International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

IoT-Based Sleep Apnea Monitoring System

Mrs. N. Radha[1], Mr. K. Reogar[2], Kodesh. G[3], Mohan. A[4]

[1,2,3,4]Department of Biomedical Engineering, Sri Manakula Vinayagar Engineering College

ABSTRACT---

Sleep is a crucial and necessary for human's life and health that aids in renewing and recharging the body and mind of a human. Every person's lifestyle, including preventing different diseases, depends greatly on the quality of their sleep. A number of people have struggled with poor sleep for a very long time. Various sleeping disorders, including sleep apnea, are experienced by people with a variety of illnesses. Due to the uneven body changes that occur while sleeping, many individuals pass away. A real-time sleep apnea monitoring device built on IoT created as a solution to this issue. Through a smartphone application, it will be possible for the US to monitor various sleep indexes and alert them when anything unusual happens. Throughout the entire sleeping time, the system can measure anyone's electrocardiogram (ECG), Gyro Sensor, Sound Sensor, and SpO2 thanks to its numerous sensors. This study is very helpful because it uses a Bluetooth module to simultaneously display the sleep indexes in a mobile application and measure them without waking the subject. Every type of person can use the system because it has been designed in such a manner. To assess various aspects of the sleep factor, the Arduino UNO is used in conjunction with a number of analog sensors. On various people's bodies, the system was investigated and tested. They are shown in the mobile application and on the monitor of the Arduino boards. In some of the individuals the system monitored, sleep apnea can be found through analysis of the data obtained.

Keywords*- Sleep Apnea, Arduino UNO, ECG, Heart rate, SpO2*

I. INTRODUCTION

Breathing repeatedly pauses and begins during sleep, which is known as sleep apnea. Apnea of Prematurity (AOP) is a condition in which premature infants (the delivery of a baby before 37 weeks, rather than the customary 40 weeks.) stop breathing for 15 to 20 seconds during sleep. Apnea is classified into three namely Obstructive, Central & Mixed Sleep Apnea. In this chapter we will discuss about the improvements of the existing models to make easier to access, here we come up with a novel idea of developing wireless infant sleep apnea detection and stimulation system. The wireless model will be simple to use, reduce infant infection risk, infant discomfort risk, infant failure risk, improve mobility, and reduce cost of care delivery.

II. LITERATURE SURVEY

Daniel Thomas White explained about the Three different types of apnea Central sleep apnea, mixed sleep apnea, and obstructive sleep apnea occurring in infants and adults. This paper also explains about the causes of apnea occurring in the premature infants which is known as the Apnea of Prematurity. They explained that if an infant is experiencing apneic event, they are diagnosed for slower heart rate, cyanosis and if there is any blockage in the airway. The paper gave a brief note on the contact monitors used in the apnea detection processes which includes the pulse oximeters, movement sensors, thoracic impedance monitors, respiratory inductive Plethysmography. The non-contact monitors are Doppler Radar Technology, Pressure sensor radar maps built into the mattress of the infant, imaging technology by the use of environmental sensors. They 11 mentioned that the developed device should not have contact with the human body in order to prevent the risk of infections for the infants. Alarm should also be added to the system and when an apnea event is detected the alarm sound is made to alert the caretaker to intervene. The emitting sound of the alarm should be at 80 decibels or above. This main purpose of the system to be developed is that it should be installed easily at home. They explained the way for analysing the temperature using the thermal imaging technique and the infrared thermometers. The paper gave a clear explanation that sound of the breathing changes can also be used in the detection of the apnea event using microphones or any type of software. This paper gave a clear note on the sensors to be used for physical orientation changes of the chest region during inspiration and expiration process, detection of bioelectrical signals, how the lung delivers oxygen to the cells of the body which indicates the blood oxygen level of the body. They also had a selected approach on the system. The selection approach they suggested for the software system is LabVIEW software. Here in this paper, they listed out the components which are efficient in the detection of the apnea event.

