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Tele-Monitoring Device for Cardiorespiration Activity

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Abstract: With increasing air pollution & changing lifestyle health monitoring has become indispensible. The system proposed in this paper is an advanced solution for measuring & monitoring the important parameters such as heart beat rate, oxygen saturation level& storing the measured data on cloud memory through IOT (Internet of Things) .The gas sensor is used to measure the CO_2 level of the breathing air and a pulse oximetry sensor intended for pulse detection & oxygen saturation level in a human body. The device includes an Arduino Uno for data processing and a Wi-Fi module for data transmission.

Keywords: Arduino Uno, pulse Oximetry sensor (MAX30100), Gas sensor (MQ135), Arduino IDE, Wi-Fi module (ESP8266).

I. INTRODUCTION

Air pollution in India is quite a serious issue with the major sources being fuel-wood and biomass burning, fuel adulteration, vehicle emission and traffic congestion. In 2016 Environmental Performance Index ranked India 141 out of 180 countries for being the polluted country in the world (Hsu, 2016). The Global Burden of Disease Study for 2010, published in 2013, had found that outdoor air pollution was the fifth-largest killer in India and around 620,000 early deaths occurred from air pollution-related diseases in 2010. According to a WHO study, 13 of the 20 most-polluted cities in the world are in India (Choudhari, 2014).

Over a million Indians die prematurely every year due to air pollution, according to the non-profit Health Effects Institute. Over two million children have abnormalities in their lung function.

Oxygen saturation is the fraction of oxygen-saturated haemoglobin relative to total haemoglobin (unsaturated + saturated) in the blood. The human body requires and regulates a very precise and specific balance of oxygen in the blood. If the level is below 90 percent, it is called as hypoxemia which may lead to respiratory or cardiac arrest (Lee, 2015).

An increase in C02 level leads to an increase in ventilation by stimulating phrenic and inter costal nerves that activate the respiratory muscles. When Co2diffuses from the blood into the cerebrospinal fluid it hydrates and forms carbonic acid. The ensuing acid dissociation release hydrogen ions. Whilst carbon dioxide acts as the initial stimulus to hyperventilation. Thus an increase in pC02 produces large acid which release oxygen from haemoglobin (Marieb, 1984).

An ideal body should have oxygen saturation level ranging between 95%-100% and heart pulse rate 70-100bpm and Co2 should be less than 200ppm.In this system the heart beat rate & oxygen saturation in blood is measured by pulse oximetry sensor and the Co2 level of breathing air is measured by gas sensor further both the sensor is interfaced with arduino uno & measured data is shown on LCD screen

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II. COMPONENT SPECIFICATION

2.1 Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a

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USB cable or power it with a AC-to-DC adapter or battery to get started. Arduino board designs use a variety of microprocessors and controllers. Flash Memory of 32 KB (ATmega328) of which 0.5 KB used by boot loader, SRAM of 2 KB (ATmega328), EEPROM of 1 KB (ATmega328) & Clock Speed of 16 MHz The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal serial bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++.

Figure 1 Arduino UNO R3

2.2 MAX 30100

MAX 30100 is a pulse oximetry & heart rate sensor IC for wearable health in 14 pin OLGA (organic land grid array) packages.The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.The MAX30100 is an integrated pulse oximetry and heart-rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. Integrated LEDs, Photo Sensor, and High-Performance Analog Front-End Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically Enhanced System-in-Package.

Figure 2 MAX 30100

16x2 LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even characters (unlike in seven segments), animation and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

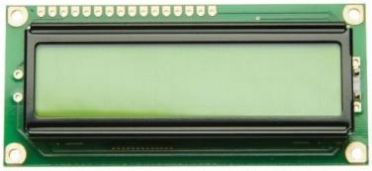

Figure 3 LCD Display (16x2)

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MQ-135

The sensor MQ-135 consist of sensitive material Sno2 which helps to measure the level of different gases present in the environment The gas sensor can detect gas concentrations anywhere from 200 to 10000ppm.This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC. There is a heating element inside the sensor which becomes hot at 5 volt and remains stand by.

Figure 4 MQ-135 GAS Sensor

Wi-Fi Module

ESP8266 is a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor .When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements.

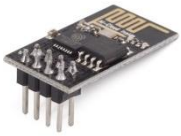

Figure 5 Wi-Fi module (ESP8266)

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III. DESCRIPTION & IMPLEMENTATION

Oxygen concentration can be measured by calculating the ratio between absorbed light from IRLED and Red LED. We have to switch the MAX30100 mode to SaO_2+ HR. That can be done by sending 0x03 to MODE configuration register. That will enable both LEDs and MAX30100 will start filling the FIFO buffer with readings from both light spectrums. The SPO2 is stands for, Saturation of Haemoglobin with Oxygen as Measured byPulse Oximetry. SPO2 is defined as a ratio of the level oxygenated haemoglobin over the total haemoglobin level. In pulse oximeter there is two LEDS; one is Red LED and another Infrared LED. The pulse oximeter measure oxygen saturation on the basis of BEER LAMBERT LAW.

