Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

School of Electrical Engineering

Special Term 5_ 2021-2022 Slot: G1+TG1+G2+TG2

EEE1008 BIOMEDICAL INSTRUMENTATION

J-Component Project Report on

Wearable Sleep Apnea Monitoring System

Submitted by

19BEE0150

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Under the guidance of

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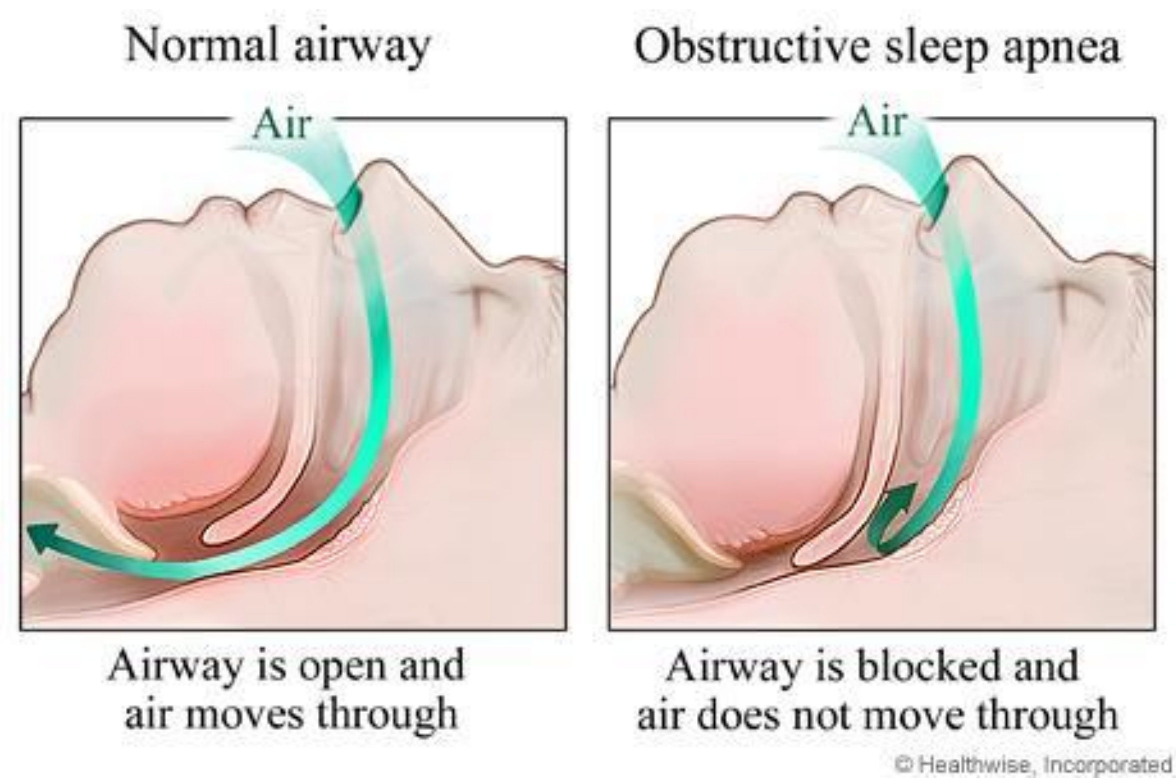
Aim

APNEA is Greek word refers to Breath. The sleep apnea is characterized as a sleeping disorder which occurs due to abnormal pause in breath during sleep time.
According to the survey, it affects roughly 2% of middle-aged women and 4% of middle-aged males. Typically, the problem of apnea is considered as "adult" problem but around 10% to 12% of healthy youngsters also experience the syndrome of apnea. The common symptoms of apnea are heavy snoring, chest pain, sweating etc. The purpose of this project is monitoring the sleep apnea using various sensor like accelerometer, pulse oximeter and nasal respiratory sensor which will embedded with a microcontroller. To avoid any false alarm situation the machine will be equipped with the smart alarm system. The whole assembly will connect wirelessly and responsible person or doctor can be informed about the condition of the patient through their phone on WhatsApp.

Introduction

Sleep apnoea refers to the cessation of breaths while sleeping and is a potential threat to the health of an individual. The main types of sleep apnea are obstructive sleep apnea, the more common form that occurs when throat muscles relax. Snoring is a sign of an irregular breathing pattern and hence a likely situation of apnea. Sleep apnea occurs in about 25% of men and nearly 10% of women. Sleep apnea can affect people of all ages, including babies and children and particularly people over the age of 50 and those who are overweight.