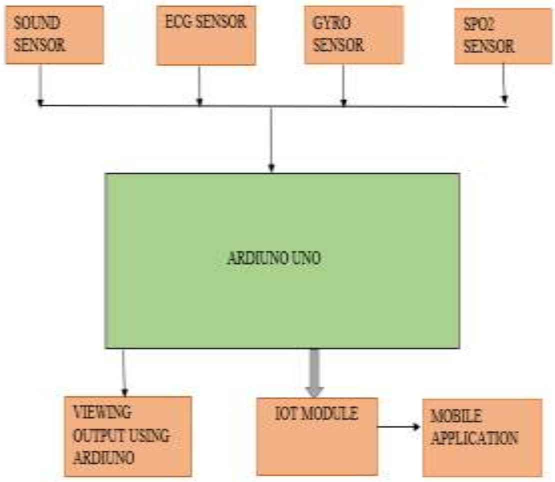
S. Mishra, R. Agarwal, M.Jeevasankar, R Aggarwal, A.K. Deorari, and V.K. Paul made a perceptive on managing apnea in new-born infants. In neonatal infants the apnea is caused due to the immature central nervous system. The Methylxanthines and Coronary Positive Airway Pressure (CPAP) forms the pillars in the therapeutic curing of apnea in the newborns. The apnea event occurring in premature infants needs either pharmacological or ventilator support in the infants who have repeated apneic episodes. They ensured that there are 2 causes of apnea, of which the first one is the AOP and second one is the secondary causes. The infants who are delivered before 34 weeks of gestation should be observed till there is absence of apneic event. The apnea monitors mentioned in this paper is the movement sensors, thoracic impedance based on monitors, pulse oximeters. 12 The emergency treatments given to the infants are giving tactile stimulation, provide oxygen to the infants if they are hypoxic, if the above-mentioned treatments do not work then ventilation with bag and mask (BMV) is done. If this BMV also fails to work, then positive pressure ventilation is provided to the infants. They gave the general measures to be taken if the apnea event is detected. Some of the specific measures includes the CPAP, mechanical ventilation, kinesthetic stimulation. They also recommended continuing the methyl xanthine medication if the apnea episodes persisted even after 34 weeks of pregnancy. The SIDS infants (2-4%) may also have AOP but of less in number.

Lauren Jean West [3] focused on how exhaled CO2 is used to detect the occurrence of apnea event. Infant death is mainly due to infant sleep apnea, sudden infant death syndrome (SIDS), or other pre-existing conditions. A proper monitoring of the infants with these diseases should be done in-order to reduce the death rate. The main aim of this project is to develop a monitor for apnea detection with the help of respiratory signals and sound signals that is audio detection of breathing patterns without any contact with the body of the infant which serves as the main advantage that is there is no need of wire being attached to the infant. The CO2 sensor used in the system design is made of the Vernier sensor DAQ, the Vernier CO2 sensor and the USB fan. The software used in this system is the LabVIEW and it is run on a Netbook. The hardware setup for this system is two microphones (unidirectional-pointed towards the infant and Omni-directional is pointed away from the infant), a dual USB audio interface and preamplifier. When the testing was done overnight and for infant, the breathing pattern results were correct with less than one feet of distance from the infant and showed false results when exceeding one foot distance. Future scope is to increase the standoff distance greater than one foot.

III. PROPOSED SYSTEM :

The proposed model needs some hardware and software components. Hardware components are those which can be fixed inside or outside of this. The sensors we are using here are the examples of hardware components. These components are able to touch and we can feel it. In order to make these hardware components we need some to program codes which is generally called as software. These are used to control the working of hardware components. The primary objective is to track a patient with sleeping abnormalities' whole sleeping duration and sleeping disorder. The IOT based sleep apnea monitoring system comprises three sections. The main section is a IOT which connects the input section and output section. Four different sensors are combined in the input section to allow the Arduino UNO to receive an analog signal, which it will use to gauge the various phases of sleep. A mobile application to show the digital data transformed by the Arduino UNO and the serial monitor of the Arduino UNO make up the output conditions, which also combines two distinct components.

IV. BLOCK DIAGRAM



ECG SENSOR

An electrocardiogram (ECG) can be used to determine the heart rate and cadence. It also shows the distinctive difference in heart rate. It can tell you whether you've experienced a myocardial infarction, how your heart is functioning while you're sleeping, and whether it has grown larger in any manner as a result of high blood pressure.

SPO2 SENSOR

The blood oxygen concentration refers to how much oxygen is circulating inside the blood. A healthy body and an ill body can be distinguished by the way oxygen moves throughout them. The blood oxygen level, also known as the oxygen saturation level, represents how equally oxygen is distributed all over the body, from the lungs to the cells. Lung conditions are one of the major causes of low oxygen saturation. Breathing problems can cause low oxygen levels, which impair the body's ability to operate. SpO2 levels in a patient with sleep apnea are usually lower than average, hovering around 90%. Low SpO2 may cause hypoxemia. It also indicates chronic lung disease.

