ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

An Intelligent Monitoring Device for Asthmatics using Arduino

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ABSTRACT: Asthma is a life time lung disease causing irregular functions and shortness in breathing. Continuous monitoring is the essential action to monitor and control the chronic disease. On-time monitoring helps asthmatics to get treated with proper medications and treatment. Spirometry test is one of the currently standardized tests to find out the serious symptoms of the lung disease in hospitals. Along with the spirometer test, Peak Expiratory Flow meters are available to detect the PEF value of the exhaled breath air pressure. The proposed system helps to monitor the activity and environmental parameters of the asthmatics. Preliminary asthma symptoms can be found out by using this proposed system. The developed system includes a hardware module to monitor the air pressure, temperature, humidity, activity and corresponding volatile gases around the asthmatics. The sensed data from the hardware are sent to the patient's doctor by a GSM module. Doctor on examining the sensed values can take desired action on the asthmatics treatment and medications. The developed system is cost efficient, reliable, and easy to use device to find out the asthma symptoms in asthmatics.

KEYWORDS: Asthma, Peak Expiratory Flow (PEF), GSM, Air Pressure.

I.INTRODUCTION

Asthma is an inflammatory lung disease, which causes shortness in breathing, wheezing, irritation in airways, etc. The frequency and rigorousness of the disease varies from adult to adult and age group. Exercise, early morning cold effects, stress, etc., leads to worseness of the disease. Apart from it allergy indulged in adults may lead to rise of asthma problems.

The World Asthma Network suggests finding out and monitoring respiratory asthma symptoms at earlier stages is the best way to control the lung disease. Now-a-days most doctors diagnose and monitor severity of symptoms through spirometry and PEF tests. Both these test measurements require supervision from specialists. Professional supervision is absolutely important, but regular visit to hospitals is really impossible. This incapability can be overcomed by using this monitoring device.

The main aim of this paper is to design a low cost monitoring device for asthmatics. The device developed includes an activity sensor to monitor the physical activity of asthma patient. The device also includes gas sensors to monitor the corresponding volatile gases around the asthma patients. Temperature and humidity are also an important issue in today's scenario. Corresponding sensors are integrated to sense the real time values. Depending upon the sensed data, the patient's current situation is determined by the doctor. This system effectively monitors the symptoms of the asthmatics and it is very cost efficient.

II.LITERATURE REVIEW

Daniel Tecihmann et al in the year 2014 proposed a study on wearable and bendable cardiorespiratory monitoring device by merging two noncontact sensor standards. The study proposes a wearable device which can be held in the patient's shirt pocket. In order to get the optimum performance the device has to combine the standards of two sensors in noncontact way by invoking into several layers of textiles used by the patient. One sensor focuses on respiratory monitoring and the other sensor focuses on pulse detection. The main drawback of this study is that only two parameters are into consideration and real time monitoring is not taken into study.

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Jun Luan et al in the year 2015 gives an overview of sternocleidomastoid muscle contraction for asthma assessment and control. This study proposes the low power detection of muscle contraction near the neck area during inhalation of air. In this study a wearable monitoring device has been developed using LED and photo detector. The experimental result of this study explains the simplification of hardware design thus showing reduction in power consumption in monitoring parameters. This paper focuses on development of wearable device to monitor abnormal sternocleidomastoid muscle contraction during the lung disease asthma which is a sign of further respiratory problems.

Chinazunwa UWAOMA et al in the year 2015 proposed a work on monitoring and detection of asthma symptoms on resource constraint mobile device. The work comprises of a resource oriented mobile device to monitor various physical and environmental factors of the asthma patients. The work concentrates on available sensors and modules in a mobile device to monitor asthmatics medical parameters, physical activities and environmental factors. The medical records are been stored in the same mobile device for patient's assistance. An algorithm is also developed to analyse the physical activity and breathe pressure. The study carried out in this paper can only be worked out in a smartphones readily available in the market.

