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Intelligent Iot Solution For Sleep Apnea

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ABSTRACT
Sleep is necessary for human health, although its specific physiological purpose is uncertain. Breathing dynamics are a critical diagnostic tool in therapeutic settings such as sleep analysis, intensive care, and central nervous and physiological disease analysis. Sleep apnea occurs when airflow to the lungs is interrupted for 10 seconds or more during sleep, often due to a loss of neuronal input from the central nervous system (Central Sleep Apnea) or upper airway collapse. (Obstructive Sleep Apnea). To solve this issue, a microcontroller-based sleep apnea monitor has been created. A respiration sensor monitors breathing conditions, a pulse sensor and SPO2 track heart rate and blood oxygen saturation, a digital humidity and temperature sensor, and a microphone detects snoring sounds are all included in the device. The microcontroller continuously checks all data, and if any breathing issues are identified, the patient's support system is activated immediately. This helpful technique assists patients in achieving consistent breathing, which can lessen or eliminate snoring, The system also includes manual and automatic modes, giving users more freedom and control over how the system behaves. While the manual mode enables users to change the settings and get feedback based on their particular needs, the automated mode may be utilized to continuously monitor and adjust the air pressure. Healthcare providers can assess patient progress and change treatment parameters as necessary with the help of IoT-based sleep apnea prevention and detection systems. For patients who reside in remote or underdeveloped locations or who have limited access to specialized medical care, this can be especially beneficial. The potential to improve the quality of life for the millions of people worldwide who are plagued by this sleep condition exists in the field of IoT-based sleep apnea prevention and detection. The continuous research and development in this field has the potential to fundamentally alter how sleep apnea is identified, treated, and managed, leading to better health outcomes and an overall improvement in quality of life.The principal aim of this paper is to provide a compact device and user-friendly app integrated into the device. The future scope is to increase the feasibility of the system by including the key concepts of machine learning for user's accurate tracking

Keywords: Sleep apnea, Self-management, Cloud.
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1. INTRODUCTION:

Millions of people across the world suffer from the widespread sleep ailment known as sleep apnea. It is characterized by respiratory pauses during sleep that might last several seconds or more. If left addressed, this interruption, which can occur numerous times throughout the night, might result in serious health issues. Daytime exhaustion, memory loss, headaches, and other symptoms are all caused by sleep apnea. Additionally, it has been connected to more severe medical disorders like diabetes, high blood pressure, heart disease, and stroke. Up to 1 billion individuals may be affected by sleep apnea, according to estimates of the disorder's increasing prevalence globally. There are various forms of sleep apnea, but obstructive sleep apnea is the most prevalent. (OSA). The person snores or gasps for air as a result of the muscles in the back of the throat failing to keep the airway open while they are sleeping. When the brain fails to tell the muscles to breathe, central sleep apnea (CSA), a less common

variant, develops. Even though sleep apnea is a serious disorder, it is treatable. Treatment options range from less intrusive approaches like lifestyle modifications like weight loss and abstaining from sedatives and alcohol to more invasive procedures like surgery or the help of a continuous positive airway pressure (CPAP) machine. Preventing long-term health issues and enhancing the general quality of life requires early detection and treatment of sleep apnea. Receiving care is essential. Therefore, it is always better to prevent illness than to treat it. Building a detection and prevention tool is so important. The system's design and implementation were made possible by the use of the flexible and programmable processors Arduino and ESP32. The MAX30100, DHT11, respiration sensor, and acceleration sensor are just a few of the sensors that have been added to track breathing patterns and other physiological data as you sleep. The system also comprises crucial parts including the compressor, mask, step-down transformer, and relay for delivering the necessary air pressure for treating sleep apnea, The main objectives of the paper:

To improve and monitor the health conditions of asthma patients.

To provide precautions to the patients.

To monitor the environment of the patient continuously.

To provide a user-friendly device.

