

DESIGNING A MASK FOR OBSTRUCTIVE BREATHING DISORDER

Submitted in partial fulfilment of the requirements for the award of
Master of Technology Degree in
Medical Instrumentation

by

SWEDHA.V (40440009)



DEPARTMENT OF BIOMEDICAL ENGINEERING

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SWEDHA.V**
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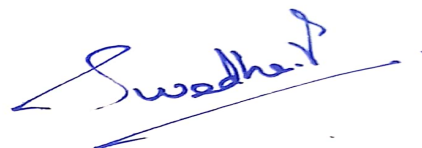
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DECLARATION

I **SWEDHA.V (40440009)** hereby declare that the Project Report entitled **“Designing a Mask for Obstructive Breathing Disorder”** done by us under the guidance of MS. **SINDU DIVAKARAN**, M.E., (Ph.D.,) Department of Biomedical Engineering submitted in partial fulfilment of the requirements for the award of **Master of Technology** degree in **Medical Instrumentation**.

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ABSTRACT

Continuous Positive Airway Pressure (CPAP) is a method of painless mechanical ventilation to keep the aviation routes open in subjects unfit to do as such independently. It is utilized to treat different scopes of ongoing ailments emerging from obstructive aviation routes infections. Along these lines, this work means to address the plan and development of a veil and test CPAP gadget as verification of idea to be utilized by subjects experiencing different obstructive breathing illnesses. To plan a veil and the test CPAP gadget with tangible instrumentation for giving information to a miniature controlled framework, electro-pneumatic circuits and sign molding sheets of sensors have been fitted to accomplish streamlined CPAP work with low energy utilization. Every one of the boundaries are checked by the microcontroller once the microcontroller identifies any hardships in breathing circumstances it will turn on the steady framework for the subject. In this proposed work breathing pattern, sleep pattern, temperature humidity controls observing will be put away in cloud. By utilizing the proposed work, steady framework subjects can breathe stably.

KEYWORDS:

Continuous Positive Airway Pressure (CPAP), obstructive sleep apnea, wheezing, surfactant dysfunction, Respiratory Distress Syndrome (RDS), Chronic Obstructive Pulmonary Disease (COPD), severe asthma, pulmonary edema(initial stage),recovering CHF(congestive Heart Failure), orthopnea, left ventricular dysfunctions(heart failure), dozing and breathing example, temperature and humidity monitoring.

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LIST OF ABBREVIATIONS

APAP	-	Automatic Positive Airflow Pressure
ARDS	-	Acute Respiratory Distress Syndrome
BIPAP	-	Bi-level Positive Airflow pressure
CHF	-	Congestive Heart Failure
COPD	-	Chronic Obstructive Pulmonary Disease
CPAP	-	Continuous Airway Pressure
CSA	-	Continuous Sleep Apnea
OSA	-	Obstructive Sleep Apnea
RDS	-	Respiratory Distress Syndrome

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CHAPTER - 1

INTRODUCTION

1.1 OUTLINE OF THE WORK:

CPAP treatment is one of the most suggested treatment choices for subjects who have obstructive breathing, in which insufficient air arrives at the lungs. The CPAP machine blows air into the nasal cover associated with the subjects which assist with swelling the lungs. This clears up the respiratory pathways, with the goal that the subject can ready to inhale steadily. [1] Keeping this working, our undertaking is to fabricate a versatile confirmation of idea level CPAP Machine for minimal price [2]. While making such gadget it's crucial for take a few focuses in thought like temperature, dampness, speed increase, pulse, blood oxygen immersion and breath pace of the subject. [3] Mix these boundaries estimations will make us competent to ceaselessly screen and notice the subject's degree of seriousness connected with aspiratory sicknesses.[4][5] By the utilization of these estimations and perceptions we should rest assured that the subject's condition is influenced quite a bit by so we can manage any progressions happens to the subjects whenever they're recognized. [6][7] The capacity to analyze such infection will give an entirely different level of solace and wellbeing help for the individuals who are experiencing particularly any breathing issues during their dozing periods.[8][9] This proposed framework includes a Respiration sensor for assessing and checking the breath condition, SPO2 and Pulse Sensor for noticing the beat and blood oxygen drenching level and Digital Humidity and Temperature sensor. All of the limits are checked by the microcontroller once the microcontroller recognizes any difficulties in breathing conditions it will thus turn on the consistent structure for the subject. By using our proposed consistent system subjects can prepare to breathe in consistently. There are two methods of activity one is auto mode and another is clock mode or manual

mode; savvy mode offers nice life for the Machine.

1.2 CPAP MACHINE:

A continuous positive airway pressure (CPAP) machine is the most commonly prescribed device for treating sleep apnea disorders.

Obstructive sleep apnea (OSA) causes interruptions or pauses in your breathing, often because your throat or airways briefly collapse or something temporarily blocks them.

A CPAP machine sends a steady flow of oxygen into your nose and mouth as you sleep. This keeps your airways open and helps you breathe normally.

Let's take a closer look at how this machine works the pros and cons of using one, and other options for sleep apnea.

1.2.1 How does a CPAP machine work?

A CPAP machine's compressor (motor) generates a continuous stream of pressurized air that travels through an air filter into a flexible tube. This tube delivers purified air into a mask that's sealed around your nose or mouth.

As you sleep, the airstream from the CPAP machine pushes against any blockages, opening your airways so your lungs receive plenty of oxygen.

Without anything obstructing this flow of oxygen, your breathing doesn't pause.

As a result, you don't repeatedly wake up in order to resume breathing.

1.2.2 Different types of CPAP machines

CPAP devices all have the same basic components:

- A motor housed in a base unit
- A cushioned mask
- A tube that connects the motor to the mask
- A headgear frame
- "Elbow" pieces that act as joints
- Adjustable straps that allow you to customize the fit of the device

What's the difference between CPAP, APAP, and BiPAP machines?

Other types of breathing machines include APAP and BiPAP devices. Here's how they differ:

➤ CPAP device:

This device is programmed to produce pressurized air at one steady air pressure level. To change the air pressure, you have to reset the device's settings.

➤ APAP (Automatic Positive Airflow Pressure) machine:

This kind checks your breathing throughout the night. It automatically adjusts the air pressure to compensate for changes in your sleep position or medications that may have changed your breathing.

➤ BiPAP (Bi-level Positive Airflow Pressure):

This device has two pressure settings, one pressure for inhaling and a lower pressure for exhaling. It's used for individuals who can't tolerate CPAP machines or have elevated carbon dioxide levels in their blood. BiPAP devices can also come with a backup respiratory rate for patients who have Central sleep apnea. The backup respiratory rate ensures the person breathes, as the main problem with central sleep apnea is initiating breath.

1.3 BENEFITS OF CPAP MACHINE:

The benefits of using a CPAP machine are well-documented. These machines deliver a continuous supply of oxygen to your body as you sleep. By doing so, they help prevent the brief breathing interruptions that are the hallmark of sleep apnea.

The benefits tend to increase with longer-term CPAP use.

1.4 DIFFERENT MASK USED:

Mask styles can vary with different CPAP machines. Which type you wear depends in part on your breathing habits, how comfortable the mask is for you to wear, and the kind of sleep apnea disorder you have.

The different types of CPAP masks include the following:

➤ *Nasal pillow mask:*

This type of mask has a small cushion that caps over your nostril area. It may also have prongs that fit into your nostrils. This mask allows you to wear your glasses easily. It also works well if you have lots of facial hair that may prevent a larger mask from fitting snugly.

➤ *Nasal mask:*

This type is a cushioned mask that covers your whole nose area. It may be a better option if you tend to move around in your sleep. It can deliver a high-pressure airstream.

➤ *Full mask:*

This type is shaped like a triangle and covers your mouth and nose. Your doctor might prescribe this kind of mask if you breathe through your mouth when you sleep or if you have a blockage of some kind in your nose.

An overview:

CPAP machines treat sleep apnea by delivering a stream of oxygenated air into your airways through a mask and a tube. The pressurized air prevents airways from collapsing, which allows you to breathe continuously while you sleep. There are several types of CPAP machines. Which one your healthcare provider prescribes for you will depend on the type of sleep apnea you have, how comfortable it is for you to wear, and according to breathing and sleeping habits.

While a CPAP machine delivers an airstream at one steady pressure, BiPAP and APAP machines change the pressure according to your needs.

1.5 PULMONARY DISEASES:

COPD (Chronic Obstructive Pulmonary Disease)

A group of lung diseases that block airflow and make it difficult to breathe. Emphysema and chronic bronchitis are the most common conditions that make up COPD. Damage to the lungs from COPD can't be reversed. Symptoms include shortness of breath, wheezing or a chronic cough. Rescue inhalers and inhaled or oral steroids can help control symptoms and minimize further damage

Respiratory Distress Syndrome:

Also known as Hyaline Membrane Disease, Neonatal Respiratory Distress Syndrome, Infant Respiratory Distress Syndrome, Surfactant Deficiency Respiratory distress syndrome (RDS) is a common breathing disorder that affects newborns. RDS occurs most often in babies born preterm, affecting nearly all newborns that are born before 28 weeks of pregnancy. Less often, RDS can affect full term new born RDS is more common in premature newborns because their lungs are not able to make enough surfactant.