III.SYSTEM MODEL AND ASSUMPTIONS

The proposed system, namely An Intelligent Monitoring System for Asthmatics uses Arduino development board to monitor and examine the lung disease symptoms in asthmatics. The proposed system consists of various sensors interfaced with the Arduino board. The Arduino board gets the results from various sensors and sends it to the doctor through a communication medium for further examination. The developed system systematically monitors the parameters to get down various results so that early detection of asthma symptoms is possible. The block diagram of the proposed system is shown in Fig 1.

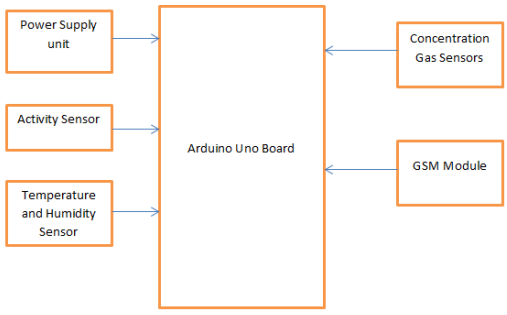

Fig. 1 Block Diagram of Monitoring System

The monitoring system involves an Arduino development board as a processing unit. Atmega microcontroller is integrated within the development to carry out the data processing. The development board works at 5V power supply, so a power supply module is been designed to power up the board and other sensors interfaced with it. An asthmatic tends to wheeze when he/she involves in doing exercise. In this situation an activity sensor is required to determine the activity of the asthmatic. Monitoring activity of the asthma patient is very important, so that unnecessary fall situations can be avoided.

Apart from activity, environmental volatile gases may also tend difficulty in inhaling pure oxygen, so respective concentration gas sensors like NO, CO2, CO and oxygen sensors are integrated to the processing unit. These gas sensors are calibrated such that they are very much sensitive to environmental volatile gases. Temperature of the environment is important because too much low and high temperature leads to cause of asthma. A human body always concentrates to the environmental temperature to feel ease. The temperature of the blood and the environmental always merges to set up the ease in the field where an adult resides. A temperature sensor always helps to measure the temperature in the environment, so that an individual can take a right decision to cut off the cause of asthma symptoms. Humidity of the exhaled air has to be measured to determine the moisture content of the air. High moisture content ensembles the severity of the asthma in the individual.

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A communication medium is also been interfaced to send the sensed values in the form of text messages to the patient's doctors. The communication medium used is the GSM module set at 9600 baud rate to send the messages. The doctor can further get down with the examination and diagnosing process to detect the asthma symptoms in asthmatics. The developed system also consists of a display unit to display the sensed values to the patient other than data transmission. A 16x2 LCD is used as a display unit in this system.

IV.SOFTWARE OF THE PROPOSED SYSTEM

A. Arduino IDE

Energia is an open-source platform for electronics. Arduino IDE is a cross platform and supported by Linux, Windows and Mac OS. Mspgcc compiler is used by the Arduino and is mainly based on wiring and Energia framework. An IDE is included in the Arduino which is based on processing. Arduino is also considered to be as a portable framework. Other wireless interface modules namely Wi-Fi, ZigBee, cellular, NFC, etc., are included in the platform. Arduino supports both Energia and MSP boards for programming.

B. Software Algorithm

The software algorithm for detecting and analyzing the asthma symptoms is as follows:

- Include header files and macros for interfacing sensors, LCD and to initiate serial communication.
- Initialize the GPIO header to interface the GSM module.
- Initialize the ADC to get the analog output values from the sensors.
- Allocate the digital and serial port to collect data from sensors and transmit it to the physician side.
- Check the temperature value.
- Get the temperature, humidity and volatile gas values from the respective sensors.
- The physical activity of the patient is sensed by the activity sensor, gyro sensor.
- The sensed data from the patient side are sent to the doctor through GSM.
- The message sent to the doctor is received for further processing and examination.