In 2007 the American Academy of Sleep Medicine (AASM) published rules for scoring respiratory events in the AASM Manual for the Scoring of Sleep and Associated Events, 1st ed. 1 (hereafter referred to as the 2007 scoring manual). The 2007 scoring manual recommends the use of the nasal pressure signal for scoring hypopnea in both adults and children. In the 2007 scoring manual the recommended sensor for detecting apnea in both adults and children is an oronasal thermal sensor. Oronasal thermal sensors have the advantage of being able to detect both nasal and oral airflow. It further suggests the use of two more sensors that monitors the respiratory efforts and oxygen saturation levels monitored using Dual thoracoabdominal RIP belts and pulse oximetry respectively

Literature Survey

1. The study was based on the apnea monitor for the children between the age of 2- to 6-year-old. Three input signals were collected which were nasal respiration signal, abdominal respiration and ECG signal and the breathing rate was calculated based on the number of pulses recorded for the certain amount of the time period and similarly ECG sensor was used to used ECG signal. The amplified signal was merged using multiplexer and the AC signal was converted in DC signal using ADC. Data obtained from the first stage was examined using the fuzzy logic and if the value exceed the threshold the timer 555 activates.

2. The second journal paper deals with the development of a wearable gadget that continually records diaphragm accelerations using an acceleration sensor implanted on the patient's diaphragm. When the accelerometer-based system detects apnea, a signal is delivered to the wristband, and the vibration motor on the wristband vibrates until the patient resumes breathing. There is no requirement for a sleeping chamber to see the patients' breathing qualities since such parameters may be kept at the patients' residences during sleep using the created gadget on a secure digital memory card.

3. The paper deal sudden death of the infant due the apnea. The system was equipped with the smart alarming system to nullify any false indication while on the communication. A method for assessing communication networks in order to assure a dependable infrastructure for routing emergency messages issued by the controller was added in the machine. The machine provides monitoring as well as assisting in case of emergency.

4. The study deals with a unique method for measuring respiration rate by monitoring the change in breathing temperature across the nasal area. Our formal experiments yielded encouraging outcomes. The test set data clearly show that two AD590 temperature sensors. Graphical recordings. corresponding to the calculated respiratory rate has been simultaneously obtained for the reference.

5. A sleep apnea event detection method based on directly acceleration readings is provided in this research paper. ANN technique was used with three layers of neuron, with three neurons in the hidden layer, two neurons in the input layer, and two neurons in the output layer. Depend on the sleeping position the position of acc was changed. Besides that, in order to increase ANN performance as well as the accelerometer misaligning, one or more extra sensors can be added to the system.

Objective

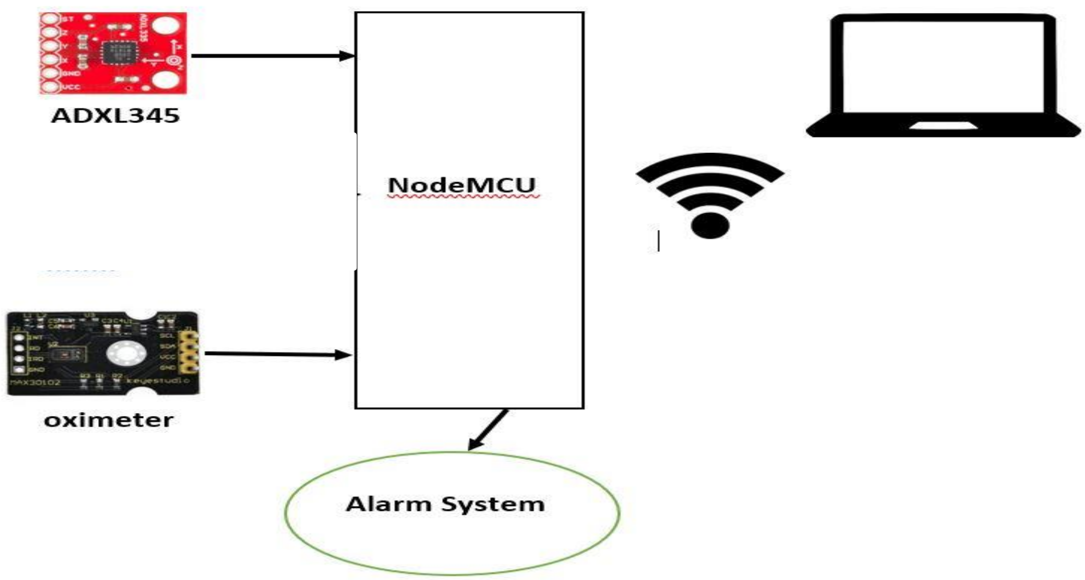
1. To come up with the working hardware model with smart alarming which help to monitor the apnea condition.