GYRO SENSOR

The term "emotional arousal" refers to changes in sweat duct activity that are a reflection of our emotional state. These changes are referred to as the "galvanic skin response," or GSR. It represents the body's electrodermal action. It happens when the autonomic nervous system triggers sweat glands in the epidermis. At various periods of the day, the skin reacts in different ways. Additionally, it varies based on a person's mental condition. Compared to someone who is happy, a person who is stressed out typically has a lower skin reaction. Additionally, while sleeping, the GSR number typically drops. Skin response is affected by sweating palms as well. Excessive sweating is one of the most prevalent side effects of hypertension. It demonstrates how the value of skin reaction is diminished.

SOUND SENSOR

Whether mechanical, electromechanical, or piezoelectric, a buzzer or beeper is an audio signaling instrument. Alarm clocks, timers, and human input confirmation, like a mouse click or keystroke, are among the common applications for buzzers and beepers. An electronic gadget that frequently makes music is a piezo buzzer. It can be used in a variety of applications, such as call bells, computers, and car or truck reversing indicators, thanks to its light weight, simple construction, and cheapcost.

ARDUINO-UNO

A microcontroller device called Arduino Uno was created by the Arduino Team. The same Atmega328 microprocessor that is used in the Arduino Uno is also used in the Arduino UNO. Due to its small size and flexibility, it has a broad range of applications and is a significant microcontroller board. Using a mini-USB port on the board, this device can receive 6 to 20 volts of power.

16×2 LCD DISPLAY

A liquid crystal display (LCD) is a type of electronic display module which generates a visual picture. The very simple 162 LCD display module is frequently employed in circuits and do-it-yourself projects. The 162 represents a display with 16 letters per line across two lines. Every letter on the LCD is presented in a matrix of 5 x 7 pixels.

V. CONCLUSION

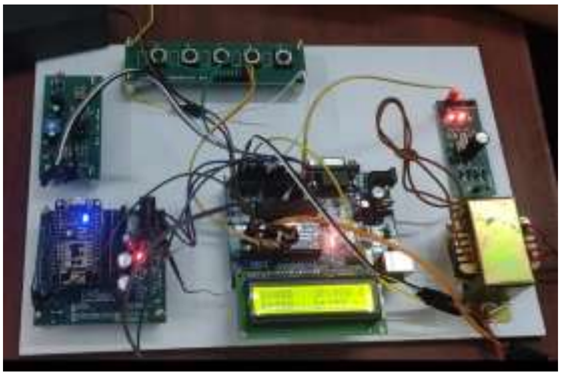
This study demonstrates how IoT gadgets can track sleep apnea. We used some of the most important health-related sensors and a basic microcontroller to build the system. A very basic app development web application was used to build the mobile application. The system provides quite acceptable findings for deciding on sleep apnea after five people were monitored. Two people do not appear to have any signs of any type of sleep apnea, according to the findings. One person who is in the age group of 36 to 50 has significant sleep-related problems. For that particular individual, the system effectively detects sleep apnea. Additionally, the system can identify obstructive sleep apnea in an individual. The individual who is 50 years or older is definitely a patient with OSA, according to the results analysis. This type of monitoring will enable individuals to identify sleep apnea early on. This study can therefore assist people in learning about sleep apnea, how to recognize it, and in getting rid of all of their sleeping issues.

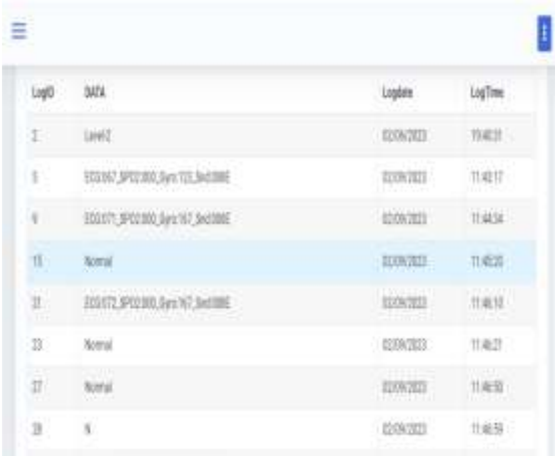
More people than ever are experiencing insomnia disorders today. A growing number of individuals experience sleep apnea due to heart disease, hypertension, and stress-related illnesses. For the purpose of tracking sleep apnea and precisely determining its duration, our technology will be much more durable. At a higher level, that mechanism is self-sustaining. Patients' lives may be made easier by the fact that it not only recognizes sleep apnea but also alerts the patient to review the system's data with the doctor.