V.EXPERIMENTAL RESULTS

A. Temperature and Humidity Result

The monitoring system is been developed and some preliminary results are been obtained. Depending upon the environmental and physical scenario, primary results are seen on the serial monitor of the Arduino IDE. The result of temperature and humidity is shown in the Fig 2.

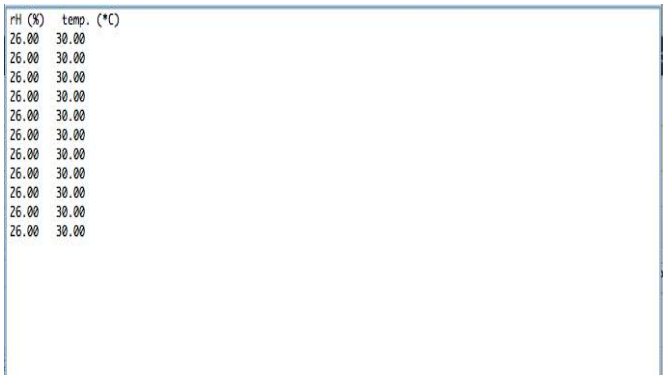

Fig. 2 Temperature and Humidity Serial Monitor results

The humidity values obtained determines the moisture content of the air exhaled by the patient. The parameter humidity mainly decides wheeze severity in the patient. The temperature is measured using a temperature sensor, which exactly portrays the environmental temperature around the patient.

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B. Volatile Gas result

Volatile gas sensors are used to sense various gas concentration levels in the environment. Volatile gases in the environment lead to severe attack on asthmatics. High concentration of volatile gases tends to breathing problem, so the same has to be monitored and controlled. The results of various volatile gas sensors are displayed on the serial monitor as shown in the Fig 3.

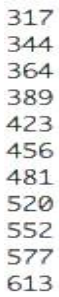

Fig. 3 Volatile Gas Serial Monitor results

C. Patient Activity Result

Gyro sensor is interfaced to sense the physical activity of the asthma patient. Physical activity examines the activity performed by the patient, which lead to the difficulty in breathing. Activity of the patient is determined in xyz axis as shown in the Fig 4.

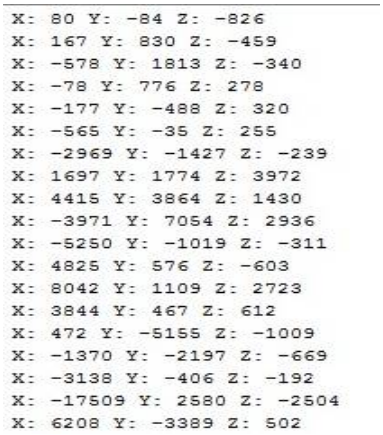

Fig.4 Activity sensor Serial Monitor results

D. GSM Modem Initialization

The GSM Modem SIM 800 initialization setup is shown in the Fig 5. The SIM800, a GSM modem is initialized through the AT Commands through software.

Fig. 5GSM Modem Initialization

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VI.CONCLUSION

Thus the proposed system for asthma patients monitors and determines the lung disease in asthmatics. This system finds the various parameters and determines the level of seriousness in patient's health. The data are sent to the specialist through mobile communication module interfaced with the designed hardware. The physician after examining the results can communicate the change in medications and severity of disease to the patient. Quick and effective way of asthma examination is achieved by the developed device. The above system is user friendly and of low cost with quick access to data.

VII.FUTURE WORK

The developed system achieves the on time monitoring through a monitoring device. The module developed monitors the basic respiratory and environmental factors. Along with it there is a small unit to monitor the physical activity. In future, advanced respiratory monitoring will be taken into consideration. Advanced respiratory monitoring for early asthma diagnosis will be achieved by using air pressure sensor through which breath analysis will be carried out. Efficient breathe analysis algorithms will be developed to determine wheeze detection, chest tightness and other lung problems. The work will be carried out to exactly resemble the spirometry test carried out in hospitals.

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