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RESEARCH ARTICLE OPEN ACCESS

Iot Based Electronic Incentive Spirometer

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ABSTRACT The Respiratory cycle include inhale and let out your breath lung volumes. Coming from the lung volume the capacity of lung will be defined. As per the ATS (American Thoracic Society) lung diseases has been increasing rapidly. Diseases like COPD, Asthma can be detected only by use of spirogram. The best approach to calculate respiratory capacity is the spirometer. Early detection of chest diseases is possible. Since patients may suffer certain breathing problems after their surgery, it also helps them in overcoming these issues. Hence rehabilitation process plays an important role in the recovery of the patient. The main objective behind this paper is to develop a flow based incentive spirometer which aid the patient in rehabilitation post lung surgery.
Keywords - Chronic kidney disease, Node MCU, IoT, Infrared distance sensor

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I. INTRODUCTION

Modern incentive spirometer is a haheld tool that enables lungs to get better after a surgical treatment or lung illness. The pateint's lungs can emerge as susceptible after extended disease. With the assist of a spirometer can maintain them lively and free. The breath incentive spirometer works as such, a piston rises in the tool and measures the extent of breath that is the inspiratory extent. These spirometers are particularly used for sufferers publish surgical treatment. The current styles of spirometer simplest do offer visible remarks which is probably hard for affected person to understand. Thus, there is a need for calibrating the data from the spirometer. The present invention of spirometer consists of an IR distance sensor, Node MCU which is also acts as the Wifi module for data transfer and the ADS 1115 module as the hardware components. The data calibration from the spirometer is done using the sensor which collects the data based on the movement of the balls in the spirometer. Further, the data collected communicates with the patient with the help of IoT. This can be achieved by creating a Web API.

A. Existing System

• Already existing spirometer might only provide visual feedback.
• They cannot show inspiratory volume of patient.

B. Proposed System

• Provides patient with their breathing status.
• Stores the patient's everyday records and helps them keep track by implementation of IoT.

II. RELATED WORKS

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

2.1 A TELEHEALTH SYSTEM FOR AUTOMATIC DIAGNOSIS OF BREATHING DIFFICULTIES AND CHRONICAL OBSTRUCTIVE PULMONARY DISEASE

Typically, the telehealth system recommended in this study runs on the simple spirometer with a Bluetooth module, MATLAB-based HA SIDO application, and Android mobile application.

Typically, the system utilizes Android os, Java, MATLAB, and PHP technologies and consists

of a spirometer, mobile application, and expert diagnostic system. A system for remotely monitoring asthma severity includes a remotely located breathing difficulties monitoring station. To be able to evaluate the potency of the system, a potential study was completed in 3 distant primary healthcare organizations. Portable spirometers: employed by medical professionals to acquire measurements of relative parameters needed in COPD/asthma analysis. Thus, it is employed to evaluate different conditions of patient, the system uses different technologies which are described below.

The unit mainly subtends three quests: a flow meter, a PCB and a Smartphone. Typically, the flow meter is attached to a control system product composed of a top pass filter, signal amplifier, stabilizer (denoted as trigger), a microcontroller and a Bluetooth module. To get light and lightweight, our spirometer could be a wireless small compact hand-held unit without any external connecting pipes/tubes, desktop consoles. The lightweight spirometer used in this study can be attached to a mobile telephone using Bluetooth. Any kind of commercially available portable spirometer wit this communication module can be applied for this telehealth system. Android based mobile application: developed for the Android os and executed in Java using Android Studio 2. 0 IDE (Integrated Development Environment). That is attached to a mobile phone and used for starting SPIR data recording, formatting, and data transmission.

2.2 INTERNET OF ITEMS IN HEALTHCARE SUPERVISING TO ENHANCE BUY PERFORMANCE OF RESPIRATORY SYSTEM DISORDER SENSORS

IoT architectural design is based on sign acquisition through sensors and, then, highly processed by using a programmable credit card. Database (DB) signs are then noted in a Centre IoT cloud storage space. Hub-IoT is a technology service regarding multiple programming different languages DB access employed in this study. It is used to acquire, save, process, in addition to analyze by implies of a program programming interface (API).

Optimization abilities for application development count on communication channels, methods (IoT, transport, in addition to priorities), low reference consumption technology, between others. An efficiency effectiveness test program is then produced. The main acquisition module includes a high-efficiency wireless private area network (WPAN) which is consists of low energy consumption sensors, and that also has a unsuccessful, broken, interrupted control system to clinical parameters.

2.3 A SMARTPHONE DEPENDENT HANDHELD WIRELESS SPIROMETER WITH FUNCTIONS IN ADDITION TO PRECISION JUST LIKE CLINICAL SPIROMETERS

The produced spirometer was demonstrated to be able to discover flow rates ranging from 0–15 L/s with an reliability of 4 mL/s, and can perform tests of flow volume (FV), pushed important capacity (FVC), forced expiratory volume in 1 t (FEV1), peak expiratory flow (PEF), and so forth By having typically the functions and accuracy just like laboratory spirometers, it satisfies the particular American Thoracic Modern society and European Respiratory Society (ATS/ERS) proposed performance requirements regarding spirometer. At typically the same time, that is inexpensive, lighting and handy, lower power consumption battery-powered. To be lighting and portable, our own spirometer can be a wi-fi small compact hand-held unit without the exterior connecting pipes/tubes in addition to desktop consoles.

