spirometer, COPD may be discovered well earlier. Monitoring cough and hissing cannot provide a correct evaluation of the asperity of asthma in a patient. With the help of the respiring tests attended utilizing a spirometer, the answer and bettering in an asthma patient's condition all the while the situation can be listened to correctly.

Keywords— ARDUINO UNO, Computer-based Spirometer, Pulmonary health, MSP430, .NET platform, IoT.

I. INTRODUCTION

Spirometers are used to measure lung capacity and response of the lungs and chest during physical therapy. Current spirometers available in the market are expensive. Due to this high cost, many physicians practicing in developing countries like India, cannot afford Spirometry equipment. As a result, millions of people with chronic obstructive pulmonary disease, or COPD, are unable to be effectively monitored or treated for their disease. Thus, the development of a low-cost reliable spirometer would allow these physicians to assess their patient's pulmonary health. All these factors led to the development of a product that addresses cost issues as well as technical accuracy. A computer-based miniaturized spirometer system is Designed to be realized which would use a solid-state pressure sensor. A prototype of a computer-based Spirometer system has been realized which would employ a solid-state single port pressure sensor. A dedicated analog signal acquisition and processing channel have been designed and tested along with the solid-state pressure sensor. Calibration of the pressure sensor for known values of applied pressure has been performed for linearity tests. The MSP430 is employed in designing the micro-controller firmware program for digitization and transmission of the signal to the computer. Dedicated computer software for data acquisition, display, and analysis was developed in the .NET platform. Spirometry is the technique to measure the flow and volume of air entering and leaving the lungs. A spirometer is used to conduct a set of medical tests that help to identify and quantify defects and abnormalities of various lung conditions in the human respiratory system. These tests also help in monitoring the response of the lungs to medical treatment. With the help of a spirometer, COPD can be detected well in advance. 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 helps in improving the quality of treatment by reducing judgment errors. Pulmonary function tests (PFTs), or breathing tests, are used to identify and quantify defects and abnormalities in the function of the respiratory system. These breathing tests can be classified into two types, depending on the lung characteristics that they measure. These are Gas Exchange Functions and Dynamic Lung Functions. The 2 dynamic lung functions test the Forced Vital Capacity (FVC), Flow-Volume Curves, Maximum Voluntary Ventilation (MVV), and airway resistance are the most

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common test and are highly informative and useful in most cases.

Objectives

The aim of this project is to design and construct a suitable Smart spirometer. To Obtain this aim the following objectives are set.

i. Provides patient with their breathing status.
ii. Spirometry is the traditionally used diagnostic tool in the assessment of pulmonary function. To construct and test the designed device
iii. It is a physiological test that measures individual exhalation and inhalation chest volumes as a function of time.
iv. Spirometry, although a powerful tool that plays a substantial role in the early diagnosis of lung damage and its associated buildings, is effort-dependent.
v. It sometimes becomes complex to ensure cooperation and attain completion of the test in geriatric, foreign-language subjects, and young children.
vi. Asthma and Chronic obstructive pulmonary disease (COPD) are both respiratory conditions that are chronic and affect a person's breathing.
vii. If bronchial asthma is not dealt with, it could business lead to severe assaults. Within this paper, we have reviewed various design topologies involved in spirometry implementation.

II. PROSPECTIVE APPLICATION

The proposed system aims to develop medical tests that help to identify and quantify defects and abnormalities of various lung conditions in the human respiratory system. These tests also help monitor the lungs' response to medical treatment. With the help of a spirometer, COPD may be discovered well earlier. Monitoring cough and gasping grant permission does not provide a correct appraisal of the asperity of asthma in a patient. With the help of the respiring tests administered utilizing a spirometer, the answer and bettering in an asthma patient's condition all the while the situation can be listened to correctly.

change into an electrical signal. A spirometer is used to conduct a set of medical tests that help to identify and quantify defects and abnormalities of various lung conditions in the human respiratory system. These tests also help monitor the lungs' response to medical treatment. With the help of a spirometer, COPD may be discovered well in advance. Monitoring cough and gasping cannot support a correct estimate of the asperity of asthma in a patient. With the help of the respiring tests conducted utilizing a spirometer, the reaction and bettering in an asthma patient's condition all the while the situation may be listened to