Surfactant is a foamy substance that keeps the lungs fully expanded so that newborns can breathe in air once they are born. Without enough surfactant, the lungs collapse and the newborn has to work hard to breathe. He or she might not be able to breathe in enough oxygen to support the body's organs. Most babies who develop RDS show signs of breathing problems and a lack of oxygen at birth or within the first few hours that follow. The lack of oxygen can damage the baby's brain and other organs if not treated promptly. RDS may change over time to become bronchopulmonary dysplasia, or BPD. This is another breathing disorder that may affect babies, especially premature babies. RDS usually develops in the first 24 hours after birth. If premature newborns still have breathing problems by the time they reach 36 weeks gestation, they may be diagnosed with BPD. Some of the life-saving treatments used for RDS may contribute to BPD. Some newborns that have RDS recover and never get BPD.

Surfactant Dysfunction:

Surfactant dysfunction is a lung disorder that causes breathing problems. This condition results from abnormalities in the composition or function of surfactant, a mixture of certain fats (called phospholipids) and proteins that lines the lung tissue and makes breathing easy.

Surfactant enables the lungs to expand more easily. Without surfactant, the air sacs in the lungs, also called alveoli, collapse very easily. This collapse leads to decreased amounts of air in the lungs. The lack of surfactant combined with alveolar collapse makes it very difficult for the infant to breathe.

Interstitial Lung Disorder:

A group of disorders that cause progressive scarring of lung tissue. Interstitial lung disease may be caused by long-term exposure to hazardous materials, such as asbestos or coal dust, or it can be caused by an auto-immune disease such as rheumatoid arthritis. Once lung scarring occurs, it's generally irreversible.

Symptoms include a dry cough. Shortness of breath can occur either at rest or after exertion.

Severe Asthma:

Asthma is a condition in which your airways narrow and swell and may produce extra mucus. This can make breathing difficult and trigger coughing, a whistling sound (wheezing) when you breathe out and shortness of breath.

For some people, asthma is a minor nuisance. For others, it can be a major problem that interferes with daily activities and may lead to a life-threatening asthma attack.

Asthma can't be cured, but its symptoms can be controlled. Because asthma often changes over time, it's important that you work with your doctor to track your signs and symptoms and adjust your treatment as needed.

Pulmonary Edema:

Pulmonary edema is a condition caused by excess fluid in the lungs. This fluid collects in the numerous air sacs in the lungs, making it difficult to breathe.

In most cases, heart problems cause pulmonary edema. But fluid can collect in the lungs for other reasons, including pneumonia, exposure to certain toxins and medications, trauma to the chest wall, and traveling to or exercising at high elevations.

Pulmonary edema that develops suddenly (acute pulmonary edema) is a medical emergency requiring immediate care. Pulmonary edema can sometimes cause death. The outlook improves if you get treated quickly. Treatment for pulmonary edema varies depending on the cause but generally includes supplemental oxygen and medications

Congestive Heart Failure:

A chronic condition in which the heart doesn't pump blood as well as it should. Heart failure can occur if the heart cannot pump (systolic) or fill (diastolic) adequately.

Symptoms include shortness of breath, fatigue, swollen legs and rapid heartbeat.

Treatments can include eating less salt, limiting fluid intake and taking prescription medication. In some cases a defibrillator or pacemaker may be implanted.

Snoring:

Snoring is the hoarse or harsh sound that occurs when air flows past relaxed tissues in your throat, causing the tissues to vibrate as you breathe. Nearly everyone snores now and then, but for some people it can be a chronic problem. Sometimes it may also indicate a serious health condition

Normal Human body temperature:

The average normal body temperature is generally accepted as 98.6°F (37°C). Some studies have shown that the "normal" body temperature can have a wide range, from 97°F (36.1°C) to 99°F (37.2°C). A temperature over 100.4°F (38°C) most often means you have a fever caused by an infection or illness.

Human body humidity percent:

Maintaining a relative humidity level between 35% and 50% is often ideal since it not only allows the body to function normally, but it also prevents the growth of allergens like dust mites and mold.

Sleeping Pattern:

An average sleep cycle lasts about 90 minutes. Ideally, you need four to six cycles of sleep every 24 hours to feel fresh and rested. Each cycle contains four individual stages: three that form non-rapid eye movement (NREM) sleep and one rapid eye movement (REM) sleep.

To understand breathing we should be aware of the normal breathing pattern. In normal breathing at rest, there are small in breaths (inhalation) followed by the out breaths (exhalation). The out breath is followed by an automatic pause (or period of no breathing) for about 1 to 2 seconds.

Heart Rate:

A normal resting heart rate for adults ranges from 60 to 100 beats per minute. Generally, a lower heart rate at rest implies more efficient heart function and better cardiovascular fitness. For example, a well-trained athlete might have a normal resting heart rate closer to 40 beats per minute.

SpO2 range:

A normal level of oxygen is usually 95% or higher. Some people with chronic lung disease or sleep apnea can have normal levels around 90%. The "SpO2" reading on a pulse oximeter shows the percentage of oxygen in blood.

CHAPTER - 2

LITERATURE SURVEY

Ming Teo, Terence Amis, Sharon Lee, RN, Karina, et.al. Proportionality of Oro Nasal and Nasal Masks during Initial CPAP Titration for Obstructive Sleep Apnea Syndrome (2018) CPAP titration was performed there is insignificant check concerning the identicalness of various cover interfaces used to start treatment. It is theorized that while utilizing an oronasal cover expands upper flying course wrinkle limit and that a higher strain might be depended upon to remain mindful of flight course patency furthermore evaluated subject propensities for the 2 cover interfaces. Subjects with obstructive rest apnea issue can for the most part switch among nasal and oronasal covers without changing machine pressure, in spite of how there are individual separations that might be clinically fundamental. Most subjects with obstructive rest apnea condition favor a nasal cover as the sign of relationship for inception of CPAP.

Fahad sayeed, Nilanjan banerjee, Ryan Robucci RestEaZe: Low-power precise rest checking using a wearable multi-sensor lower leg band (2020) Presents RestEaZe, a multi-sensor lower leg band that can get two leg advancement totals: Dorsiflexions that are connected with rest issues like RLS (Restless leg condition) and ADHD, (Attention Deficit Hyperactivity Disorder) and Complex Leg Movements that are related with surface of rest, specifically rest intermittence and brief arousals. This paper, revolve around the gear and programming designing of the RestEaZe structure, and present an estimation that uses moderate identifying to decrease the power use of the lower leg worn sensor. RestEaZe assembles a lot of like nature of leg improvement data (with botch in the rest measures $< 10\%$), while having an extensive stretch of 5X stood out from a reliably on sensor.

Zhang, Nannan; Li, Yuzhou; Xiang, Siwei; et,al. Vague rest really looking at bedding for remote rest clinical consideration and early contamination assurance (2020) proposed a particular response for indistinct remote rest seeing to satisfy the dynamic clinical consideration and distant finding. Enlivening by the standard fillers inside cushion, class of self-controlled body-advancement sensors with fractal down-like or tuft like arrangement were made to fill into every day bedding as a delicate and sensitive store. Taking benefits of the especially sensitive and dependable fractal load structure, proficient energy related with body improvements can be changed over into electrical signs, which can not exclusively be seen as different train works out, yet similarly be used, to driving Wi-Fi signal-sending central processors for overcast huge information servers.

Adriane Iurck Zonato, Cíntia Felício Adriano Rosa, et, al. Practicality of nasal covers versus nasal pads cloak during incessant positive avionics course pressure titration for subjects with obstructive rest apnea (2020) Comparing the polysomnography results during CPAP titration while checking out two sorts of covers (nasal and cushions) and to assess whether or not the subject ascribes shifted between shroud tendencies. CPAP pressures were truly titrated Anthropometric data and OSA earnestness was accounted for. Nasal cushions covers give off an impression of being essentially pretty much as suitable as nasal shroud and may be seen as a basic choice for CPAP titration

For Heydari, Malikeh and Mehmet, Chest based Real Time Pulse and Respiration Monitoring Based on Bio Impedence (2019) The Blmp signal is separated from a wearable contraption set on the shoulder. Utilizing the rate computation assessment beat (HR), and breath rate (RR) values are taken out unequivocally. Blmp signal acquired at the chest is all the more clear and has the limit of remembering Blmp for other crucial signs checking utilizing the rate computation assessment, HRs and RRs values are confined. Beat wave

seeing from focal foyers considering Blmp can be utilized in different assessments, for example, cuffless BPdevice. In the framework introduced in this overview, we can no ifs, ands or buts bind the beat wave and breathe in actuating especially low or high rate respiratory evaluations.

Sanghoon Jeon, TaeJoon Park, A wearable rest position overall arranging structure thinking about Dynamic State Transition Framework (2019) It recommended a two-level classifier explicit for rest improvement thinking about Dynamic State Transition (DST) - system. The DST structure is relied upon to process the spatio-transient rest improvement information collected through accelerometer/gyro distinguishing and demand twelve rest position (SP) advancements from four rest positions. Results show that this framework truly and absolutely bundle twelve SP improvements for following rest positions, and hence, fills in as a key development block for complete rest care applications related with rest positions.