2. EXISTING METHODS

In this segment we present an overview of some important contributions made by several researchers in the field of embedded and IoT Mamoun Al-Mardini et.al. (2014) designed a device, the approach makes use of the built-in sensors, pervasiveness, computational power, and user-friendly interface of a smartphone to screen OSA. We generally use three sensors to get physiological data from patients: an oximeter to track oxygen saturation, a microphone to capture breathing effort, and an accelerometer to record body movement. Finally, we compare the ability of our method to screen for the condition to the industry standard using 15 samples to evaluate it. The results showed that while 100% of patients were correctly identified as having the condition, only 85.7% of patients were correctly identified as not having it. These first results underscore the critical role smartphones play in healthcare and emphasise the significance of the built system's performance in relation to the gold standard. Ina Djonlagic et.al. (2015) conducted a study. At the Brigham and Women's Hospital Sleep Disorders Laboratory, the first 44 patients who met the inclusion criteria had either a diagnostic polysomnography or a CPAP titration trial were included in the 3 study. Following polysomnography (PSG), participants were divided into three groups: (1) healthy controls (control group), (2) obstructive sleep apnea patients who did not receive treatment (OSA group), and (3) OSA patients who had a full night of CPAP therapy. (CPAP group). In contrast to the OSA group, participants had to have an AHI of more than 15/h in order to be classified as healthy controls. Ahmed S. BaHammam et.al. (2017), the majority of TECSA cases experience self-limited and persistent apnea episodes during the initial PAP titration, which has been suggested as a therapy method. A follow-up is necessary to make sure that the emergent important events disappear with continued therapy. This will be possible by tracking the PAP saved data. However, the therapist ought to recognise and deal with any problems that could be causing treatment-emergent CSA. PAP should be reduced and titration should be done gradually to address the issue of over-titration. When a major mask leak is discovered, the interface needs to be changed. PSG may be repeated in difficult circumstances. Mohamed Nabi EL Gharib (2019) developed a system, In this method, the patient falls asleep with a mask placed over their nose, forcing air into their nasal passages with the force of an air blower. The air pressure needs to be precisely controlled, constant, and continuous in order to prevent throat contractions while you sleep. Although nasal CPAP prevents airway obstruction, sleep apnea episodes can occasionally reoccur when it is used improperly or is stopped altogether. (Figure 1). using a CPAP machine while ill Women who have gestational sleep apnea during their pregnancy run the chance of continuing to have severe respiratory suppression after giving birth. As a result, utilising medicines that prevent breathing should be limited and regulated by experts. Anatolii Petrenko (2019) developed a system, the accuracy of determining the breathing pattern in various settings for various physical states of patients is improved when twodimensional conversion accelerometer signals are used as opposed to not using them for diagnosing and monitoring sleep apnea at home. One-dimensional (1d) accelerometer signals are transformed into twodimensional (2d) graphical images, which are then analysed by CNN using numerous processing layers. Hiwa Mohammadi et.al. (2021) conducted a case study, 23 healthy controls and 4 31 OSAS patients (mean age, 48.50). Every individual had polysomnography the entire night. For those who had OSAS, it was further divided into groups of mild, moderate, and severe cases. Balavenkata B chatruvedula et.al. (2021) developed a method for the treatment, Patients with underlying pathologies such as obstructive adenoids, chronic mouth breathing, asthma, and those with a BMI of greater than 24.9 were also disqualified, as were those who had already finished an interceptive orthodontic/orthopaedic therapy phase. The study was limited to the lateral cephalograms that closely fitted the aforementioned specifications. the cerebral pictures. The upper and lower airways' dimensions were also measured. The airway measurements were compared between the three groups using one-way ANOVA tests, and the odd's ratio was calculated to find a relationship between the airway measurements and the growth trend of the person. In order to statistically examine the data, IBM SPSS software, version 20, was used. Prathap chandar manivannan et.al (2021) developed a system for making an empirical and historical diagnosis of OSAS. Confirmation is provided by polysomnography. (PSG). Background and analysis: A thorough medical history should be taken, including details on both nocturnal and diurnal symptoms as well as OSAS related morbidities like neurobehavioral deficits, behaviour, fatigue, failure to thrive, and systemic hypertension. A person's history of snoring at night is the most crucial factor in predicting OSA. Allergy rhinitis or any other ailment that could make nasal airflow resistance worse, as well as the relative size (micrognathia) and location (retrognathia) of the mandible, should all be taken into account.

SYSTEM OUTLINE The system's design and implementation were made possible by the use of the flexible and programmable processors Arduino and ESP32. The MAX30100, DHT11, respiration sensor, and acceleration sensor are just a few of the sensors that have been added to track breathing patterns and other physiological data as you sleep. The system also comprises crucial parts including the compressor, mask, step-down transformer, and relay for delivering the necessary air pressure for treating sleep apnea. The system also includes manual and automatic modes, giving users more freedom and control over how the system behaves. While the manual mode enables users to change the settings and get feedback based on their particular needs, the automated mode may be utilized to continuously monitor and adjust the air pressure.