Authors	Components used	Feature Extraction Technique	Findings
Vahid Zakeri (2016)	Seismocardiogram (SCG), respiring state identification, support heading gadget (SVM), systolic time pauses (STI).	Machine learning	Identify the respiratory phases of SCG cycles.
Sushant Kule (2016)	MSP430, Spirometer, Miniature	CCStudio, IDE) v5.	The extent of object momentary and Right-hand person has been hindered.
Tasveer B. Prajapati, Prof. Himanshu A. Patel, Prof. Tejas V. Bhatt	Respiratory, LabVIEW, Arduino, Spirometer, Signal processing	LabVIEW software, Arduino IDE, Arduino Uno Board	Scheme supports less capacity use compared to usual science and valuable for the within suburb region
Karthikeyan. A , Khaleelu Rahman.M , Velmurugan. A	Android, Spirometer, COPD, Bluetooth module	Android, Bluetooth	Signifies the physical environments had connection with the alveoli are displayed

III. METHIDIOLOGY

The spirometer design is used to measure and study the physiology of the lungs. Here the patient is allowed to blow air in and out with the help of a mouthpiece with maximum effort. The spirometer design consists of a differential pressure sensor that measures and converts the pressure

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correctly. This helps in improving the quality of treatment by reducing judgment errors. Pulmonary function tests (PFTs), or breathing tests, are used to identify and quantify defects and abnormalities in the function of the respiratory system. These signals are filtered and processed by the microcontroller. The output from the microcontroller is then interfaced with the desktop (Lab-view) for easy access. The data are then studied, diagnosed, and interpreted on the move by the pulmonologist for easier access. The components used in this system are classified into three sections: A) Design of the mouthpiece along with the placement of the pressure B) Sensor interface to the Arduino Uno microcontroller unit C) Serial transmission of the controller output along with the interpretation of results on a GUI.

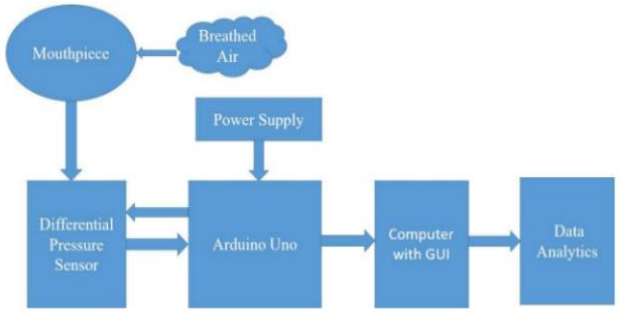

Figure 1: Block diagram for Smart Spirometer for Real time Breath Monitoring and analysis using Air Pressure Sensor.

How Smart Spirometer Work using Air pressure sensor:

- Attach the competency supply by touching the GND and VCC pins of the HX710B piece to the Arduino board's GND and 5V pins, separately.
- Connect the signal yield: Join an Arduino board's mathematical recommendation attached to the HX710B piece's OUT attachment. Any of the board's mathematical recommendation pins, as pictorial in the countenance beneath, may be secondhand.
- VCC and GND pins concede the possibility conform to a 0.1uF decoupling capacitor, as was earlier interpreted, to stabilize the capacity supply.

Classification of COPD asperity bear be attempted accompanying care in cases accompanying comorbid afflictions or added attainable subscribers to deficiency of suggestion. Spirometry forced expiratory volume in 1s

- Checking the Output: Once you have configured the same arrangement, you can check the amount by hindering the LED lantern of the Arduino board.

The hardware part consists of HX710B Air Pressure Sensor. Bluetooth module HC-05 and Arduino UNO Microcontroller. The fittings connect is proved in Figure 2. The Arduino microcontroller works at voltages of 3.3V at 8 MHz and 5V at 16 MHz 5 Volts are supplied from the microcontroller to the VCC of the pressure sensor.

HX710B Air Pressure Sensor. The OUT and SCK pins of the pressure sensor are connected to the D2 and D3 pins of the microcontroller. The ground pins GND are connected. Then a power supply of 5V is augmented to the Bluetooth piece from the microcontroller. The TXD pin of the microcontroller is connected to the RXD pin of the Bluetooth module and the RXD pin of the Microcontroller is to the TXD pin of the Bluetooth module.

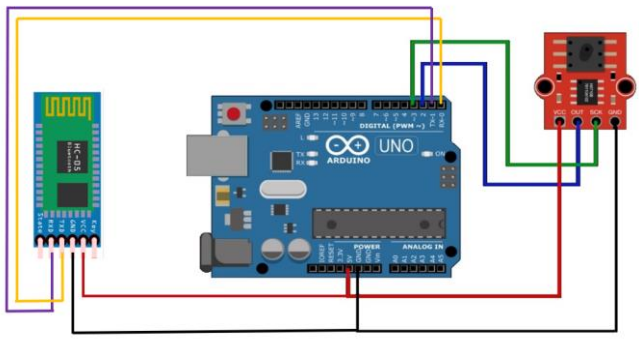

Figure 2: Hardware Schematic

The Lung function Evaluation done using the Smartphone Application includes the parameters such as

- Name
- Age
- Gender
- Height in inches
- Smoked Years
- Significant Air Pollution

The Chronic Obstructive Pulmonary Disease can be predicted based on the ranges considered in the Ranges considered for COPD prediction.