The BEER LAMBERT Law : It states that the linear relationship between absorbance and Concentration of species. When the light pass through the finger then on the basis of light absorbance and concentration of species we calculate ratio by BEER LAMBERT LAW and finally get the value of oxygen saturation and heart rate of patient. The PULSE OXIMETER never works without beer lambert law.SPO2 range in between 95-100.

Oxygen saturation=hbo2/total hemoglobin.
The heart rate is determined by measuring the elapsed time between peaks of the IR signal.
Heart rate=60/periods (sec).

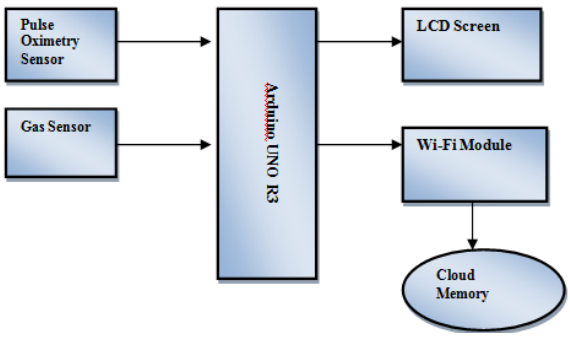

Figure 6 Implementation Model

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The MQ-135 works consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. The gas sensor can detect gas concentrations anywhere from 200 to 10000ppm.This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC. There is a heating element inside the sensor which becomes hot at 5 volt and remains stand by. When no gas, digital output is 1 and analog output gives 1023 max value. When gas is present, digital output is 0 and analogue output is much less than 1023. Using potentiometer on chip we can control the turning OFF point of digital pin at some value of analog pin. The sensor needs a load-resistor at the output to ground. Its value could be from 2kOhm to 47kOhm. The lower the value, the less sensitive is the sensor. If only one specific gas is measured, the load-resistor can be calibrated by applying a known concentration of that gas.

The measured data will be display on LCD screen & further the measured data will be store on cloud memory by using the HTML programming.

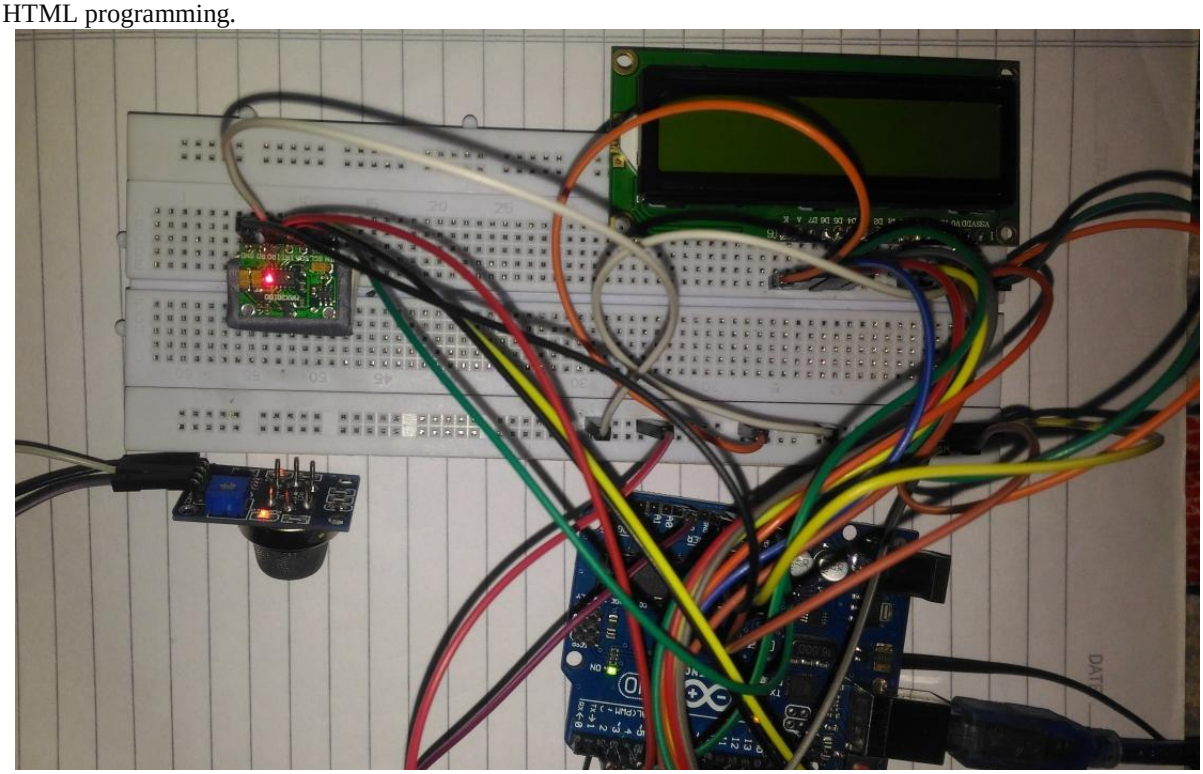

Figure 7 Functional overview of hardware implementation

IV. RESULTS & CONCLUSION

On measuring the carbon dioxide level through the sensor in different locations we get the following result:

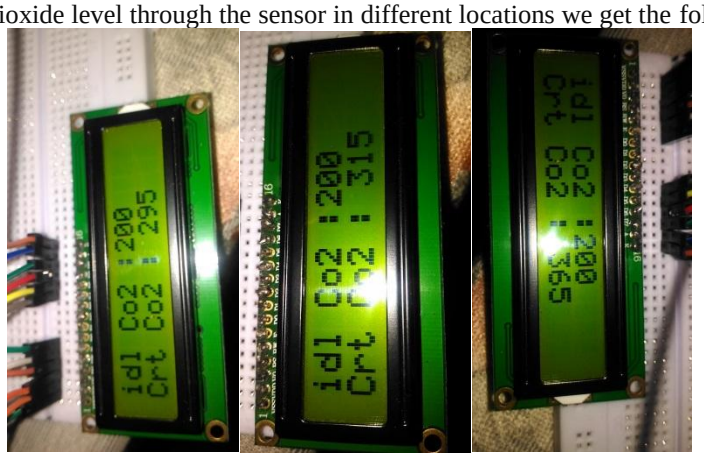

Figure 8 Result of Gas sensor

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The device presented here shows ability to monitor cardiorespiratory activity. On measuring Co2 level of breathing air are 295 ppm, 315ppm, 365ppm.Heart rate/oxygen saturation level: 81.67bpm / SpO2:95%

Figure 9 Result of Pulse oximetry sensor on serial monitor

On comparing the result of the tele-monitoring device with FitBit Surge band some samples were drawn which are as follows

Time	FitBit Surge Heart beat rate (in bpm)	Tele monitoring Device (Heart rate in bpm)
00:00	48	69.12
09:00	50	97.94
Noon	45	69.14
15:00	73	100.24
19:00	105	94.53
11:59	75	76.27

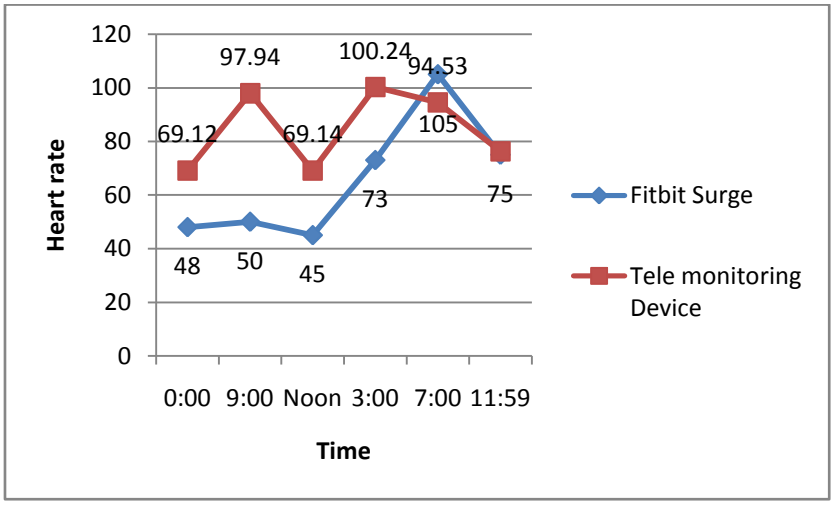

Figure 5 Comparison between result of FitBit Surge band & Tele monitoring Device

The above comparison shows that the measurement of FitBit surge is deviating large enough from the ideal range of heart beat rate while the tele monitoring device measured result are near to the ideal range.

IV. CONCLUSION

The device presented here shows the good ability of measuring the cardiorespiratory activity. The setup of this device consist of two sensor & arduino uno for data processing ,display the measured value on LCD screen furthermore the

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Wi-Fi module is able to store the data in cloud memory. As the device is using arduino uno hence the overall power consumption is low, easy to use, and easy to operate for every user. The measured value has been compared with existing fitness band which show the stability of tele-monitoring device. It is suitable for every health concern person, also for the patient of asthmatics, Sinusitis, Cardiac arrhythmia, lung cancer, emphysema & other cardiopulmonary diseases.

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