Xuyu Wang, Chao Yang , Resilient Respiration Rate Monitoring with Realtime Bimodal CSI data(2020) This paper, presents ResBeat, a thing 5 GHz WiFi based construction to take advantage of bimodal channel state data (CSI), including abundancy and stage capability, for realtime, extended length, and sans contact breath rate taking note. The ResBeat structure for strong breath rate seeing with thing WiFi and developed the framework including information preprocessing, versatile sign choice, and breathing sign checking, where bimodal CSI information were displayed to be corresponding to one another were taken advantage of to accomplish high flexibility. An appraisal of Breathing sign characteristics and Peak affirmation to check breath rate.

Brian Coffein , pattrick scott, shaad Mahmud Real-time Wireless Health Monitoring A Ultra-low Power Biosensor Ring for Heart Disease Monitoring(2020)In request to take into account more regular wellbeing

checking, could be a wearable ring sensor, worn on the finger, that actions pulse and action through an intelligent photoplethysmogram (PPG) sensor and an accelerometer. This was investigated, and a model was constructed, which sent information over Bluetooth 4.0 (BLE) to an Internet-associated cell phone. The calculation uses an upgraded progressed moving normal and IIR separating, as well as a subsidiary based top discovery to gauge exact thumps each moment and Heart Rate Variability (HRV) boundaries, against a FDA endorsed business pulse observing gadget. The significant discoveries of the proposed work fit the depiction of recognition of cardiovascular sicknesses by estimating precise HRV. The estimation depends on two variables, how one can apply channels and intensification to extricate the measurable and precise pulse without inactivity and how the it serves to dependably distinguish inconsistencies. Exact estimation of HRV and pulse permits parental figures to The significant discoveries of the proposed work fit the portrayal of identification of cardiovascular infections by estimating precise HRV. The estimation depends on two variables, how one can apply channels and enhancement to separate the measurable and precise pulse without idleness and how the it serves to dependably distinguish inconsistencies. Exact estimation of HRV and pulse permits parental figures to notice the seriousness of heart infections and perform early mediation

Notice the seriousness of heart illnesses and perform early mediation

Cao Q, Yu C, Cheng X-Feng, Sun W-Ji, He J-Hui, Li N-Jun, Li H, Chen D-Yun, Xu Q-Feng, Lu J-Mei Polysquaramides: Rapid and stable dampness detecting for breath checking and morse code correspondence(2019) polysquaramide-based dampness sensor is intended for breath checking. Profound/shallow and quick/slow breath were recognized and recorded from a distance. The mugginess sensor shows fast reaction/recuperation time less and is steady under surrounding air basically for thirty days.

Results showed that polysquaramides can be used in powerful mugginess sensors with quick reaction, beating numerous other tactile materials,

advanced the sorts of formed polymers utilized for moistness sensor and extended the utilization of stickiness sensor.

Gihan Jayatilaka, Harshana Weligampola Non Contact Infant Sleep Apnea Detection (2019) this paper presents a clever calculation for distinguishing rest apnea with video handling. The arrangement is non-contact, exact and lightweight enough to run on a solitary board computer. the proposed calculation is automated. The calculation is lightweight and can run on a modest single-board PC. Subsequently, the expense of a gadget is exceptionally low. The adjusted watchful edge recognition calculation is strong than the standard vigilant edge location calculation because of its versatile thresholding. Moreover, the new breathing example discovery calculation has a higher exactness contrasted with the current calculations.

Vijayalakshmi, C. Ramkumar, An Early Alert System for Sleep Apnea Disorder Using IOT (2020) paper proposes a simple, extremely modest, and versatile methodology for the checking of patients with OSA utilizing IoT (Internet of Things). A framework that can recognize OSA issue and furthermore a ready framework has been planned. IoT is utilized so it would give a simple access from anyplace from the world. This framework gives a harmless way to identification and alarming of rest apnea with decreased cost and expanded effectiveness.

Sk.Mamun , Md. Mahadi Hassan Obstructive Sleep Apnea Detection in view of Sound Interval Frequency utilizing Wearable Device(2020) This paper acquaints a robotized approach with distinguish the presence of Resistant Obstructive Sleep Apnea relying upon breathing sign. The way of behaving of the breathing sounds is conveyed by dynamic sound span that distinguish respiratory sign when inhale and hold breathing and have utilized the capacity of recording breathing sound by a receiver and broke down by sound recurrence presence. Whether the recording information is strange has been

investigated with Audacity software. Respiratory signals are effectively examined by the dynamic sound stretch recurrence made with 89.4% precision.

Omar S. Alwan, K. Prahald Rao Committed constant Monitoring System for Health Care utilizing ZigBee (2017) Wireless transmission has been applied through two classifications. The initial segment which contains Arduino with ZigBee will convey the messages to the subsequent gadget, which contains Raspberry with ZigBee. The subsequent gadget will gauge the patient information and send it to the initial gadget through ZigBee handset. The planned framework is shown on volunteers to gauge the internal heat level which is clinically critical to screen and analyze for fever in the patients. Using these two specific electronic equipment circuits the speed upgrades at lower power utilization contrasted and different adaptations of RTMS advancements. It tends to be stretched out for the ideal physiological boundaries falling with fitting patient checking gadgets, for example, circulatory strain, pulse; SPO2 beat oximeter, etc, in light of the kind of disease of the patient. The doctor can screen the patients from a distance and can get ready for additional course of treatment.

CHAPTER - 3

AIM AND SCOPE

3.1 AIM

To support the patient with breathing discomfort this proposed system consists of a health monitoring system includes Respiration sensor for measuring and monitoring the breath condition, SPO2 and Pulse Sensor for monitoring the heart rate and blood oxygen saturation level and Digital Humidity and Temperature sensor. All the parameters are monitored by the microcontroller once the microcontroller detects any difficulties in breathing conditions it'll automatically turn on the supportive system for the patient.

By using the proposed supportive system patients can able to breathe stably.

3.2 EXSISTING SYSTEM DISADVANTAGES

- Cost of existing system is too high
- Size of the system is big compared to the proposed one
- Completely manually controlled

3.3 PROPOSED METHODOLOGY

In order to design a mask & the experimental CPAP device with sensory instrumentation for providing data to a micro-controlled system, electro-pneumatic circuits and signal conditioning boards of sensors have been fitted to achieve optimized CPAP function with low energy consumption.

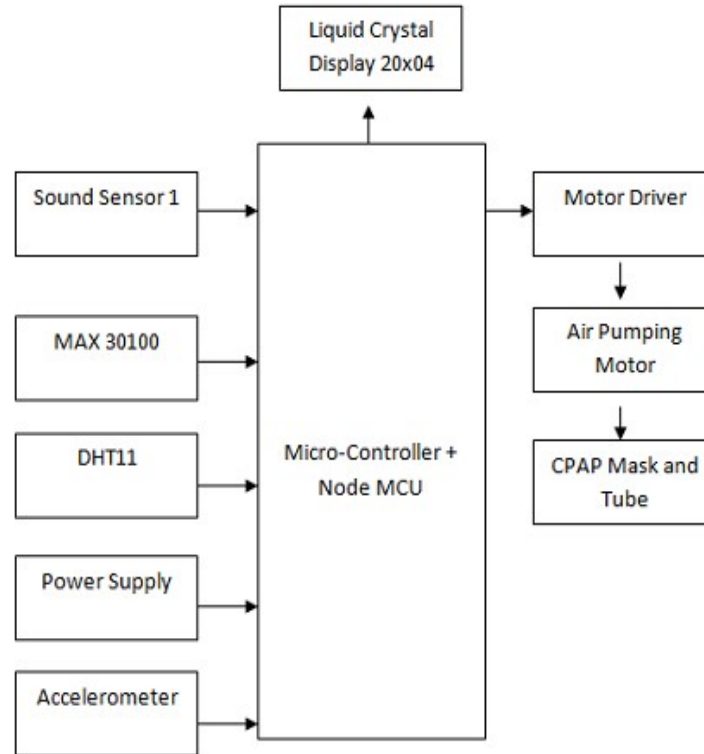


Fig no 3.1 Block diagram of proposed method

Every one of the boundaries are checked by the microcontroller once the microcontroller identifies any hardships in breathing circumstances it will turn on the steady framework for the subject. There are two modes of operation one is auto mode and another one is timer mode or manual mode; smart mode offers decent life for the Machine.

In this proposed work breathing pattern, sleep pattern, temperature humidity controls monitoring and all the controls and recordings can be stored in cloud.

3.3 SCOPE OF THE WORK

Obstructive breathing is the initial symptom which most of the pulmonary diseases begins with. Aiming to diagnose these diseases, focusing on some literal anatomies this work could help them to lead a normal life.

It is critical to make a device that screens the subject parameters like temperature, mugginess, dozing pattern, pulse rate, blood oxygen saturation and breath pace of the subject. Consolidating these boundaries estimations will

make us proficient to constantly screen and notice the subject's degree of seriousness connected with sickness.

By understanding and analyzing these parameters, the condition of the subject can be predicted and hence any difficulties faced can be overcome with timely interventions by caretakers and doctors.