2. To connect the whole hardware model with the IoT for continuous tracking of the patients.

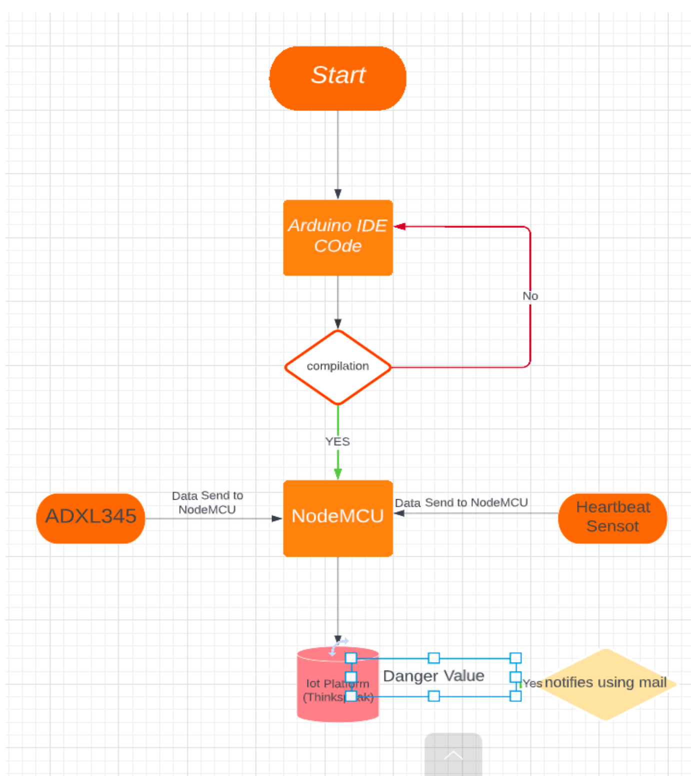
Methodology

The Apnea machine will consist NodeMCU (Wi-Fi Module) which is connected to all two sensor and all the data recorded from the sensor will sent to cloud using NodeMCU. The Monitoring system will also have a notification facility on WhatsApp which will send the live scenarios patient to responsible person. A Smart alarm will be equipped with the machine which will nullify the chances of wrong information.
The alarm system will be based on one LED code which. If BOTH of sensor value will be above/ below the normal value the THE LED will glow that will notify that the person going through Apnea. The thinkspeak portal is connected to mail and mail will be sent to person who is responsible for the patient.
The history of the patient will be recorded in thinkspeak which can be used later for the medical purposes

Block Diagram



FLowChart



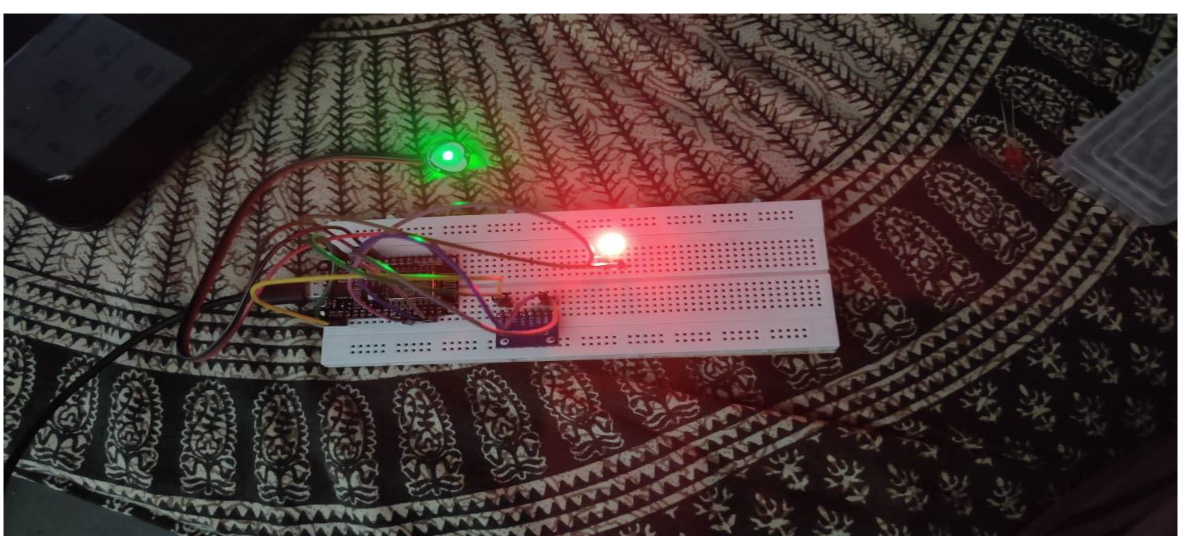
In the flow chart given the Arduino code will be first complied in the IDE. If the compilation is success the code will be flashed in the NodeMCU. From NodeMCU the data will be sent to the IOt plafrom. The heart rate and the ADXL345 will collect the data and send it to the thikspeak.