A. MICRO-CONTROLLER

NodeMCU is an open-source development board based on the ESP8266 Wi-Fi module. It has FCC certified Wi-Fi modules and a PCB antenna. The board integrates general purpose input output (GPIO), interintegrated circuit (IIC), ADC (analog to digital converter). Its firmware runs on Express ESP8266 WiFi Soc system. NodeMCU typically has 128 KB of memory. It's scripting language easy and visual. The board uses a micro-USB port for power and communication with the PC. It can be easily operated from a USB to a micro USB port via a power bank. Due to the comparative ease of use and the built-in Wi-Fi modules, NodeMCU is generally preferred over other micro-controllers.

Fig. Example of Node MCU

ARDUINO NANO

The Arduino Nano is known for its adaptability in addition to its compact size and low power consumption. The board may be programmed to carry out several of activities and is compatible with a wide range of sensors and electronic components. Robotics, home automation, and Internet of Things (IoT) projects frequently use the Arduino Nano.The airflow of a CPAP machine can be monitored and controlled using an Arduino Nano in sleep apnea devices. It can be set up to read data from sensors that measure air pressure and flow, and then adjust the flow rate in order to maintain airway pressure at an appropriate level. In order to effectively manage sleep apnea, it is necessary to make sure the patient is receiving the right amount of air pressure for keeping their airway open. Monitoring the patient's sleep patterns is another way that Arduino Nano can be included in sleep apnea devices. It can be set up to warn the doctor or guardian when the patient stops breathing. This may help to spot patterns in the patient's breathing during sleep and alter the treatment strategy accordingly.

Fig.Arduino Nano

B. SENSOR

RESPIRATION SENSOR

snoring is a typical sign of sleep apnea and is a result of vibrations in the upper airway during breathing, sound detecting sensors are used to monitor sleep apnea. The patient's breathing patterns during sleep can be inferred from the vibrations that sound detection sensors pick up on. For the purpose of monitoring sleep apnea, a

variety of sound detection devices, including piezoelectric sensors, MEMS microphones, and acoustic sensors, can be utilized. The vibration of the larynx during breathing can be picked up by piezoelectric sensors because they are sensitive to pressure fluctuations. MEMS microphones are inexpensive, tiny sensors that are simple to connect with other electronics like microcontrollers or smartphones. Acoustic sensors are capable of detecting breathing noises and are sensitive to pressure variations.

Fig. Example of Respiration Sensor

Humidity and Temperature sensor:

Here we are using DHT11 sensor which is an economical digital temperature and humidity sensor. It features a humidity sensor and a thermistor that measures the surrounding atmosphere and provides a digital signal on the data pin. It is easy to use but requires more time to locate the data. The output is obtained within 2 seconds [6].

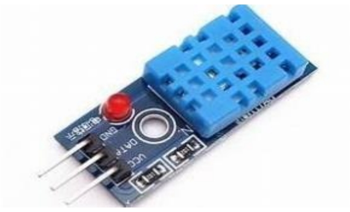


Fig. DHT11

Heart rate sensor:

The MAX30100 is a highly integrated sensor module for monitoring heart rate and pulse oximetry. One compact module house two LED drivers, a photodetector, and signal-processing circuitry. In many medical, fitness, and wearable devices, the MAX30100 sensor module is used to track heart rate and blood oxygen saturation levels. Two LED drivers are used by the MAX30100 sensor module, one for red light and the other for infrared light. Deoxygenated haemoglobin absorbs infrared light while oxygenated haemoglobin absorbs red light. The MAX30100 can determine the oxygen saturation level in the patient's blood by observing the variation in absorption between the two light wavelengths. The MAX30100 can monitor blood oxygen saturation as well as heart rate by identifying the pulsatile component of blood flow. Changes in the amount of light passing through the patient's skin are detected by the sensor module using a photodetector. A pulsatile signal that can be utilised to determine the patient's heart rate is produced as blood flows through blood vessels and alters the amount of light that reaches the

photodetector. The MAX30100 can detect the pulsatile component of blood flow and measure heart rate in addition to blood oxygen saturation monitoring. The amount of light that reaches the photodetector changes as blood flows through the blood vessels, resulting in a pulsatile signal that can be used to determine the patient's heart rate. The patient may be having a respiratory episode if there are changes in heart rate.