CHAPTER - 4

MATERIALS AND METHODS

4.1 HARDWARE UTILISED

- Atmega328 microcontroller
- Accelerometer
- Sound sensor
- DHT11 sensor
- Motor controlling unit
- Max 30100
- Node MCU
- Air flow tube
- Liquid crystal display

4.1.1 Hardware specification

Max 30100

The MAX30100 is an integrated pulse oximetry and heartrate 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. 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.

Absolute Maximum Ratings:

VDD to GND - -0.3V to +2.2V

GND to PGND - -0.3V to +0.3V

x_DRV, x_LED+ to PGND	-	-0.3V to +6.0V
All Other Pins to GND	-	-0.3V to +6.0V
Output Short-Circuit Current Duration	-	Continuous
Continuous Input Current into Any Terminal	-	±20mA
Continuous Power Dissipation (TA = +70°C)		
OESIP (derate 5.8mW/°C above +70°C)	-	464mW
Operating Temperature Range	-	-40°C to +85°C
Soldering Temperature (reflow)	-	+260°C
Storage Temperature Range	-	-40°C to +105°C
Package thermal characteristics		
OESIP		
Junction-to-Ambient Thermal Resistance (θ_{JA})	-	150°C/W
Junction-to-Case Thermal Resistance (θ_{JC})	-	170°C/W

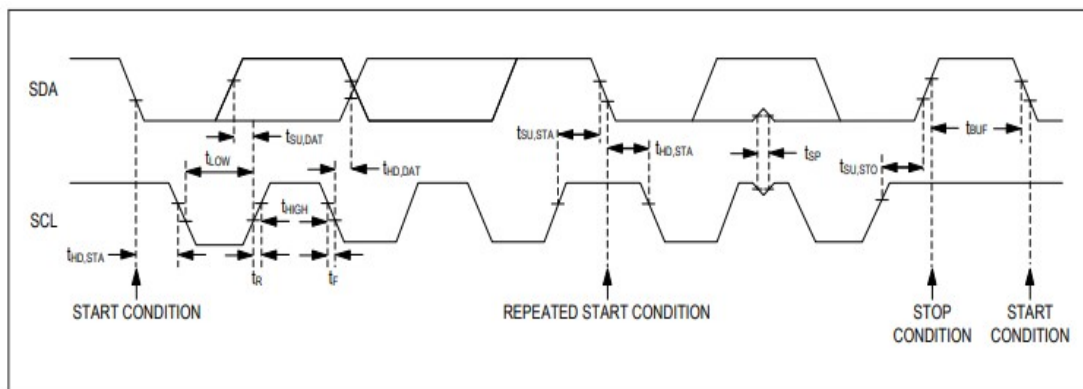


Figure 4.1 I2C-Compatible Interface Timing Diagram

Detailed Description

The MAX30100 is a complete pulse oximetry and heartrate sensor system solution designed for the demanding requirements of wearable devices. The MAX30100 provides very small total solution size without sacrificing optical or electrical performance. Minimal external hardware components are needed for integration into a wearable device. The MAX30100 is fully configurable through software registers, and the digital output data is stored in a 16-deep FIFO within the device. The FIFO allows the MAX30100 to be connected to a microcontroller or microprocessor on a shared bus, where the data is not being read continuously from the device's registers.

SpO2 Subsystem

The SpO2 subsystem in the MAX30100 is composed of ambient light cancellation (ALC), 16-bit sigma delta ADC, and proprietary discrete time filter. The SpO2 ADC is a continuous time oversampling sigma delta converter with up to 16-bit resolution. The ADC output data rate can be programmed from 50Hz to 1 kHz. The MAX30100 includes a proprietary discrete time filter to reject 50Hz/60Hz interference and low-frequency residual ambient noise.

Temperature Sensor

The MAX30100 has an on-chip temperature sensor for (optionally) calibrating the temperature dependence of the SpO2 subsystem. The SpO2 algorithm is relatively insensitive to the wavelength of the IR LED, but the red LED's wavelength is critical to correct interpretation of the data. The temperature sensor data can be used to compensate the SpO2 error with ambient temperature changes.

LED Driver

The MAX30100 integrates red and IR LED drivers to drive LED pulses for SpO₂ and HR measurements. The LED current can be programmed from 0mA to 50mA (typical only) with proper supply voltage. The LED pulse width can be programmed from 200μs to 1.6ms to optimize measurement accuracy and power consumption based on use cases.

Applications Information

Sampling Rate and Performance

The MAX30100 ADC is a 16-bit sigma delta converter. The ADC sampling rate can be configured from 50sps to 1ksps. The maximum sample rate for the ADC depends on the selected pulse width, which in turn, determines the ADC resolution. For instance, if the pulse width is set to 200μs, then the ADC resolution is 13 bits and all sample rates from 50sps to 1ksps are selectable. However, if the pulse width is set to 1600μs, then only sample rates of 100sps and 50sps can be set.

Power Considerations

The LEDs in MAX30100 are pulsed with a low duty cycle for power savings, and the pulsed currents can cause ripples in the LED power supply. To ensure these pulses do not translate into optical noise at the LED outputs, the power supply must be designed to handle peak LED current. Ensure that the resistance and inductance from the power supply (battery, DC/DC converter, or LDO) to the device LED+ pins is much smaller than 1Ω, and that there is at least 1μF of power-supply bypass capacitance to a low impedance ground plane. The decoupling capacitor should be located physically as close as possible to the MAX30100 device. In the heart-rate only mode, the red LED is inactive, and only the IR LED is used to capture optical data and determine the heart rate. This mode allows power savings due to the red LED being off; in

addition, the IR_LED+ power supply can be reduced to save power because the forward voltage of the IR LED is significantly less than that of the red LED.

Applications

- Wearable Devices
- Fitness Assistant Devices
- Medical Monitoring Devices



Fig no 4.2 Max30100 sensor

Benefits and Features

- Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design
 - 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
- Ultra-Low-Power Operation Increases Battery Life for Wearable Devices
 - Programmable Sample Rate and LED Current for Power Savings
 - Ultra-Low Shutdown Current (0.7 μ A, type)
- Advanced Functionality Improves Measurement Performance
 - High SNR Provides Robust Motion Artifact Resilience
 - Integrated Ambient Light Cancellation
 - High Sample Rate Capability
 - Fast Data Output Capability

Accelerometer sensor

Detects disturbance during sleeping. An accelerometer is an electromechanical device used to measure acceleration forces. Such forces may be static, like the continuous force of gravity or, as is the case with many mobile devices, dynamic to sense movement or vibrations. Acceleration is the measurement of the change in velocity, or speed divided by time. Accelerometers are commonly worn for 24 hours per day, thus providing information over the day and night; making them potentially valuable for sleep research. A major challenge in accelerometer-based sleep measurement is to derive sleep parameters without additional information from sleep diaries

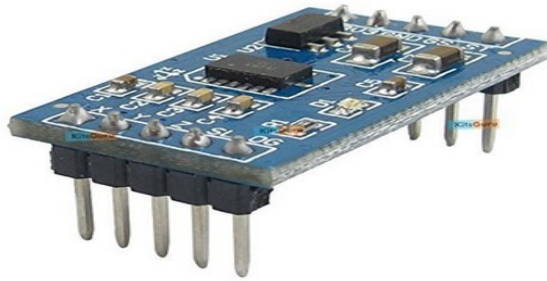


Fig no 4.3 Accelerometer sensor

An accelerator looks like a simple circuit for some larger electronic device. Despite its humble appearance, the accelerometer consists of many different parts and works in many ways, two of which are the piezoelectric effect and the capacitance sensor. The piezoelectric effect is the most common form of accelerometer and uses microscopic crystal structures that become stressed due to accelerative forces. These crystals create a voltage from the stress, and the accelerometer interprets the voltage to determine velocity and orientation.

The capacitance accelerometer senses changes in capacitance between microstructures located next to the device. If an accelerative force moves one of these structures, the capacitance will change and the accelerometer will translate that capacitance to voltage for interpretation.

Accelerometers are made up of many different components, and can be purchased as a separate device. Analog and digital displays are available, though for most technology devices, these components are integrated into the main technology and accessed using the governing software or operating system.

Typical accelerometers are made up of multiple axes, two to determine most two-dimensional movement with the option of a third for 3D positioning. Most smart phones typically make use of three-axis models, whereas cars simply use only a two-axis to determine the moment of impact. The sensitivity of these devices is quite high as they're intended to measure even very minute shifts in acceleration. The more sensitive the accelerometer, the more easily it can measure acceleration.

Accelerometers, while actively used in many electronics in today's world, are also available for use in custom projects. Whether you're an engineer or tech geek, the accelerometer plays a very active role in a wide range of functionalities. In many cases you may not notice the presence of this simple sensor, but odds are you may already be using a device with it. Sleep pose and activity are determined by sensing data obtained from a three-axis accelerometer sensor. Heart rate and respiratory rate are estimated by sensing data obtained from a pressure sensor. Sleep stage is classified by activity and heart rate.