That should have features and precision similar to laboratory spirometers, in order to perform a variety of tests, such as flow volume level (FV), forced crucial capacity (FVC), forced expiratory volume inside 1 s (FEV1), peak expiratory circulation (PEF), maximum non-reflex ventilation, and tidal spirometry, etc.

Typically, the architectural design is dependent on signal acquisition via sensors and, then, processed by using a programmable card. Database (DB) signals are then recorded in the Hub IoT fog up server. Hub-IoT is usually a solution for multiple programming different languages DB access used in this research. It is employed by simply medical professionals to be able to acquire measurements
regarding relative parameters needed in COPD/asthma diagnosis.

Thus, it is used to evaluate different conditions of individual, the system uses different technologies which often are described inside the given diagram below to fulfill the further want in the physicians. This should also satisfy the performance list requirements for spirometer recommended by typically the American Thoracic Society/European Respiratory Society (ATS/ERS). Specifically, it ought to be able to be able to respond flow costs which range from 0 in order to 14 L/s with a resolution far better than 25 mL/s, and have a new precision of ≤±3% for FVC, in addition to ±10% for PEF.

Moreover, it should have the capacity to display the test results including both data and graphics right after the analyze, and at the same time

transfer them to family members doctors or a new hospital unit. By having the capabilities and precision just like to laboratory spirometers, satisfies the Us Thoracic Society in addition to European Respiratory Modern society. In 2015 Lambodar J. and Narendra Ku. K. have got experimented with 8 machine learning models applying WEKA data exploration tool. The best Receiver Functioning Characteristic (ROC) in addition to accuracy were offered by Naive Bayes, Multi-layer Perception plus J48 algorithms because ROC of just one plus accuracies of zero. 950, 0. 9975 and 0. 99 respectively. Inside the mentioned work, Kappa Statistics is utilized to get the discussion strength and possesses offered the highest regarding 0. 9947 for multilayer perceptron, 0. 9786 as the next highest regarding decision table plus J48 algorithms.

Thinking of the related function based on UCI CKD data established, it absolutely was observed that the reasons for many in order to have less precision are the weak handling of absent values and typically the technique of attributes assortment.

III. METHODOLOGY

The proposed methodology consists of two major sections - one is the user section and other is the spirometer section. Typically in the spirometer section the input signal i.e, the breathing signal is scored by the IR distance sensors which detect the distance by the movement of the balls in each column of the spirometer. The IR distance sensors only provide analog values. Next, the particular analog values through the sensor is converted into digital form employing a analog to electronic converter. An analog to digital ripping tools is added in order to the setup since the microcontroller we possess used has just one analog in order to digital converter yet we have about three input signals. Therefore, the converted electronic digital values are provided towards the Node MCU. Finally, the digital values are displayed using the arduino application. Further, a web application on the is created in order to store the values produced by the spirometer which helps create a reassurance for patient that their health is improving. The web application framework we have used is .NET core platform.

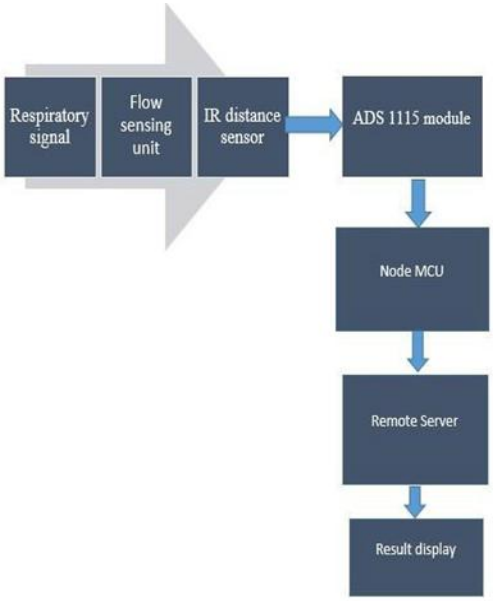

Fig. 1: Flow Diagram of Electronic Incentive Spirometer

IV. HARDWARE USED

This spirometer requires certain essential hardware components for proper functioning. The listed below component's specifications and functions are as follows,

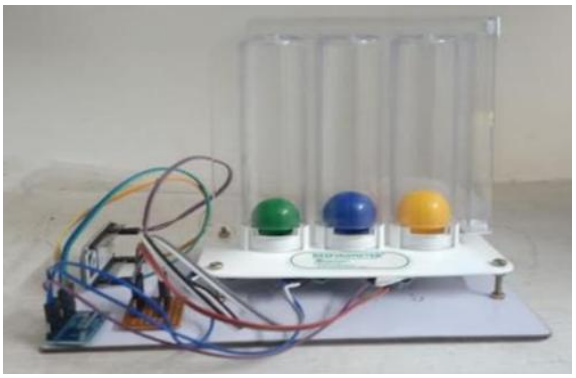

Fig. 2: Hardware connections

4.1 MICROCONTROLLER (NODE MCU ESP 8266)

The microcontroller we have used is the Node MCU ESP 8266 12 E. The ESP8266 12e microcontroller is low cost and consists of TCP/IP protocol stack. The protocol helps to provide network access to any microcontroller. This specific microcontroller is used because of its WiFi capabilities. To access the Wifi network we have to feed the network name and password. In order to send the data from the module to server, we need to feed the IP address and port number.