Fig. MAX100 Sensor

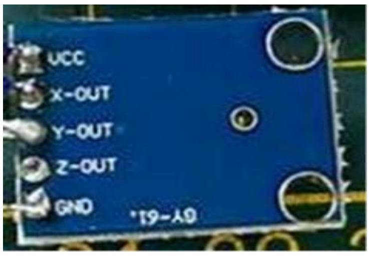
d) LCD

Easy to interface with microcontrollers like Arduino, Low power consumption, perfect for battery-powered projects, Simple to program for basic text/output display.

Fig. 6 Example of LCD

e) ACCELEROMETER SENSOR

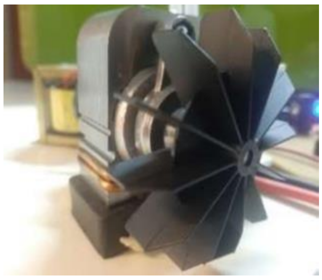
Accelerometer sensors can be used to track body movements and breathing effort when monitoring sleep apnea. An accelerometer can be used to measure variations in acceleration brought on by the movement of the chest or abdomen while breathing. This allows for the detection of respiratory effort. Monitoring changes in acceleration can also be used to identify body movements like turning over or getting out of bed.Low noise floors and great sensitivity to minute changes in acceleration are common characteristics of accelerometer sensors used for sleep apnea monitoring. They can be set up to filter out higher frequency noise from sources like ambient vibration, which is often designed to function at low frequencies like the range of human breathing and body motions.



Fig, Accelerometer sensor

C. COMPRESSOR

A compressor is a mechanical device is shown in fig. that raises the pressure of a gas or vapour in order to decrease the volume of the gas or vapour. It is frequently utilised in industrial and commercial contexts for a variety of purposes, including gas compression, air conditioning, refrigeration, and the operation of pneumatic tools. the compressor in a sleep apnea machine is in charge of producing a constant flow of pressurized air that aids in maintaining the airway open while you sleep. This component is vital to the CPAP therapy's efficiency and is important in assisting individuals with sleep apnea in getting uninterrupted, deep sleep during the night. A mask that the patient wears over their face. By keeping the airway open throughout sleep, this air flow helps to avoid breathing pauses.



Fig, Compressor

ARDUINO SOFTWARE

The Arduino IDE which is abbreviated as Arduino Integrated Development Environment is a software tool which is used to write and upload code to different Arduino boards. This software consists of various inbuilt libraries that contain necessary functions that make programming easy. It also has a great feature which makes it convenient to debug errors and troubleshoot problems.

The NodeMCU can also be programmed using Arduino IDE by installing the libraries required and choosing ESP8266 NodeMCU in the Board Manager Option. The NodeMCU microcontroller is programmed using embedded C language [8].

D. FIREBASE

Firebase is one of the cloud platform that is used to collect data in real time. Firebase works with the most popular platforms like Arduino, ESP8266 and

Raspberry Pi. It has a powerful API. It allows the user to send and view data in the cloud. If the threshold from the data is found correctly, there are options to set triggers. Data can be instantly updated to the cloud every 1 second, allowing real-time data monitoring. It is built on rails and nodes on Ruby. The dashboard in IO allows the user to allow different feeds in different formats of his choice. Data received from the gas sensor is transmitted to this cloud platform.

IV. WORKING This paper aims to reduce the risk of asthma by providing a compact and portable device along with an android app that provides continuous precautions to the patients whenever required. The hardware consists of different sensors like the gas sensor to detect the hazardous gases in the atmosphere, a temperature sensor to sense the temperature, a humidity sensor to sense the changes in the climate, a pulse sensor to detect the heart rate as well as the oxygen level in the blood, a GPS module to track the location of the user and also to identify the polluted area this information is updated to the government as well as to the cloud and a Wi-Fi module is used to upload the values of the sensor to the cloud. All the values from these sensors are uploaded to the cloud, and rapid changes in these values are altered to the patients via an android app. The premium step in the android app is to properly register the personal details of the user, and then it is continued with asthma and trigger symptom test which consists of a number of questions to test the symptom of asthma before consulting a doctor. If the test comes out to true then two options are provided, consult the doctor or to take the test again. The regular precautions are instantly given to the specific user by accurately comparing the specific health conditions as well as environmental conditions. The user's health condition is regularly monitored and updated in the database for subsequent reference. In the case of a critical situation, the app has an enhanced feature to call the doctor or a family member. The device is compact and portable which can be used by asthma patients as well as by an ordinary user. The personal app is userfriendly and encourages the user to take care of their health and take precautions in severe conditions which naturally make them selfdependent and asthmatics will be able to remedy before getting an asthma attack.