Compressor motor

Helps to pass air under pressure & the maximum flow rate is 8 to 9 LPM (litres of air per minute)



Fig no 4.4 Compressor motor

Compressed air is essential in the medical field. From providing the air that helps operate tools used in dentistry and surgical practices to helping patients breathe, its use cases are incredibly high-touch and should be assessed with the utmost acuity. Having a well-serviced, medical-grade vacuum package is critical in ensuring patients is kept safe during all medical procedures.

While there are various use-cases for medical vacuum packages, we'll be focusing on medical nebulizer compressors and applications where they are used for breathing treatments and therapy.

As pressurized air passes through the various tubes on the medical nebulizer compressor, it quickly turns the medicine into smaller mist particles that can aid during an asthma attack or a respiratory infection. This mist can often be easier to inhale when airways become narrow, for this reason, compressed air nebulizers can deliver short-term and long-term relief for patients.

These types of compressors can also make it possible to receive multiple breathing treatments in one session due to the ability to combine multiple medications at once. Generally, they require between 30-45 PSI per 8ML of medication, making them ideal for multiple uses. Treatments generally last anywhere from 5-10 minutes, but timing can vary depending on medication size, power type and particle size. Some are made for more intermittent use while others are made for continuous use.

Understanding the output of your medical nebulizer compressor is important and can easily be a driving factor in your decision to purchase or service your compressed air system.

Motor regulator

To control the speed of the compressor motor while sleep

A motor regulator is that it controls the pressure of a fluid or gas to a desired value, using negative feedback from the controlled pressure. Regulators are used for gases and liquids, and can be an integral device with a pressure setting, a restrictor and a sensor all in the one body, or consist of a separate pressure sensor, controller and flow valve.



Fig no 4.5 Motor regulator

Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

Technical specifications

Table no: 4.1 Technical specifications of Arduino Nano

Microcontroller	ATmega328
Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB of which 2 KB used by boot loader
SRAM	2 KB
Clock Speed	16 MHz
Analog I/O Pins	8
EEPROM	1 KB
DC Current per I/O Pins	40 mA (I/O Pins)
Input Voltage	7-12 V
Digital I/O Pins	22
PWM Output	6
Power Consumption	19 mA
PCB Size	18 x 45 mm
Weight	7 g
Product Code	A000005

Power

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply. The power source is automatically selected to the highest voltage source.

Memory

The ATmega328 has 32 KB, (also with 2 KB used for the boot loader. The ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

It is a small, complete, breadboard friendly Microcontroller board based on ATmega328p. It can be programmed through Arduino IDE which is an Integrated Development Environment that runs both online and offline. Here it is connected to oxygen and pulse sensor.

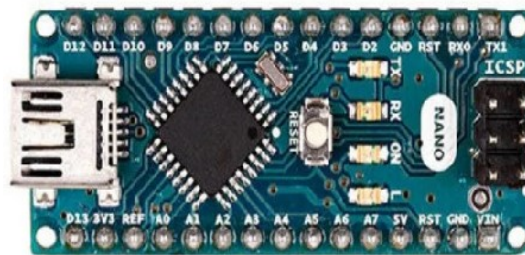


Fig no 4.6 ATmega328

Node MCU

It has independent Wi-Fi organizing arrangement used to transfer data in cloud stage. This microcontroller will read all the data from Arduino Nano and its own sensors reading and together the data will be uploaded.

Node MCU is an open source firmware for which open source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (micro-controller unit). The term "Node MCU" strictly speaking refers to the firmware rather than the associated development kits

Both the firmware and prototyping board designs are open source

The firmware uses the Lua scripting language. The firmware is based on the e-Lua project, and built on the Express if Non-OS SDK for ESP8266. It uses

many open source projects, such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a WI-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications

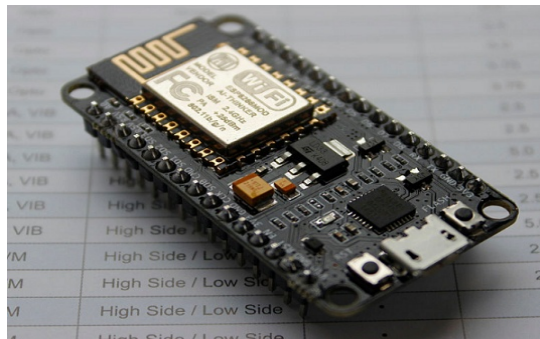


Fig no 4.7 Node MCU

Power supply

A transformer is a passive component that transfers electrical energy from one electrical circuit to another circuit, or multiple circuits. A varying current in any coil of the transformer produces a varying magnetic flux in the transformer's core, which induces a varying electromotive force across any other coils wound around the same core. Electrical energy can be transferred between separate coils without a metallic (conductive) connection between the two

circuits. Faraday's law of induction, discovered in 1831, describes the induced voltage effect in any coil due to a changing magnetic flux encircled by the coil.

Transformers are used to change AC voltage levels, such transformers being termed step-up (or step-down) type to increase (or decrease) voltage level. Transformers can also be used to provide galvanic isolation between circuits as well as to couple stages of signal-processing circuits. Since the invention of the first constant-potential transformer in 1885, transformers have become essential for the transmission, distribution, and utilization of alternating current electric power. A wide range of transformer designs is encountered in electronic and electric power applications. Transformers range in size from RF transformers less than a cubic centimeter in volume, to units weighing hundreds of tons used to interconnect the power grid. In order to get required DC output from AC input power regulator board and 12amp 1volt transformer are utilised



Fig no 4.8 12amp 1volt transformer

LCD Display:

All parameters of the sensor will be displayed. A 20x4 LCD means it can display 20 characters per line and there are 4 such lines.

In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. This is standard HD44780 controller LCD.



Fig no 4.9 LCD display

DHT11 sensor

It is used to detect and record the dampness and temperature inside the mask

The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

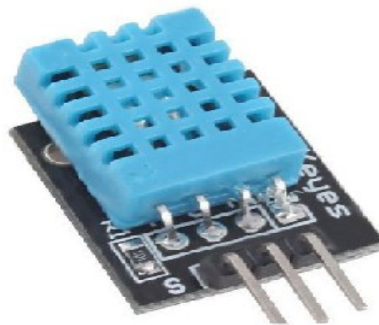


Fig no 4.10 DHT11 sensor

DHT11 Specifications

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%

- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: $\pm 1^{\circ}\text{C}$ and $\pm 1\%$

Sound/ Mic sensor

Detects sound waves through its intensity and converting it to electrical signal with this breathing pattern can be noticed.

A sound sensor additionally referred to as an acoustic sensor is described as a module that detects sound waves via its depth and changing it to electric signals. The sound sensor includes an in-constructed capacitive microphone, a height detector, and an amplifier that's exceedingly touchy to sound

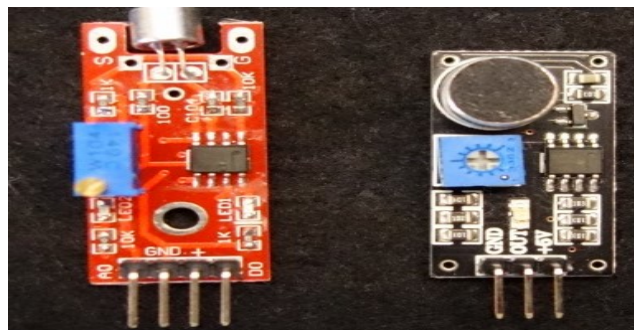


Fig no 4.11 Mic/Sound sensor

Benefits and benefits of sound sensors

- Prevention of publicity to excessive stages via management of ambient sound degree.
- Monitoring of noise stages in each open area and closed areas, permitting in-depth expertise of the sound hobby in a positive place.
- They are used for protection systems.
- Often it works with a speech reputation software program in which sound or speech is transformed to text. This is a quicker method evaluate to typing the usage of the keyboard. This is likewise utilized by disabled people.

- It is simple to govern sound in actual time. Hence the advance recording isn't always needed.
- The sound sensors are used at the same time as using through switching at the radio. This facilitates in enhancing protection the usage of voice activation machine primarily based totally on a sound sensor.
- They are without difficulty affordable.
- Wireless sound sensors offer extremely good freedom at the same time as speaking. Moreover, it does now no longer require cabling evaluation to the stressed-out Mic.

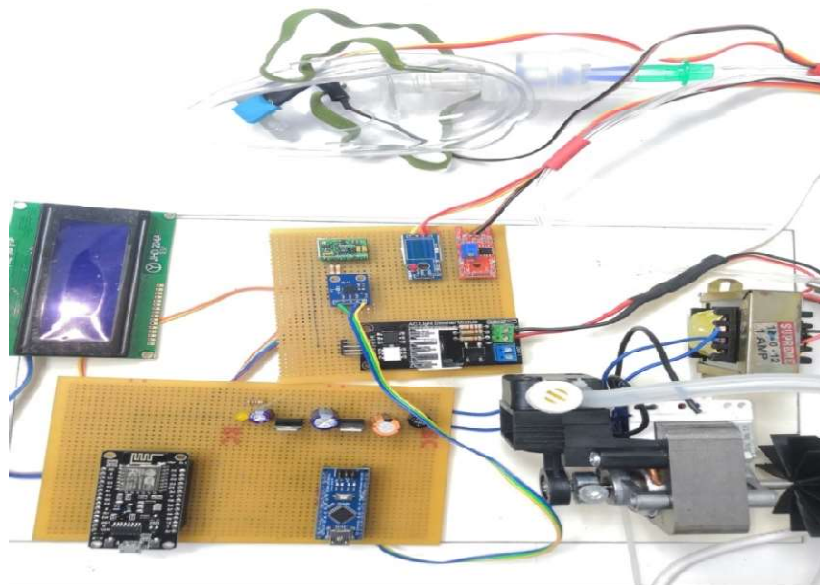


Fig no 4.12 Hardware complete setup

4.2 SOFTWARE UTILISED

- Arduino IDE
- Program language – embedded C
- Cloud platform - ThinkSpeak

4.2.1 Software specification

- *Arduino IDE*

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right and corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor

4.2.2 Program Language used – Embedded C

The term “Arduino-compatible coding” refers to all Arduino and Arduino-compatible microcontroller boards that can be programmed and uploaded using Arduino IDE.

