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Effective Respiratory Monitoring Device for Pulmonary Inflammatory Patients

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***Abstract*— In this project we designed a portable device to monitor the severity of several lung function parameters and record the data of pulmonary inflammatory patients(asthmatic). By continuous home monitoring system and transferring the information by telemetric system using ZIGBEE technology. In this device consists of a chemical sensor pressure sensor and heart rate sensor. The electrochemical sensors are used to measure the nitrous oxide,oxygen,carbon monoxide.Data obtained by chemical sensor sent to the microcontroller that converted a concentrated value. A microcontroller PIC16F877A is used to control the sensors and transmit the data to the physician, monitor by the text or e-mail. Now a days the classic spirometry and peak flow meter are used butthey are non portable one and inconvenient to use. So that, we have to create a user-friendly, accurate, portable external mobile device accessory that collects patient information i.e.) respiratory parameters from patient safe two breath maneuvers with heart rate monitoring feature**

***Index Terms*— Asthma monitoring, sensors, ZIGBEE**

I. INTRODUCTION

ASTHMA is a chronic pulmonary inflammatory disease that affects the airways**.** Pulmonary inflammation affects over 300 million people worldwide. Asthmatics experience difficulty in breathing and airflow obstruction caused by inflammation and constriction of the airways. Subsequent stimulation may prompt the airways to narrow and induce production of mucus causing less air to flow into the lungs. Common symptoms of asthma include wheezing, shortness of breath, and chest tightness. The intensity of an acute asthma exacerbation, also known as an asthma attack, is unpredictable and has the potential to be life threatening. More than 5 million children have asthma and the prevalence of asthma is greater than 15% for children living in low-income families. The severity of symptoms, triggers, and responsiveness to treatment medication are often unique to each individual. Thus, a comprehensive guideline for an asthma action plan recommends focusing on monitoring asthma symptoms as a goal for asthma therapy. Home monitoring of lung function is the action to give physicians and asthma patients a chance to control the disease. Thus, it is important to develop accurate and efficient asthma monitoring devices that are easy for patients to use. While there are medical treatments available to alleviate asthma symptoms, there is no cure. Personal monitoring of lung function is to control the disease by created a user-friendly, accurate and portable external device accessory. This device collects multiple parameters (exhaled nitric oxide, carbon monoxide, oxygen concentration, heart rate, pressure rate) from patient safer two breath maneuvers. In clinical assessment, the first step done by the doctors is asking about the patient's background and focuses more on the medical history. They want to identify the symptoms, the occurrence and any possible asthma trigger such as allergens. After that, a physical test is conducted especially around the upper respiratory tract. The doctors will listen for wheezing sound and may look for nasal secretion or any similar allergy-related symptoms. The doctor keeps the symptoms record on a diary card and the data obtained is often used in clinical trials. This is the simplest method and takes least time compared to Spirometer and peak flow meter, however symptoms may not indicate the severity of disease and there is no strong evidence regarding the patient health. Some physicians may be unsure to determine the degree of airway obstruction. Sometimes, the improvement in airway obstruction is because of oxygen therapy alone. Although the symptoms may be gone after the patients undergo medical treatment, it does not necessarily correlate with patients health status. Until now, there is no asthma severity monitoring tool yet. There are various options available to assess airway obstruction, which are clinical assessment, peak flow meter estimation and by using Spirometer have their own disadvantage.

II. LITERATURE SURVEY

Rapid rise to tidal peak flow was analyzed in two ways, percentage of volume expired at tidal peak flow and percentage of expiratory time to tidal peak flow. Both these indices correlated significantly with conventional measurements of airway obstruction. The patterns of expiratory flow in airflow obstruction during quiet breathing resemble that of a forced expiratory maneuver at similar lung volumes. In some cases this way is caused by dynamic compression occurring during tidal breathing. In others the pattern may result from the static recoil of the lung being permitted to drive flow freely in expiration, rather than being braked by post inspiratory contraction of inspiratory musculature.[1]