Working.

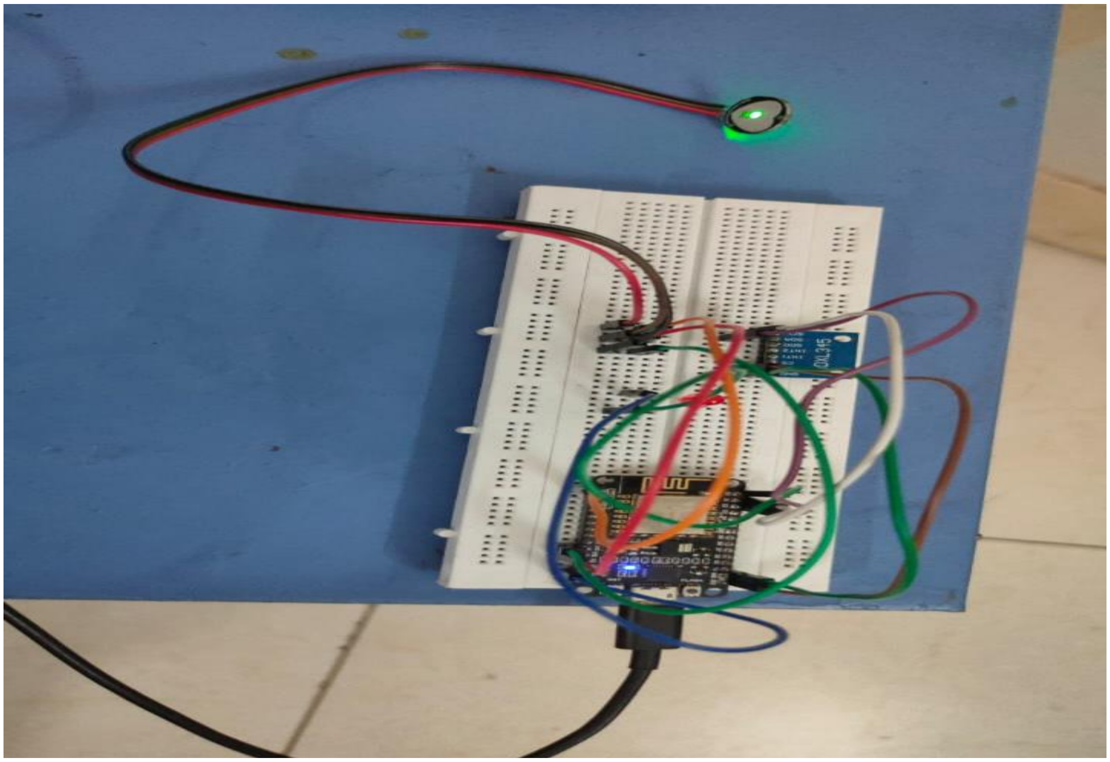
The project consist of NodMCU which is used for sending the data collected form the Sensor to the Thinkspeak cloud.The ADXL345 is 3 axis accelerometer which measures the velocity in all three direction X, Y and Z direction.
Pulse waves—changes in a blood vessel's volume brought on by the heart pumping blood—are measured by an optical heart rate sensor. An optical sensor and green LED are used to measure the volume change in order to identify pulse waves. The sensor block's use of an optical filter designed for pulse wave detection reduces the impact of ambient light, including red and infrared rays. This makes it possible to collect high-quality pulse signals even outside. In addition, ROHM was able to greatly raise the sensitivity of the sensor block by utilising optical sensor technology that had been developed over a long period of time. It is feasible to create a low power optical heart rate monitoring system without the use of extra electronics thanks to support for low brightness low VF LEDs.

The ADXL will strap around the chest of the patient and it will measure the velocity of the diaphragm. Due to apnea there will sudden increment in the velocity of X axis because the person will be gasping for the air, that will be the first alarm that person is going under apnea. To confirm it there is another sensor which will measure the pulse and during apnea the pulse rate will go below 60. If that condition the notification will be sent to the person responsible and a mail will be sent.