In the majority of studies, sleep apnea is measured or tracked using ECG data as well as other information. In a hospital setting, the majority were being monitored by medical personnel. Our product, however, will make it possible for patients to work at home comfortably and with even superior results. Real-time data will provide instant reports on apnea indexes so that patients can take preventative measures. The fact that our device sends notification data to the patient's concerned person, who can then handle any problems that may arise at any time, is an additional advantage for elderly people and those who are physically or mentally disabled. With this real-time data, we will further attempt to create our own dataset and use a variety of machine learning models to evaluate it. Using this real-time data, we will try to build our own dataset and then evaluate it employing various kinds of machine learning algorithms in order to evaluate the whole thing and how our system can function with greater efficiency. Technology unquestionably makes it possible to live a healthy, sound existence free of sleeping disorders.

VI. RESULT AND DESCRIPSION

After the device completed monitoring the parameters, the results are shown in the Wifi-IOT logs. The results are shown as level 1, level 2 or normal based on the variations in the parameters.





VII. REFERENCES

[1] T. Kasai,"Sleep apnea and heart failure,"Journal of Cardiology, vol. 60, no. 2, pp. 78–85, 2012.

[2] J. Jin and E. Sánchez-Sinencio, "A home sleep apnea screening device with time-domain signal processing and autonomous scoring capability," IEEE Transactions on Biomedical Circuits and Systems, vol. 9, no. 1, pp. 96–104, 2015.

[3] A. Malhotra and D. P. White,"Obstructive sleep apnoea," Lancet, vol. 360, no. 9328, pp. 237–245, 2002.

[4] J. Crow, "Sleep Apnea Statistics. Rest Right Mattress," https:// restrightmattress.com/sleep-apnea-statistics/.

[5] M. Rakicevic, 31 Important Sleep Apnea Statistics You Should Know in 2021, Disturbmenothttps://disturbmenot.co/sleepapnea-statistics.

[6] R. Boneberg, A. Pardun, L. Hannemann et al., "High plasma cystine levels are associated with blood pressure and reversed by CPAP in patients with obstructive sleep apnea," Journal of Clinical Medicine, vol. 10, no. 7, p. 1387, 2021.

[7] G. Cay and K. Mankodiya, "SleepSmart: smart mattress integrated with e-textiles and IoT functions for sleep apnea management," in 2020 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops), pp. 1-2, Austin, USA, 2020.

[8] I. Sadek, E. Seet, J. Biswas, B. Abdulrazak, and M. Mokhtari, "Nonintrusive vital signs monitoring for sleep apnea patients: a preliminary study," IEEE Access, vol. 6, pp. 2506–2514, 2018.

[9] Su Hwan Hwang, Hong Ji Lee, Hee Nam Yoon et al., "Unconstrained sleep apnea monitoring using polyvinylidene fluoride film-based sensor," IEEE Transactions on Biomedical Engineering, vol. 61, no. 7, pp. 2125–2134, 2014.

[10] T. Penzel, M. Glos, I. Fietze, S. Herberger, and G. Pillar, "Distinguish obstructive and central sleep apnea by portable peripheral arterial tonometry," in 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), pp. 2780–2783, Montreal, QC, Canada, 2020.

[11] D. Falie and M. Ichim, "Sleep monitoring and sleep apnea event detection using a 3D camera," in 2010 8th International Conference on Communications, pp. 177–180, Bucharest, Romania, 2010.

[12] E. Dafna, A. Tarasiuk, and Y. Zigel, "Sleep-quality assessment from full night audio recordings of sleep apnea patients," in 2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society, pp. 3660–3663, San Diego, CA, USA, 2012.

[13] T. Reza, S. B. A. Shoilee, S. M. Akhand, and M. M. Khan, "Development of android based pulse monitoring system," in 2017 Second International Conference on Electrical, Computer and Communication Technologies (ICECCT), pp. 1–7, Coimbatore, India, 2017