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Exhaled breath analysis is a rapidly expanding area of research to study airway inflammation and lung oxidative stress, allowing the detection of volatile and non-volatile substances from the airways. The most studied volatile marker is exhaled nitric oxide (FENO), which is considered a good marker of airway inflammation. Induced sputum is a valid and well established method for analyzing both cellular and biochemical markers of airway inflammation. However, this procedure is not easily performed in children, and the inhalation of hypertonic saline solution may induce coughing, bronchoconstriction, and a temporary inflammatory response. An alternative and simple means for detecting non-volatile substances from the lungs is the method of exhaled breath condensate (EBC), which enables the components of the fluid lining the respiratory tract to be studied. Measurement of several endogenous substances can then be carried out in the condensate. EBC is considered safe and feasible, but limited information concerning its use in preschool 7 and school age 6 8 children is available and to our knowledge, no studies have formally addressed the safety and the feasibility of this sampling procedure in asthmatic children, particularly during acute asthma exacerbation. Although considered safe, EBC collection involves a prolonged oral breathing which, without the humidifying and warming action of the nose, could lead to airway mucosa dehydration and act as a bronchoprovocative stimulus in patients with airway hyper responsiveness. [2] discussed that In surgical planning and cancer treatment, it is crucial to segment and measure a liver tumor's volume accurately. Because it would involve automation, standardisation, and the incorporation of complete volumetric information, accurate automatic liver tumor segmentation would substantially affect the processes for therapy planning and follow-up reporting. Based on the Hidden Markov random field, Automatic liver tumor detection in CT scans is possible using hidden Markov random fields (HMRF-EM).

This home management of asthma monitoring device demonstrate that short term compliance with PEF monitoring is fairly good. However, long-term compliance with PEF measurements is poor, and long-term management of asthma should not rely on PEF measures alone, but should include educational intervention, ideally aimed at improving patient recognition of asthma symptoms. Peak flow meter use should probably be reserved for those patients who show a significant interest in using the device, poor perceivers of airflow obstruction, and severely asthmatic subjects. In clinical trials on asthma that include PEF measurements as an important outcome, the use of electronic peak flow meters that store recorded data could help ensure the validity of the data.[3].

A simple technique which consists in applying negative pressure at the mouth during a tidal expiration (NEP). Patients in whom NEP elicits an increase in flow throughout the expiration are not flow-limited. In contrast, patients in whom application of NEP does not elicit an increase in flow during most or part of the tidal expiration are considered as flow limited. Using this technique, 26 stable COPD patients were studied sitting and supine. Eleven patients were flow-limited both seated and supine, eight were flow-limited only when supine, and seven were not flow-limited either seated or supine. Only 5 of 19 patients who were flow-limited seated and/or supine had severe ventilator impairment (forced expiratory volume in one second (FEV1) <40% predicted). Hence it conclude that the NEP technique provides a simple, rapid, and reliable method for detection of expiratory flow limitation in spontaneously breathing subjects, which does not require the patient's co-operation, and can be applied in different body positions both at rest and during muscular exercise. Thus the results also indicate a high prevalence of flow limitation in COPD patients at rest, particularly when supine. [4] discussed that Liver tumor division in restorative pictures has been generally considered as of late, of which the Level set models show an uncommon potential with the advantage of overall optima and functional effectiveness. The Gaussian mixture model (GMM) and Expected Maximization for liver tumor division are introduced. In the early liver division process Level set models are utilized. This proposed strategy uses Gaussian blend models to demonstrate the portioned liver image, and it transforms the division issue into the most significant probability parameter estimation through the use of Expected Maximisation (EM) calculations. The proposed methodology outperformed existing techniques by a significant margin, according to the results of our comparison.

Asthma is a common chronic respiratory disease caused by inflammatory in the bronchioles and narrow airways. Tools usually use by doctor to detect signs or symptoms of asthma are spirometer and peak flow meter, and yet there is no tool that is able to monitor the severity of asthma. However, there are obvious drawbacks of the current tools as patients always have bad effect and their symptoms worsen after they performed the maneuvers. Capnography which is used non-invasively to measure the concentration of carbon dioxide in breath out air was recently introduced to overcome the current limitation. This study aims to design a GUI (graphical user interface) to detect the severity of asthma by using MATLAB software.[5]. The GUI build will present the data into simpler and friendly program. It consists of patient information part and capnography analysis which is able to detect the severity of asthma. Success of this project widen the usage of capnography in medical areas and the GUI build may serve as new method to help the healthcare professionals to monitor the severity of asthma due to its properties of non-invasive, effort-independent and continuous monitoring. [6] discussed that Tumor segmentation required also the identical automatic initialization as regarding the liver. This phase was applied only in order to liver volume, obtained following automatic delineation of lean meats surface: this latter, used to original dataset quantity, was used as a new mask in order to be able to prevent processing overloads and even avoid errors related to be able to arsenic intoxication surrounding tissues delivering similar gray scale droit.