Hardware Model



A person going under apnea



Normal Condition

Software

Bio_med | Arduino 1.8.19

File Edit Sketch Tools Help

Bio_med

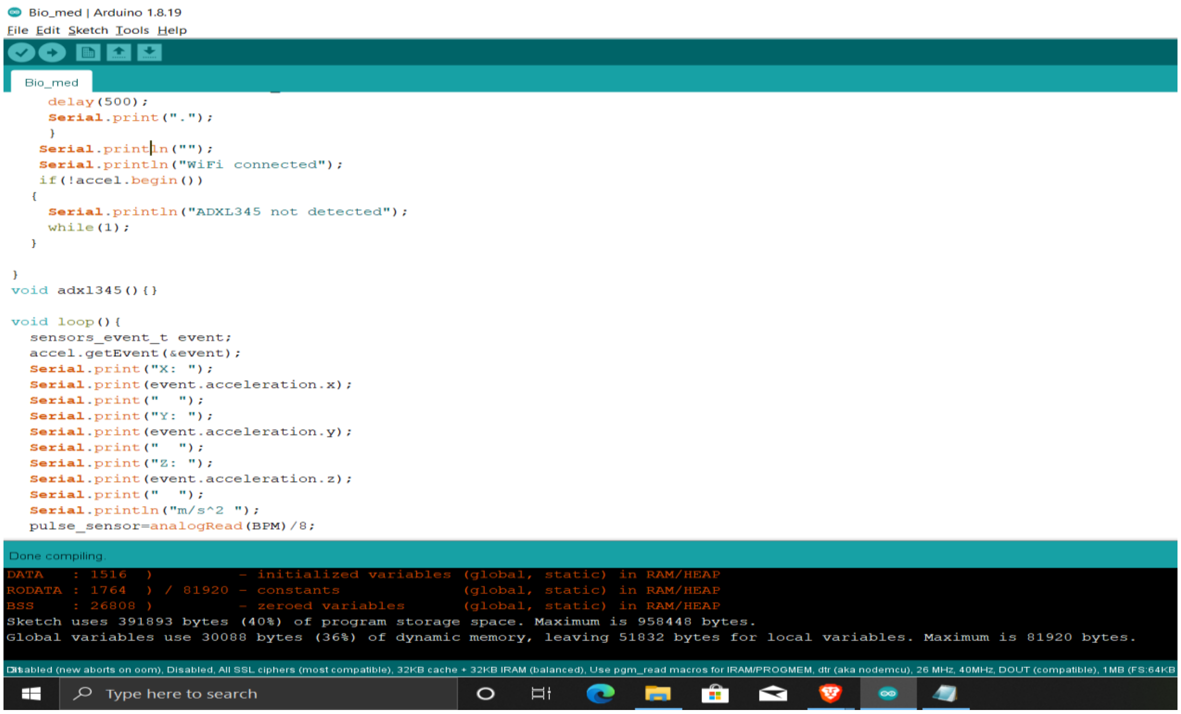
```
#include <ArduinoJson.h>
#include <ThingESP.h>
#include <ThingSpeak.h>
#include <PulseSensorPlayground.h>
#include <Wire.h>
#include <Adafruit_ADXL345_U.h>
#include <ESP8266WiFi.h>

ThingESP8266 thing("Abhay", "BioMed", "123456789");
#define BPM A0
const char *ssid= "Abhay";
const char *pass= "Abhay@1234";
WiFiClient client;
unsigned long myChannelNumber = 1841968;
const char * myWriteAPIKey = "374HCZOX1WHZ5UBI";
Adafruit_ADXL345_Unified accel = Adafruit_ADXL345_Unified();
const int LED1 = 5;
const int LED2 = 4;
float pulse_sensor=0.0;

void setup() {
  Serial.begin(115200);
  delay(10);
  Serial.println("Connecting to ");
  Serial.println(ssid);
  WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED){
    delay(500);
```

Done compiling.

```
DATA   : 1516  )         - initialized variables (global, static) in RAM/HEAP
RODATA : 1764  ) / 81920 - constants             (global, static) in RAM/HEAP
BSS    : 26808 )         - zeroed variables      (global, static) in RAM/HEAP
Sketch uses 391893 bytes (40%) of program storage space. Maximum is 958448 bytes.
Global variables use 30088 bytes (36%) of dynamic memory, leaving 51832 bytes for local variables. Maximum is 81920 bytes.
```