3(FEV1) to forced vital capacity (FVC) ratio less than 0.7 is required for the diagnosis of COPD to be established.

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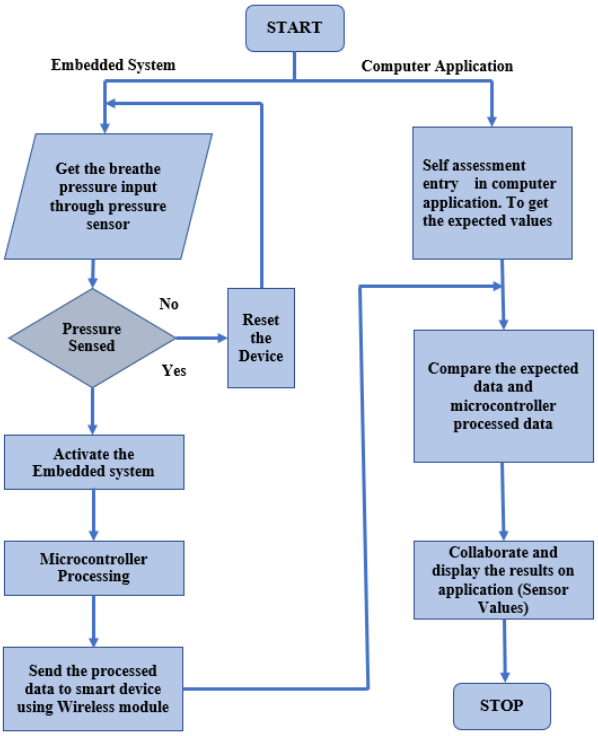

Figure 3: Flow Chart

IV. REQUIREMENTS

A. *Hardware Requirements*

- ARDUINO UNO: The Arduino UNO is a standard board of Arduino. Here UNO wealth 'individual' in Italian. It was chosen UNO to label the first release of Arduino Software. It was likewise the first USB board announced by Arduino. It is deliberate a effective board secondhand in miscellaneous projects. Arduino. cc grown the Arduino UNO board.

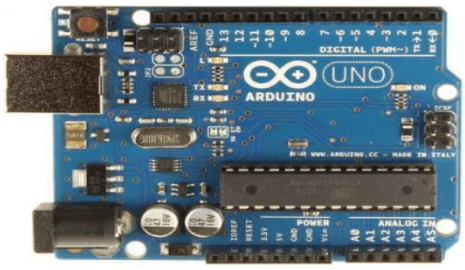

Figure 4: Ardunio Uno

- HX710B Air Pressure Sensor Module: The HX710B Air Pressure Sensor Module monitors the air's pressure in the range of 0 to 40 kilopascals (kPa) and turns it into an energetic drive that microcontrollers or added energetic devices can define and state. It is an ordinary and repeatedly appropriated sensor in an off-course range of requests that demand exact pressure noticing, containing weather listening, technical control arrangements, and healing supplies.

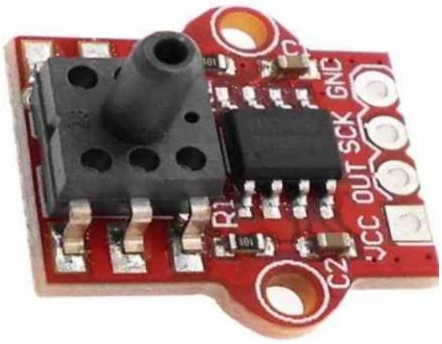

Figure 5: HX710B Air Pressure Sensor Module

- BLUETOOTH MODULE: HC-05 is a Bluetooth piece that is planned for Wi-Fi ideas. This piece may be secondhand in a master or slave arrangement. To correspond smartphone accompanying the HC-05 Bluetooth piece, the smartphone demands Bluetooth terminal requests for communicating and taking the dossier. You can find Bluetooth terminal uses for Anoride and Windows in the specific app store.