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III. PROPOSED SYSTEM

Portable external monitoring device which collects multiple informations from patient safer two breath maneuvers. When air is blow through airflow detector the sensors present in this device automatically sense and gives the digital result in display. Telemetric system is capable to deliver the information to the physician for further treatment by ZIGBEE technology. In existing system classic spirometry and peak flow detectors are used but the output is a graphical representation to observe by the physician more complex. So, we develop the digital output by a LCD. Telemetric capabilities help physicians to receive asthma symptoms and lung function over time.

IV. BLOCK DIAGRAM AND DESCRIPTION

This project deals with providing a monitoring device which continuously monitors the asthmatic patients by using ZIGBEE. This monitoring device consists of heart rate sensor, pressure sensor, chemical sensor which display in LCD.

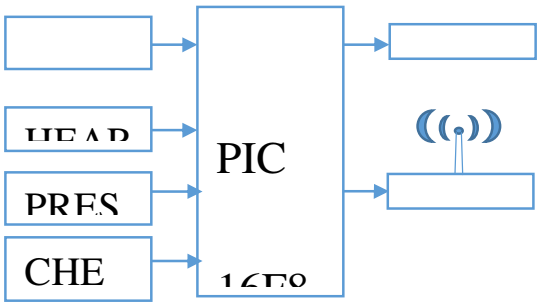

Fig.1 Transmitter Block Diagram

This fig. shows that the sensor detect the signals and transfer it to the microcontroller as a electrical energy and convert it in to the digital output in LCD display. By using ZIGBEE it sends the information to the physician.

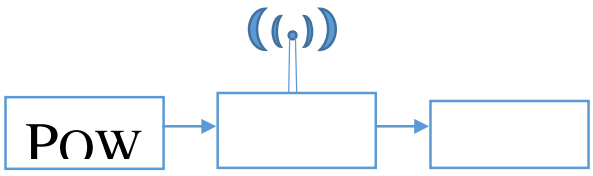

Fig.2 Receiver Block Diagram

This Fig. shows the power supply is given to the receiver side and it transfer the data to the computer of a physician used to control the disease.

V. CIRCUIT DIAGRAM AND DESCRIPTION

This circuit diagram is the total circuit connection of the project. This project deals with providing an effective lung function monitoring system which consists of chemical sensors, pressure sensor and heart rate sensor to detect the respiratory functions.

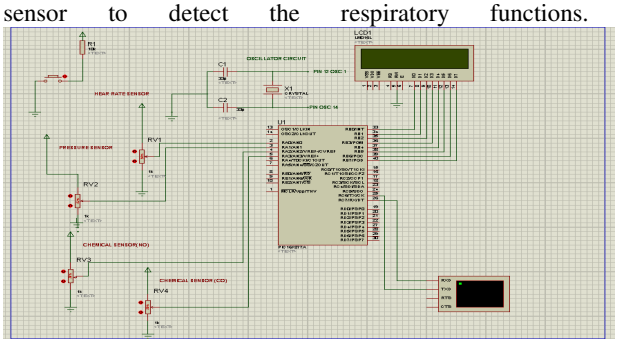

Fig. 3. Circuit Diagram of Lung Function monitoring Device

PCB Fabrication

- PC Based Art Work
- Taking the PCB layout print using a laser printer.
- Transfer of the conductor pattern.
- Etching
- Drilling and Cleaning.
- Soldering.

Procedure

1. Make a layout of the circuit.
2. Straighten and clean the component leads using blade or knife. Apply a little flux on the leads. Take a little solder on soldering iron and apply the molten solder on the leads.
3. Mount the components on the PCB by bending the leads of the components using nose-pliers.
4. Apply flux on the joints and solder the joints. Soldering must be done in minimum time to avoid dry soldering and heating up of components. Wash the residue using water and brush.