Much like other microcontrollers, the AVR microcontrollers housed in Arduino boards are programmed in a subset of C. A general term for such subsets is “Embedded C” because they apply to programming embedded controllers. The language in which Arduino is programmed is a subset of C and it includes only those features of standard C that are supported by the Arduino IDE.

A microcontroller can interact with other hardware components or devices only through these five ways:

- *Digital Input.*

This may be received in digital LOW or HIGH from other devices. These will be TTL logic levels or voltages converted to TTL logic levels before being applied to the GPIO.

- *Digital Output.*

This may be output that’s digital LOW or HIGH compared to other devices. Again, the output will be TTL logic levels.

- *Analog Input.*

It may “sense” analog voltage from other devices. The sensed voltage is converted to a digital value using a built-in, analog-to-digital converter.

- *Analog Output.*

It may output analog voltage to other devices. This analog output is not analog voltage but a PWM signal that approximates analog voltage levels

- *Serial Communication*

It may transmit, receive, or transceive data with other devices in serial, according to a standard serial data protocol such as UART, USART, I2C, SPI,

micro wire, 1-wire, and CAN, etc. The serial communication with other devices can be peer-to-peer (UART/USART), half-duplex (I2C), or full-duplex (SPI).

4.2.3 Cloud platform - *ThinkSpeak*

Sensors, or things, sense data and typically act locally. Thing Speak enables sensors, instruments, and websites to send data to the cloud where it is stored in either a private or a public channel. Thing Speak stores data in private channels by default, but public channels can be used to share data with others. Once data is in a Thing Speak channel, you can analyze and visualize it, calculate new data, or interact with social media, web services, and other devices.

Storing data in the cloud provides easy access to your data. Using online analytical tools, you can explore and visualize data. You can discover relationships, patterns, and trends in data. You can calculate new data. And you can visualize it in plots, charts, and gauges. Thing Speak provides access to MATLAB to help you make sense of data. Here it is possible to, Convert, combine, and calculate new data

- ✓ Schedule calculations to run at certain times
- ✓ Visually understand relationships in data using built-in plotting functions
- ✓ Combine data from multiple channels to build a more sophisticated analysis

Thing Speak provides tools that enable device communication for all of these actions and more. We can

- React to data - both raw data and new data that you calculate as it comes into a channel
- Queue up commands for a device to execute

CHAPTER - 5

RESULT AND DISCUSSION

5.1 RESULT

The device is connected to the subject and followings are the readings are taken. This device has two modes of operations one is automatic and another one is timer mode. Automatic mode can do two specific functions one is central sleep apnea another one is obstructive sleep apnea. In obstructive sleep apnea mode the subject is monitored and when any obstruction or apnea is detected the compressor motor will be turned on automatically and will be turned off once the breathing is stabilized. In central sleep apnea mode it will sense the subject for every 10sec and at 8th sec it will turn on the motor irrespective of the subject's ability to breath, usually it will be suggested by the doctors upon subject's severity conditions. Once the subject is connected with this device, temperature, humidity, heart rate and SPO2 rate will be sensed and displayed in the LCD display which is shown in Figure 5.4 and recorded. Figure 5.1, 5.2, 5.3 shows the graphical representation of the subject's status lives from IOT platform. Table 5.1 reports the parameters that are recorded from the subject. The temperature, heart rate, SpO2 ranges recorded is displayed. The 0's and 1's represents the sleeping pattern of the subject. 1 indicates awaken state and 0 indicates the sleep state. These are obtained with the accelerometer connected to the subject. The status of the compressor motor when it is switched ON to aid in breathing is represented by 1 and a 0 represents the OFF condition

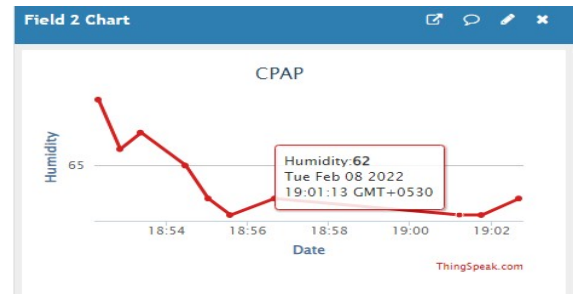
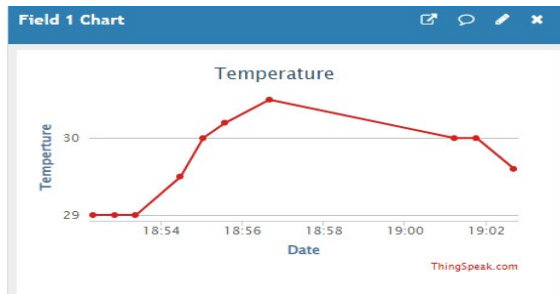


Fig no 5.1 Temperature and Humidity output

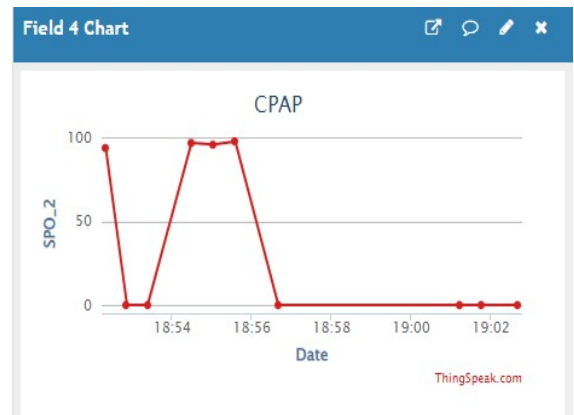
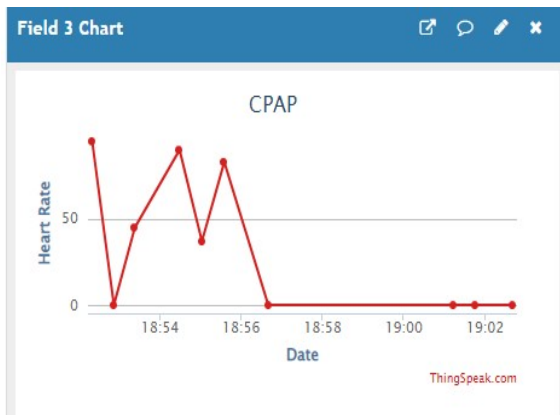


Fig no 5.2 Heart rate and SpO2 level output

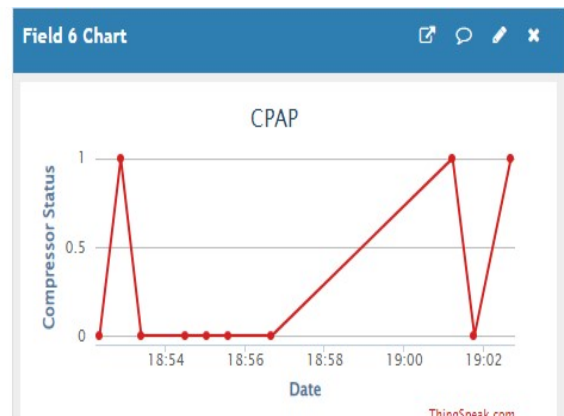
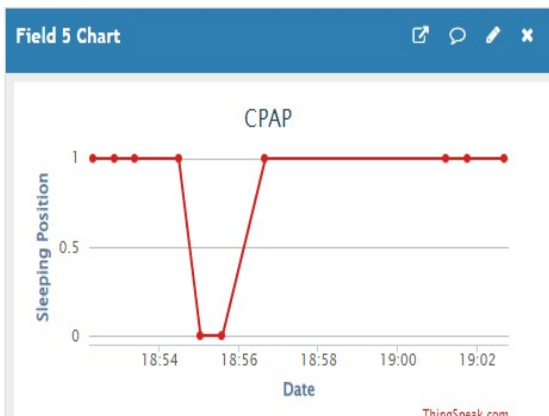