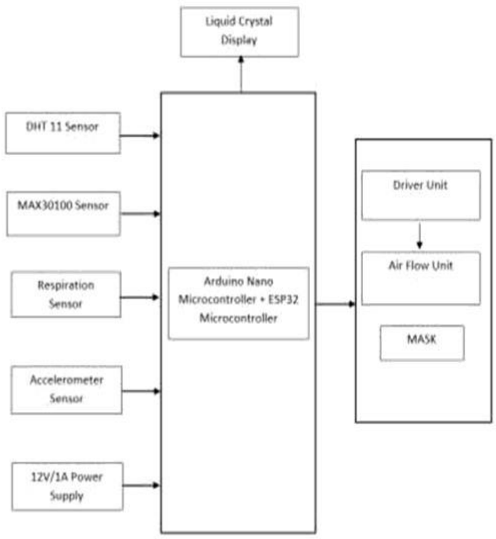


Fig. Basic Block Diagram of Prototype

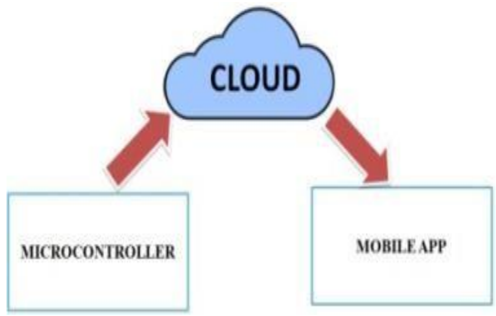


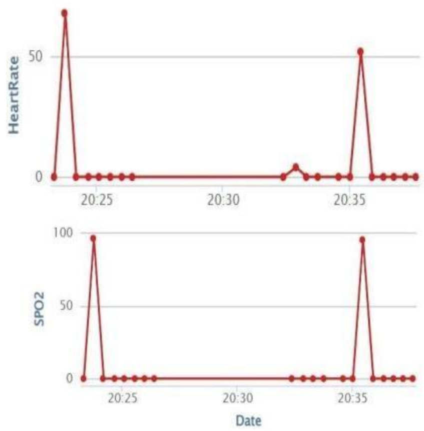
Fig.Basic Overview

IV. RESULTS

The sensors were able to gather information on a variety of factors, including heart rate, temperature, mobility, and respiration rate, which were then shown in real-time on the LCD display .patient received continuous positive airway pressure (CPAP) from the compressor, which helped maintain their airways open and enhanced breathing as they slept. The ThingSpeak app was able to gather and process the sensor data, creating a graphical depiction of the patient's sleep metrics and patterns. This made it possible for doctors to keep track of the patient's development and modify their treatment plans as necessary. Patients may select between automated and manual control of the CPAP equipment thanks to the usage of an automatic and manual mode switch, which allowed for flexibility in the management of sleep apnea. The patient's general health and well-being have been improved by this personalized approach to sleep apnea care, which assisted in the detection and prevention of sleep apnea.

Fig. Basic Prototype

Fig. Graphical representation of SpO2



Fig, Graphical representation of Snoring

VI.CONCLUSION

Sleep apnea is a serious disorder that can negatively affect a patient's health and quality of life. To avoid problems and enhance the patient's quality of life, it is critical to adequately recognize and manage the illness. Continuous monitoring of multiple parameters, including heart rate, temperature, acceleration, and respiration rate, is provided by this device. The severity of the problem can be determined using this comprehensive method, and personal treatment programs can be developed to properly control the symptoms. It has been demonstrated that using a CPAP machine may reduce the severity of sleep apnea symptoms, including snoring and daytime tiredness, and enhance the patient's quality of life. A complete and efficient method of managing sleep apnea is made possible by the use of a device that includes a compressor, a number of sensors, and the ThingSpeak app. The tool can considerably enhance the patient's general health and well-being by identifying and preventing sleep apnea.

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