Advantages

- Reduce the manual power
- Low cost and Reliable.

VI. SOFTWARE DESCRIPTION

1. *CCS C Compiler for PIC Series Microcontrollers Embedded*

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations.

2. MP LAB

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MPLAB IDE is a software program that runs on a PC to develop applications for Microchip microcontrollers. It is called an Integrated Development Environment, or IDE, because it provides a single integrated environment to develop code for embedded microcontrollers. Experienced embedded systems designers may want to skip ahead to Components of MPLAB IDE. It is also recommended that MPLAB IDE On-line Help and MPLAB IDE Updates and Version Numbering be reviewed. The rest of this chapter briefly explains embedded systems development and how MPLAB IDE is used. Description of an Embedded System .An embedded system is typically a design making use of the power of a small microcontroller, like the Microchip PICmicroÆ MCU or dsPICÆ Digital Signal Controller (DSCs). These microcontrollers combine a microprocessor unit (like the CPU in a desktop PC) with some additional circuits called peripherals, plus some additional circuits on the same chip to make a small control module requiring few other external devices. This single device can then be embedded into other electronic and mechanical devices for low-cost digital control.

VII. RESULTS AND DISCUSSIONS

Monitoring asthma by using this device is a new approach in medical technology and it is not yet widely used in Malaysia. As the current method to monitor and manage the presence of asthma posses limitation, monitoring by is an alternative way to solve the limitations. In this project, a sensor to detect and monitor the severity of asthma was successfully created by the previous researcher to enhance the efficiency of the tool. Computerize analysis to physician may extend the usage in medical areas and promote the use for the purpose of monitoring asthmatic patient during asthmatic attack. With further research, may serve as a new method in monitoring asthma as it has great potential due to its properties of non-invasive, effort-independent, and continuous monitoring. Also, in future, analysis of asthmatic patient using the peak flow meter and spirometer will be included so that a complete monitoring tool can be produced to monitor severity of asthma it also detect the harmful gases by using the sensors CO, CO2,NO.

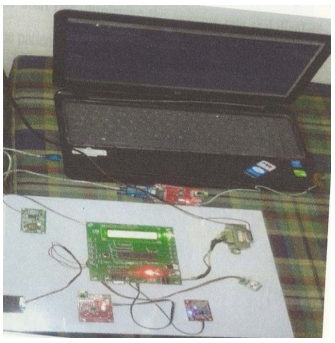

Fig. 4. Lung function monitoring kit

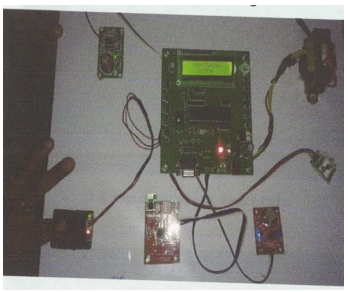

Fig.5. checking heart rate

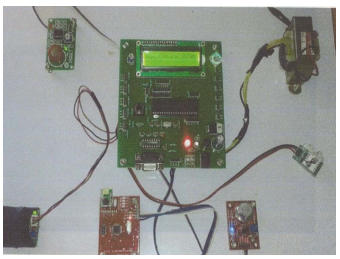

Fig. 6.checking CO rate

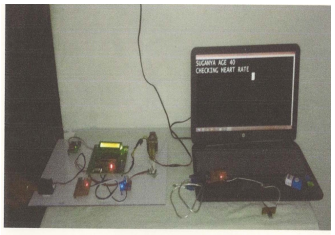

Fig. 7.Displaying Heart rate on physician side display

Fig. 8Displaying the information in physician section

VIII. CONCLUSION

This project is aimed towards the welfare of asthmatic patients. Now a days,lot of machines was discovered to monitor the asthmatic condition ,bt no one can give the accurate result. This project represents a major importance to the asthmatic patient through its monitoring feature and the telematery capability.So, that it was great advanced one in medical field. As a whole, the approach described here shows the feasibility of a cost effective, fast and easy method to detect the lung function. Hence, this project is sure to create a revolution in medical field and ensure complete support from the physician. At the international arena this project will definitely achieve greater hights and is expected to be welcomed by communities for helping the asthmatic patients.

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