Bio_med | Arduino 1.8.19
File Edit Sketch Tools Help
Bio_med

```
      delay(500);
      Serial.print(".");
      }
    Serial.println("");
    Serial.println("WiFi connected");
    if(!accel.begin())
   {
      Serial.println("ADXL345 not detected");
      while(1);
   }

}
void adxl345(){}

void loop(){
   sensors_event_t event;
   accel.getEvent(&event);
   Serial.print("X:  ");
   Serial.print(event.acceleration.x);
   Serial.print("   ");
   Serial.print("Y:  ");
   Serial.print(event.acceleration.y);
   Serial.print("   ");
   Serial.print("Z:  ");
   Serial.print(event.acceleration.z);
   Serial.print("   ");
   Serial.println("m/s^2 ");
   pulse_sensor=analogRead(BPM)/8;
```

Done compiling.

```
DATA    : 1516   )          - initialized variables  (global, static) in RAM/HEAP
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```

Disabled (new aborts on oom), Disabled, All SSL ciphers (most compatible), 32KB cache + 32KB IRAM (balanced), Use pgm_read macros for IRAM/PROGMEM, dtr (aka nodemcu), 26 MHz, 40MHz, DOUT (compatible), 1MB (FS:64KB

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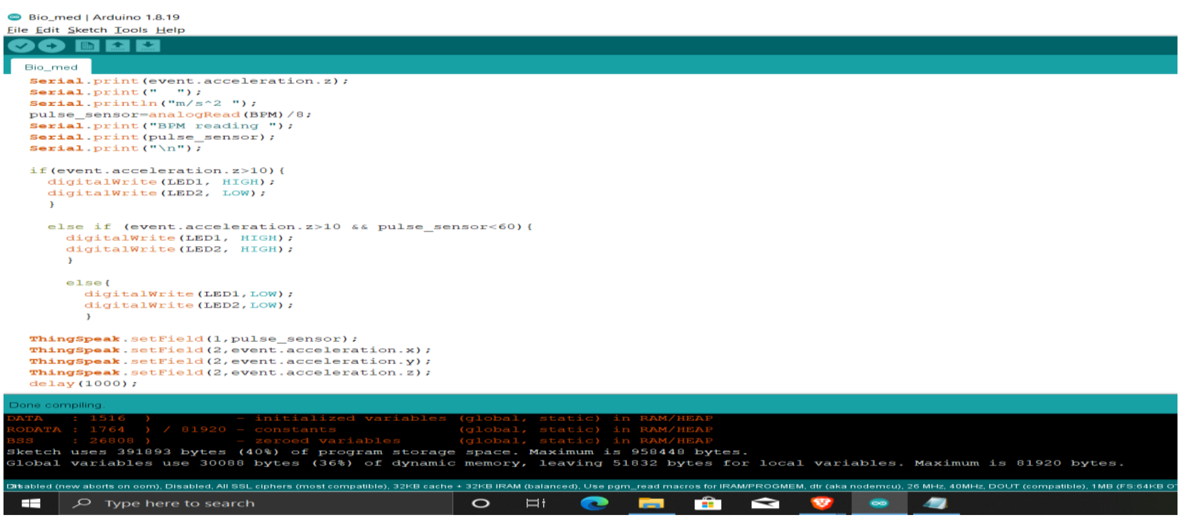

Bio_med | Arduino 1.8.19
File Edit Sketch Tools Help
Bio_med

```
   Serial.print(event.acceleration.z);
   Serial.print("   ");
   Serial.println("m/s^2 ");
   pulse_sensor=analogRead(BPM)/8;
   Serial.print("BPM reading ");
   Serial.print(pulse_sensor);
   Serial.print("\n");

   if(event.acceleration.z>10){
     digitalWrite(LED1, HIGH);
     digitalWrite(LED2, LOW);
     }

     else if  (event.acceleration.z>10 && pulse_sensor<60){
       digitalWrite(LED1, HIGH);
       digitalWrite(LED2, HIGH);
       }

       else{
         digitalWrite(LED1,LOW);
         digitalWrite(LED2,LOW);
         }

   ThingSpeak.setField(1,pulse_sensor);
   ThingSpeak.setField(2,event.acceleration.x);
   ThingSpeak.setField(2,event.acceleration.y);
   ThingSpeak.setField(2,event.acceleration.z);
   delay(1000);
```

Done compiling.