Fig no 5.3 Sleeping pattern and compressor motor status

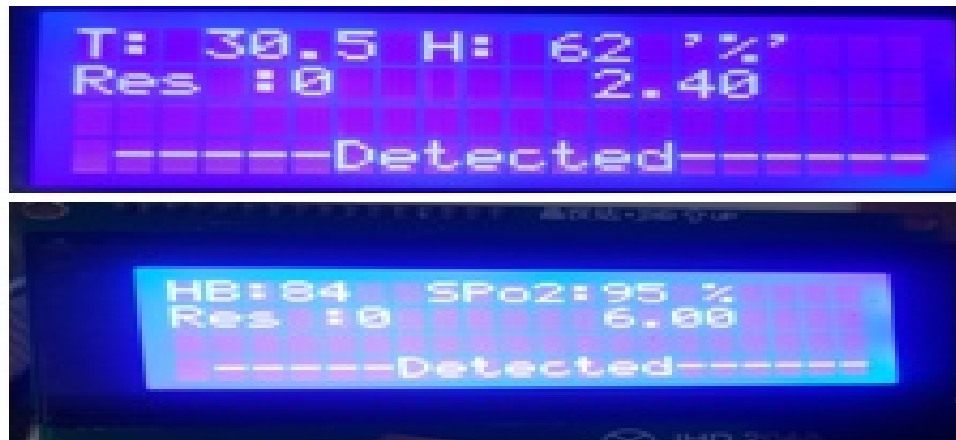


Fig no 5.4 LCD display

Table 5.1 Parameter Report

Patient	Temperature	Humidity	Heart rate	SpO2	Sleeping pattern	Compressor status	Mode
1	26.7	64	72	95	0	0	
2	26.8	63	68	96	0	0	Auto
3	26.5	64	79	92	0	0	Auto
4	26.5	63	92	97	0	0	Auto
5	26.3	63	68	97	0	0	Auto
6	26.3	62	72	97	0	0	Auto
7	26.3	61	77	97	0	0	Auto
8	26.3	61	72	97	0	0	Auto
9	28.1	64	71	95	0	0	Auto
10	29.5	63	65	95	0	1	
11	30	62	67	95	0	1	
12	30.6	61	68	90	0	0	Manual
13	31.2	60	73	97	0	0	Manual
14	31.7	60	72	97	0	0	Manual
15	31.7	59	80	78	0	0	Manual
16	31.8	60	81	78	0	0	Manual
17	32.3	60	73	85	0	0	Manual
18	32.4	59	75	89	0	0	Manual
19	32.6	58	65	90	0	0	Manual
20	28.6	65	69	90	1	0	
21	29	64	70	88	1	0	
22	29	64	71	85	1	0	

5.2 DISCUSSION AND SUMMARY

This work is to support subject with pulmonary conditions like COPD, Interstitial lung disease, surfactant dysfunction, pulmonary edema etc. The basic anatomy behind these diseases is that, there is a fluid accumulation in the lungs. When they are in fowler's position this fluid in the lower part of the lungs won't disturb them but when they are at supine position these fluid fills up the entire lungs which causes breathing discomforts the air sacs get damaged due to these conditions, thereby disturbing the gas exchange between the alveoli and blood capillaries. To help bring back that breathing to the normal level they are connected with the supportive system. This will maintain the flow of air inside the mask through which the respiratory pathway blocks will be cleared up and it will enhance the gas exchange; the subject can breathe stably. The device comes with compressor motor which can be found in nebulizer, which passes air under pressure to clear up the blockages. It comes in two modes of operation; automated mode can do two specific functions, in Central sleep apnea mode for every 10sec the sensor monitor the subject at 8th sec the compressor motor will be turned on automatically irrespective of the subject's breathing ability this mode can be used as per the recommendation of the doctors upon subject's condition. In Obstructive sleep apnea mode, if it detects snoring or apnea, the motor is turned on. The entire operation is automatic, whereas in timer mode it can be manually operated. The compressor motor will run until it is turned off. The major advantage of this work is that it is commercial , can be used for nebulizer, ease of usage, easy report and live data monitoring facilitating the doctors to have frequent subject follow ups. The device is portable and cost efficient.

CHAPTER - 6

CONCLUSION

6.1 CONCLUSION

Obstructive breathing is the initial symptom which most of the pulmonary diseases begins with. Aiming to diagnose these diseases, focusing on some literal anatomies this work could help them to lead a normal life.

It is critical to make a device that screens the subject parameters like temperature, mugginess, dozing pattern, pulse rate, blood oxygen saturation and breath pace of the subject. Consolidating these boundaries estimations will make us proficient to constantly screen and notice the subject's degree of seriousness connected with sickness. By understanding and analyzing these parameters, the condition of the subject can be predicted and hence any difficulties faced can be overcome with timely interventions by caretakers and doctors. The capacity to analyze such illness will give a totally different level of solace and wellbeing help for the people who are experiencing particularly pneumonic infections. To summarize, appreciating the worth of human existence will lead us to limitless scope of imagination and upon that we dealt with our thought to add something that can influence decidedly and support the soundness of our general public.

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APPENDICES

```
#include <ESP8266WiFi.h>
#include <LiquidCrystal_PCF8574.h>
#include <Wire.h>
#include <SoftwareSerial.h>
#include "DHTesp.h"
#include "ThingSpeak.h"
```

```
#include "hw_timer.h"
const byte zcPin = D7;
const byte pwmPin = D8;
```

```
DHTesp dht;
```

```
//Swedha990011
```

```
LiquidCrystal_PCF8574 lcd(0x27);
```

```
#define RX D5
#define TX D6
SoftwareSerial ard_node(RX, TX, false, 256);
//SoftwareSerial ard_node;
```

```
const int ACC = 0x68; // I2C address of the MPU-6050
unsigned int AcX, AcY, AcZ;
int fStatus, f_Status;
```

```
#define splash splash2
```

```
#define resp A0
```

```
#define ky1 D3
```

```
#define ky2 D4
```

```
int Sleep_Apnea;
```

```
int a, b;
```

```
char ssid1[] = "Project";
```

```
char password1[] = "1234567890";
```

```
unsigned long channelID = 1636394;
```

```
const char * writeAPIKey = "L3BNDG4MSXA49BW9"; // write API key for your  
ThingSpeak Channel
```

```
const char* server = "api.thingspeak.com";
```

```
String th;
```

```
String modefn = "";
```

```
int tup = 20;
```

```
WiFiClient client;
```

```
int H_B, SPO_2;
```

```
int hum;
```

```
float temp;
```

```
int res_r, resfn;
```

```
int res_r_t = 580;
```

```
float res_tim = 0.0;
```

```

int C_Status;
int C_tim = 10;
float cc_tim = C_tim;

int k1_r, k2_r;
int C_auto;

int DispDelay;

byte fade = 1;
byte state = 1;
byte tar_Val = 1;
byte cur_Val = 0;
byte zcState = 0; // 0 = ready; 1 = processing;

void setup() {
    // put your setup code here, to run once:
    Serial.begin(115200);
    ard_node.begin (115200);
    // ard_node.begin (115200, SWSERIAL_8N1, RX, TX, false, 256);
    dht.setup(D0, DHTesp::DHT11);
    ard_node.println("");
    pinMode(ky1, INPUT_PULLUP);
    pinMode(ky2, INPUT_PULLUP);
    Wire.beginTransmission(0x27);

    LcDSet();
    k1_r = digitalRead(ky1);
    k2_r = digitalRead(ky2);
    if (k1_r == 0 ) {

```

```

    Sleep_Apnea = 1;
    splash(2, "Central Sleap");
    splash(3, "Apnea Mode");
}
else {
    splash(2, "Obstructive Sleep");
    splash(3, "Apnea Mode");
}
delay(2000);
lcd.clear();
setupWifi();
ThingSpeak.begin(client);
lcd.clear();
pinMode(zcPin, INPUT_PULLUP);
pinMode(pwmPin, OUTPUT);
attachInterrupt(zcPin, zcDetectISR, RISING);    // Attach an Interupt to Pin 2
(interupt 0) for Zero Cross Detection
//attachInterrupt(digitalPinToInterrupt(D6), zcDetectISR, RISING);
hw_timer_init(NMI_SOURCE, 0);
hw_timer_set_func(dimTimerISR);

}

void LcDSet() {

    lcd.begin(20, 4);
    // Print a message to the LCD.
    lcd.clear();
    lcd.setBacklight(1);
    splash(0, "CPAP");
    splash(1, "Machine");

```

```

    delay(1000);

}

void setupWifi() {

    Serial.println();
    Serial.println();
    Serial.print(ssid1);
    WiFi.begin(ssid1, password1);
    Serial.print("Connecting to ");

    while (WiFi.status() != WL_CONNECTED)
    {

        if (b <= 0) {
            b = 2;
        }
        delay(800);
        Serial.print(".");
        lcd.setCursor(0, 0);
        lcd.print("I'm Connecting ");
        lcd.setCursor(0, 1);
        lcd.print("to");
        lcd.setCursor(b, 1);
        lcd.print(".");

        b = b + 1;
        if (b >= 16)
        {
            lcd.clear();