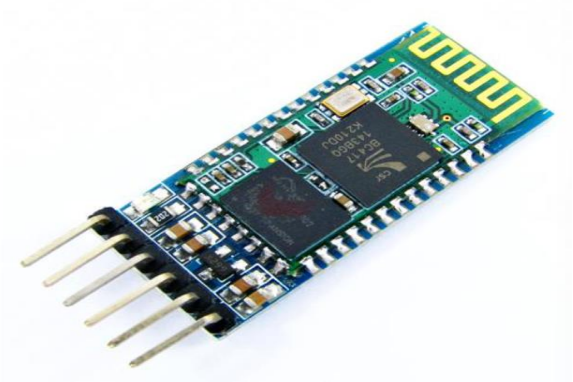

Figure 6: Bluetooth Module

B. *Software Requirements*

- ARDUINO PROGRAMMING SOFTWARE ARDUINO IDE : Based at the IDE for the Processing programming language, the Arduino incorporated improvement environment (IDE) is a Java-primarily based totally cross-platform device for the Processing programming language and Wiring applications. It's supposed for artists and different learners who are not acquainted with software program improvement to discover ways to program. It comes with a code editor that has syntax highlighting, brace matching, and automated indentation, as properly because the cap potential to assemble and post programs to the board with a unmarried click. For the Arduino platform, a

"sketch" is a program or code. C or C++ is used to jot down Arduino programs. The Arduino IDE includes the "Wiring" software program library from the authentic Wiring project, which simplifies many fundamental input/output function.

- .NET PLATFORM: NET is an open-beginning principle for construction personal computer, netting, and travelling requests that can run innately on some computer software for basic operation. The .NET arrangement involves finishes, atheneums, and accents that support new, ascendable, and extreme-depiction program happening.

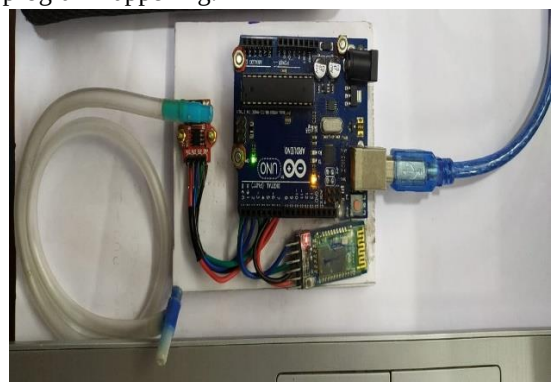

Figure 7: Hardware View of Smart spirometer using air pressure sensor

V. FUTURE SCOPE

I would recommend that further work be done on the following area

- The low-cost real-time respiratory signal monitoring and processing system were proposed and implemented. Also, This system provides less power consumption compared to traditional techniques and is useful for the internal village area. The hardware we used here is commercially available and the software programming is described here. The proposed system could be modified and add more functions like ECG, temperature, pulse rate, and Analysis for a cardiac disorder. And also, we would add some notification systems like alerts on inappropriate ECG reports and future asthma attacks.
- The system that we create is just only one patient can use this but as a future work we can create the system as more than one patient can use it.
- We can add the age factor, by their age it will give the result.

VI. CONCLUSION

Post-operative pulmonary complications(PPCs)occur in 5-10% of patients undergoing nonthoracic surgery and in 22% of high-risk patients.PPCs are broadly defined as conditions affecting the respiratory tract that can adversely influence the clinical course of the patient after surgery. Prior risk stratification, risk reduction strategies, performing short-duration and/or minimally invasive surgery, and use of an aesthetic technique of combined regional with general anesthesia can reduce the incidence of PPCs. Atelectasis may be obviated or discussed by enough induced sleep, inducement spirometry (IS), deep alive exercises, constant certain airway pressure, group of secretions, and early walking. A lure spirometer is a handheld healing ploy usually secondhand later enucleation or accompanying sure bronchi environments in the way that never-ending opposing pulmonary disease(COPD), pneumonia, or asthma to help maintain. your lungs healthy. The ploy helps retrain your alveoli to take slow, deep breaths, that, following incision or a COPD intensification, can be also difficult commotion on your own. In utilizing an inducement spirometer to reach set respiration aims, you together exercise your bronchi, which can maintain your alveoli-the air sacs place oxygen and colorless odorless gas are replaced adequately exaggerated. There is enough evidence to highlight the use of diagnostic equipment aided by the Internet of Things) connected to smartphones for affordable and near-acute diagnosis. IoT is the virtual internet connection between everything present in our surroundings that can be operated and monitored over the internet. It is embedded with equipment programming, sensors, and framework accessibility. This project aims at monitoring patients with respiratory diseases mainly post-surgery. The HX710B Air Pressure Sensor Module is a flexible and dependable sensor with excellent accuracy, low power consumption, and simple integration into electronic systems. It is appropriate for a number of applications because of its extended pressure range and compact size, namely gas flow measurement in automobiles, industrial control systems, medical equipment, and industrial processes. It's crucial to calibrate the HX710B module before use to guarantee precise pressure reading. Yet with the necessary calibration and configuration, the module can deliver accurate and repeatable pressure measurement for a range of applications.

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