```
DATA    : 1516   )          - initialized variables  (global, static) in RAM/HEAP
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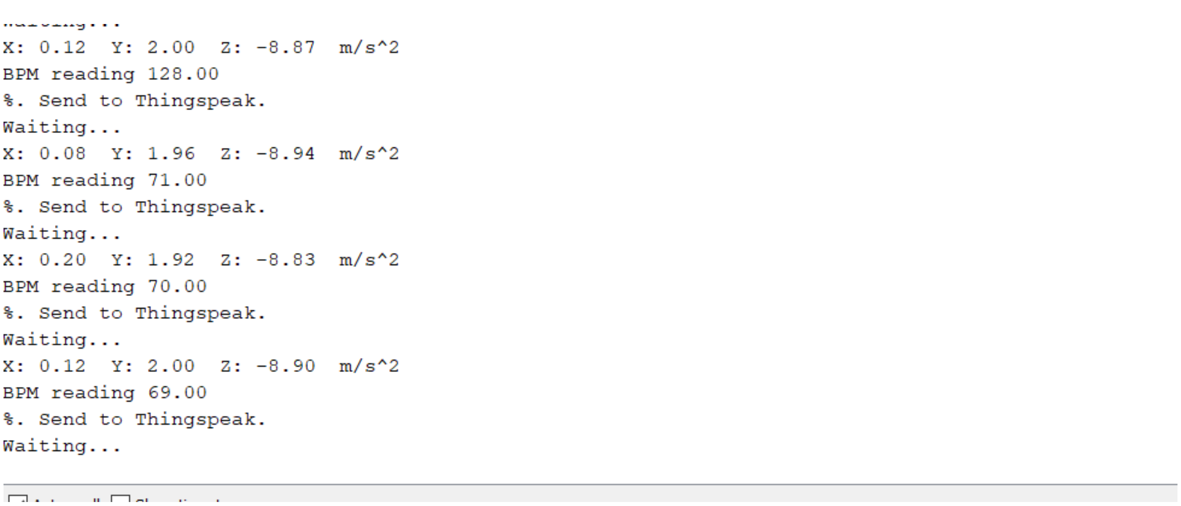
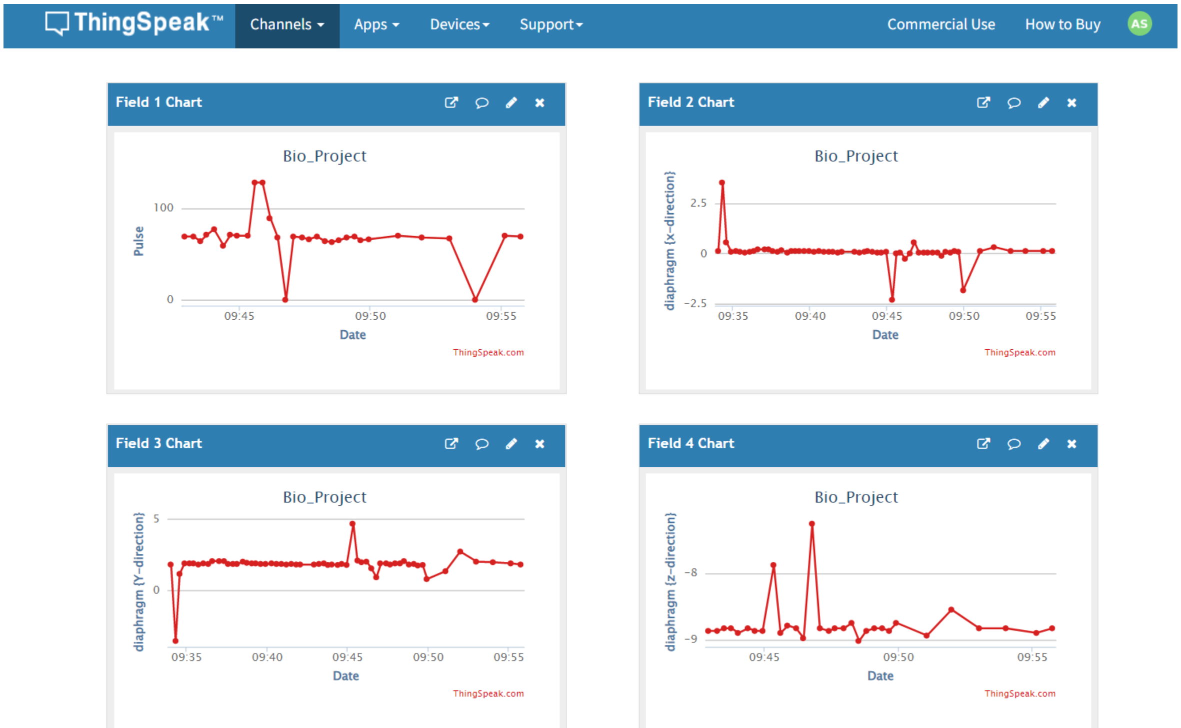
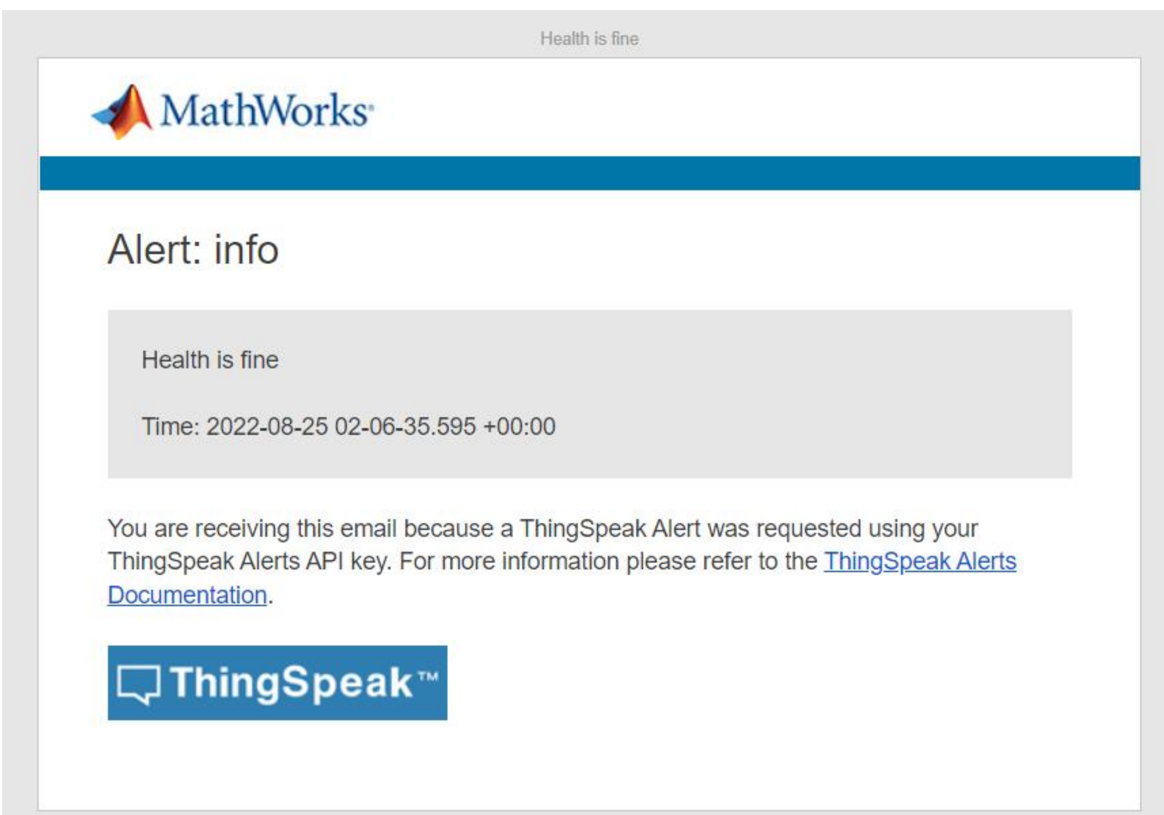


```
Waiting...
X: 0.12  Y: 2.00  Z: -8.87  m/s^2
BPM reading 128.00
%. Send to Thingspeak.
Waiting...
X: 0.08  Y: 1.96  Z: -8.94  m/s^2
BPM reading 71.00
%. Send to Thingspeak.
Waiting...
X: 0.20  Y: 1.92  Z: -8.83  m/s^2
BPM reading 70.00
%. Send to Thingspeak.
Waiting...
X: 0.12  Y: 2.00  Z: -8.90  m/s^2
BPM reading 69.00
%. Send to Thingspeak.
Waiting...
```

IOT connectivity





COST

S.no	Components	Amount (rupees)
1	NodeMCU	300
2	ADXL345	145
3	Nasal Respiratory System	160
4	Oximeter	250
5	LED	5
6	Buzzer	15
	Total	**875**

Video link:-

https://drive.google.com/drive/folders/1ZhcHXyh9VVrNjUAINKuMfb2ohFJbtnzl?usp=sharing

Result

We were able to monitor the condition of the Apnea at regular interval of time with the help of the real time data which is provided by the device.The data was uploaded on the cloud, this data can be accessed by anyone sitting anywhere including the doctor, patient and patient's guardian. Due to Apnea the pulse rate decrease which is detected using this machine.If the pulse rate is below 60 a notification will be send by mail.SInce, the heart rate sensor used in the project is the cheap ,the response time is more. The accuracy was around 85% .

Reference

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