```

```

        b = 2;
    }

}

Serial.println("");
Serial.println("WiFi connected");
Serial.println("IP address: ");
Serial.println(WiFi.localIP());
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Connected !!" );
delay(1000);
lcd.clear();

delay(1000);
}

void loop() {
    lcd.setCursor(0, 2);
    lcd.print("          ");
    getArd();
    getDht();
    lcd.home();
    setDisp();
    k1_r = digitalRead(ky1);
    k2_r = digitalRead(ky2);
    if (k1_r == 0 and C_auto == 0) {
        splash(2, "Auto Mode OFF");
        modefn="Manual";
        delay(100);
    }
}

```

```

    C_auto = 1;
}
else if (k1_r == 0 and C_auto == 1) {
    splash(2, "Auto Mode ON");
    modefn="Auto";
    delay(100);
    C_auto = 0;
}

if (C_auto == 0) {
    getres();
}
else {

    if (k2_r == 0 and C_Status == 0) {
        //    digitalWrite(led, HIGH);
        tar_Val = 70;
        delay(200);
        tar_Val = 100;
        delay(200);
        tar_Val = 110;
        delay(200);
        tar_Val = 120;
        delay(200);
        tar_Val = 130;
        splash(3, "C ON");
        delay(100);
        C_Status = 1;
    }
    else if (k2_r == 0 and C_Status == 1) {

```

```

    tar_Val = 130;
    delay(200);
    tar_Val = 1;
    splash(3, "C OFF");
    //    digitalWrite(led, LOW);
    delay(100);
    C_Status = 0;
    lcd.setCursor(0, 3);
    lcd.print("          ");
}
}

UpdateServer();

delay(300);
}

void getArd() {
    String SS = ""; String SSs = "";
    while (ard_node.available() > 0) {

        char S = ard_node.read();
        SS += S;

        delay(10);

    }
    if (SS.length() > 0) {
        Serial.println(SS);
        String sys = getSplitValue(SS, ',', 0);
        String dia = getSplitValue(SS, ',', 1);
    }
}

```

```

    String ff = getSplitValue(SS , ',', 2);
    H_B = sys.toInt();
    SPO_2 = dia.toInt();
    f_Status = ff.toInt();

    ard_node.flush();

}
}

void getDht() {

    int humidity = dht.getHumidity();
    float temperature = dht.getTemperature();
    Serial.print(humidity, 1);
    Serial.print("\t\t");
    Serial.println(temperature, 1);
    temp = temperature;
    hum = humidity;
}

void getres() {

    res_tim += 0.40;

    res_r = analogRead(resp);
    Serial.print("res ");
    Serial.println(res_r);
}

```

```
if (Sleep_Apnea == 0) {
```

```
    if (C_Status == 0) {  
        if (res_r > res_r_t) {  
            resfn++;  
            splash(2, "Snoring");  
            splash(3, "Detected");  
        }  
    }  
}
```

```
if (res_tim > 8 and resfn >= 2 and C_Status == 0) {  
    Serial.println("Comp ON");  
    tar_Val = 130;  
    C_Status = 1;  
    resfn = 0;  
    res_tim = 0;  
}
```

```
else if (res_tim > C_tim and C_Status == 1) {  
    C_Status = 0;  
    tar_Val = 1;  
    Serial.println("Comp OFF");  
    lcd.setCursor(0, 2);  
    lcd.print("Air Flow OFF    ");  
    resfn = 0;  
    res_tim = 0;  
}
```

```

else if (res_tim > 10) {
    C_Status = 0;
    tar_Val = 1;
    Serial.println("Normal");
    lcd.setCursor(0, 2);
    lcd.print("Stable      ");
    resfn = 0;
    res_tim = 0;
}
lcd.setCursor(0, 2);
lcd.print("      ");
}

else {

    if (C_Status == 0) {
        if (res_r > res_r_t) {
            resfn++;
        }
    }

    if (res_tim > 8 and resfn == 0 and C_Status == 0) {
        Serial.println("Comp ON");
        tar_Val = 130;
        C_Status = 1;
        resfn = 0;
        res_tim = 0;
    }

    else if (res_tim > C_tim and C_Status == 1) {

```

```

    C_Status = 0;
    tar_Val = 1;
    Serial.println("Comp OFF");
    lcd.setCursor(0, 2);
    lcd.print("Air Flow OFF    ");
    resfn = 0;
    res_tim = 0;
}

else if (res_tim > 10) {
    C_Status = 0;
    tar_Val = 1;
    Serial.println("Normal");
    lcd.setCursor(0, 2);
    lcd.print("Stable        ");
    resfn = 0;
    res_tim = 0;
}

}

}

void setDisp() {

    if (DispDelay >= 0 and DispDelay < 20) {
        display_ard(H_B, SPO_2);

    }

    else if (DispDelay >= 20 and DispDelay < 40) {

```

```

    display_T(temp, hum);

}
else {
    DispDelay = 0;
}

if (C_Status == 0) {
    lcd.setCursor(0, 1);
    lcd.print("Res :      ");
    lcd.setCursor(5, 1);
    lcd.print(resfn);
    lcd.setCursor(12, 1);
    lcd.print(res_tim);
    cc_tim = C_tim;
}
else if (C_Status == 1 and C_auto == 1 ) {
    lcd.setCursor(0, 2);
    lcd.print("Air Flow ON      ");

}
else {
    lcd.setCursor(12, 1);
    lcd.print("0.00");
    lcd.setCursor(0, 2);
    lcd.print("Air Flow ON      ");
    lcd.setCursor(12, 2);
    lcd.print(cc_tim -= 0.38);
}
DispDelay++;
}

```

```
void display_ard(int val1 , int val2) {
```

```
    lcd.setCursor(0, 0);  
    lcd.print("HB:      ");  
    lcd.setCursor(3, 0);  
    lcd.print(val1);  
    lcd.setCursor(7, 0);  
    lcd.print("SPo2:      ");  
    lcd.setCursor(12, 0);  
    lcd.print(val2);  
    lcd.setCursor(15, 0);  
    lcd.print("% ");
```

```
}
```

```
void display_T(float val1 , int val2) {
```

```
    lcd.setCursor(0, 0);  
    lcd.print("T:      ");  
    lcd.setCursor(3, 0);  
    lcd.print(val1, 1);  
    lcd.setCursor(8, 0);  
    lcd.print("H:      ");  
    lcd.setCursor(11, 0);  
    lcd.print(val2);  
    lcd.setCursor(14, 0);  
    if (f_Status) {  
        lcd.print("%");  
    } else {
```

```

    lcd.print("% ");
}

}

void UpdateServer() {

    tup++;
    if (tup >= 50) {
        splash(1, "Sending Data");
        if (client.connect(server, 80)) {
            ThingSpeak.setField(1, String(temp));
            ThingSpeak.setField(2, String(hum));
            ThingSpeak.setField(3, String(H_B));
            ThingSpeak.setField(4, String(SPO_2));
            ThingSpeak.setField(5, String(f_Status));
            ThingSpeak.setField(6, String(C_Status));
            ThingSpeak.setField(7, modefn);

            // write to the ThingSpeak channel
            int x = ThingSpeak.writeFields(channelID, writeAPIKey);
            if (x == 200) {
                Serial.println("Channel update successful.");
                splash(1, "Data Sent");
            }
            else {
                Serial.println("Problem updating channel. HTTP error code " + String(x));
                splash(1, "Sending Failed");
            }
        }
    }
}

```

```

    tup = 0;
  }

}

#include <Wire.h>
#include "MAX30100_PulseOximeter.h"
#include <SoftwareSerial.h>
SoftwareSerial ard_node(3, 2);

#define REPORTING_PERIOD_MS    1000

PulseOximeter pox;

uint32_t tsLastReport = 0;

void onBeatDetected()
{
  Serial.println("Beat!");
}

void setup() {
  // put your setup code here, to run once:
  Serial.begin(115200);
  ard_node.begin(115200);
  Serial.print("Initializing pulse oximeter..");
  delay(5000);

  if (!pox.begin()) {

```

```

    Serial.println("FAILED");
    for (;;)
  } else {
    Serial.println("SUCCESS");
  }

  // The default current for the IR LED is 50mA and it could be changed
  // by uncommenting the following line. Check MAX30100_Registers.h for all
the
  // available options.
  pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);

  // Register a callback for the beat detection
  pox.setOnBeatDetectedCallback(onBeatDetected);
}

void loop() {
  // put your main code here, to run repeatedly:
  // pox.begin();
  pox.update();

  // Asynchronously dump heart rate and oxidation levels to the serial
  // For both, a value of 0 means "invalid"
  if (millis() - tsLastReport > REPORTING_PERIOD_MS) {

    int x = analogRead(A0);
    int y = analogRead(A1);
    int z;
    Serial.print("Heart rate:");
    Serial.print(pox.getHeartRate());
    Serial.print("bpm / SpO2:");

```

```
Serial.print(pox.getSpO2());  
Serial.print ("%");
```

```
Serial.print(" x ");  
Serial.print(x);
```

```
if (y > 360 or y < 300) {  
    z = 1;  
} else {  
    z = 0;  
}  
Serial.print(" x ");  
Serial.println(z);
```

```
ard_node.print(pox.getHeartRate());  
ard_node.print(",");  
ard_node.print(pox.getSpO2());  
ard_node.print(",");  
ard_node.print(z);  
ard_node.print(",");
```

```
    tsLastReport = millis();  
}  
}
```