4.2 INFRARED SENSOR

An infrared sensor is used to sense distance by emitting infrared radiation. The sensor emits infrared radiation and detects the reflected radiation. The radiation is being reflected by an object or the surroundings. The range of this sensor is between 2 cm to 30 cm and the operating voltage is around 3v to 5v.

4.3 ANALOG TO DIGITAL CONVERTER

The analog to digital converter ADS1115 module is used to convert the analog values of the sensor. Externally this used because three inputs are produced by the spirometer

V. SOFTWARE USED

5.1 ARDUINO IDE SOFTWARE

Arduino IDE is the software which has been used for writing, compiling and uploading the code to the Node MCU. First the program is written in the editor space based on the TCP/IP protocol, then the board is selected. In order to transfer the data to the server, microcontroller module needs to be connected to WiFi network which is the access point. Each access point is recognized by a SSID, that essentially is name of network to be selected.

5.2 VISUAL STUDIO IDE

The Visual Studio IDE is a prerequisite for ASP.NET core platform. This software used to edit, debug, and build code, and then publish an application. This software is used to create a web application to post the data obtained from the Arduino IDE. The architecture used for creating the web application is MVC(Model-View-Control). This architecture is used because it helps avoid overlapping of code.

5.3 MONGODB

It is a document-oriented database which stores data in JSON-like documents. It has a dynamic schema. It can store records without worrying about the data structure. The database is used to enhance the security and support data availability.

5.4 OUTPUT AND RESULT

Each column of the spirometer is employed with a specified volume as 600cc, 300cc, 300 cc which will add up to a total of 1200cc. The output is calibrated as a result of 10 counts of breaths by the patient. So a total average of each column andcorresponding inspiratory volume is generated. Further, it displays the data with time and date which helps the patient keep track and keep a check upon their lung activity.

The output will be as follows. If the patient can maintain displacement of the balls in first and second columns of device for 3 seconds, the estimated or good condition indication may be around 2.7 litres which is 900cc with the time period of 3 seconds.

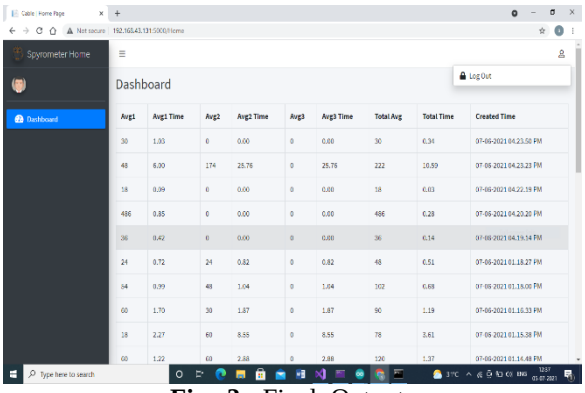

Fig. 3: Final Output

VI. CONCLUSION

Post-operative pulmonary complications (PPCs) occur in 5–10% of patients undergoing non-thoracic surgery and in 22% of high-risk patients. PPCs are broadly defined as conditions affecting the respiratory tract that can adversely influence clinical course of the patient after surgery. Prior risk stratification, risk reduction strategies, performing short duration and/or minimally invasive surgery and use of anaesthetic technique of combined regional with general anaesthesia can reduce the incidence of PPCs. Atelectasis is the main cause of PPCs. Atelectasis can be prevented or treated by adequate analgesia, incentive spirometry (IS), deep breathing exercises, continuous positive airway pressure, mobilisation of secretions and early ambulation.

An incentive spirometer is a handheld medical device commonly used after surgery or with certain lung conditions such as chronic obstructive pulmonary disease (COPD), pneumonia, or asthma to help keep your lungs healthy. The device helps retrain your lungs to take slow, deep breaths, which, following surgery or a COPD exacerbation, may be too painful to do on your own.

In using an incentive spirometer to reach set breath goals, you simultaneously exercise your lungs, which can keep your alveoli-the air sacs where oxygen and carbon dioxide are exchanged-sufficiently inflated.

There is enough evidence to highlight the use of diagnostic equipment aided by 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, framework accessibility. This project aims at monitoring patients with respiratory diseases mainly post-surgery. Here we incorporate IoT technology for storage of data which helps the patient give a satisfaction about their health.

After surgery, patients that have breathing issues are suggested to perform breathing exercises

to track the most effective exercise routine for them. Since a health specialist can't be physically around 24/7 and some patients may misread or disregard their worsening symptoms, there is a need for IoT to help users address their acute lung concerns.

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