Chapter 9

Smart Sleep Apnea Monitoring Device

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Abstract

Sleep apnea is a serious sleep disorder in which breathing repeatedly stops and starts again. The risk factors include age and obesity. The sleep disorder is associated with a medical disorder where the normal sleeping pattern of the person is disturbed. The common sleep disorder is sleep apnea. Sleep apnea has different types. Obstructive sleep apnea is the most common form that occurs when throat muscles relax, whereas Central sleep apnea occurs when the brain doesn't send proper signals to the muscles that control breathing. About 1 billion people worldwide suffer from sleep apnea disorder, and the age group of above 40 years old is affected by this disorder. Sleep apnea symptoms are loud snoring, morning headache, irritability, and gasping for air during sleep. It rarely occurs in men for 20-44years old and mostly affects in men for 45-64 years old. The existing sleep apnea devices are costly and not very user-friendly. The proposed proposal is designed to monitor heart rate detection. It is very comfortable for patients, and the design is compact and can be used for infants, as well as the graphical output can be continuously monitored through a computer screen or LCD.

Keywords: Sleep apnea; snoring; sleeping disorders; breathing; heart rate monitor

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1. Introduction

Sleep disorder is associated with a medical disorder where the normal sleeping pattern of the person is disturbed. Some sleeping disorders may lead to serious problems in physical, mental, social health. Some of the common types of sleep disorders are sleep apnea, narcolepsy, jetlag, sleepwalking, Sleep paralysis. The general factors that cause sleep disorders are physical, mental and environment and psychiatric problems and other factors such as genetics, night shift duty, Medicines and aging. Sleep apnea types are Obstructive sleep apnea, the more common form that occurs when throat muscles relax. Central sleep apnea, which occurs when your brain doesn't send proper signals to the muscles that control breathing about 1 billion people suffer from sleep apnea disorder and above 40 age is affected for this sleep apnea disorders. Sleep apnea symptoms are loud snoring, morning headache, irritability, gasping for air during sleep. The risk factors are acute stroke, neurological problems, congestive heart failure etc. This sleep apnea disorder may be lethal if it is untreated. prevalence of obstructive sleep apnea disorder is 2.4% to 4.96% in men and 1% to 2% in women in the Indian subcontinent.

2. LITERATURE SURVEY

A. Christian Rotariu, et.al (2016) designed continuous respiratory monitoring device for detection of sleep apnea episodes. In this proposed device architecture includes piezoelectric thoracic belt attached to the patient's chest and used to measure respiratory signal. Signal conditioning contains op-amp and it contain arduino atmega 32. Tablet pc is used to display the signal [1]

B. Santhoshini Arulvallal, et.al (2019) design and development of wearable device for continuous monitoring of sleep apnea disorder. In this paper they could detect heart rate, spo2 sensors are connected to arduino. Liquid crystal screen is used to show these parameters. Measure parameters are transferred from the device to smart phone through Bluetooth [2].

C. Hongxu Zhu1,et.al(2018) development of Sleep apnea monitoring for smart health care .In this paper a new classifier designed for sleep stage classification among awake , light sleep , deep sleep .A new kernel is designed is used for sleep apnea classification .In this paper new support vector machine proposed for sleep apnea assessment .They find the average distribution of sleep stages for normal people and sleep apnea patients and they mainly take two

3. **METHODOLOGY**

The proposed method has been designed for detection of sleep apnea continuously. The proposed proposal has to monitor heart rate and respiration rate using accelerometer sensor. It is very comfortable for patients and the design is compact and can be used for infants as well as the graphical output can be continuously monitored through a computer screen or LCD display.

3. Block Diagram

The working methodology of smart sleep apnea monitoring device was explained in the block diagram. The heart rate and respiration values were obtained from the subjects using ky052 and sensor respectively. The microcontroller Arduino UNO is programmed to display the values of the parameters such as heart rate, respiration rate and accelerometer sensor rate in the personal computer.

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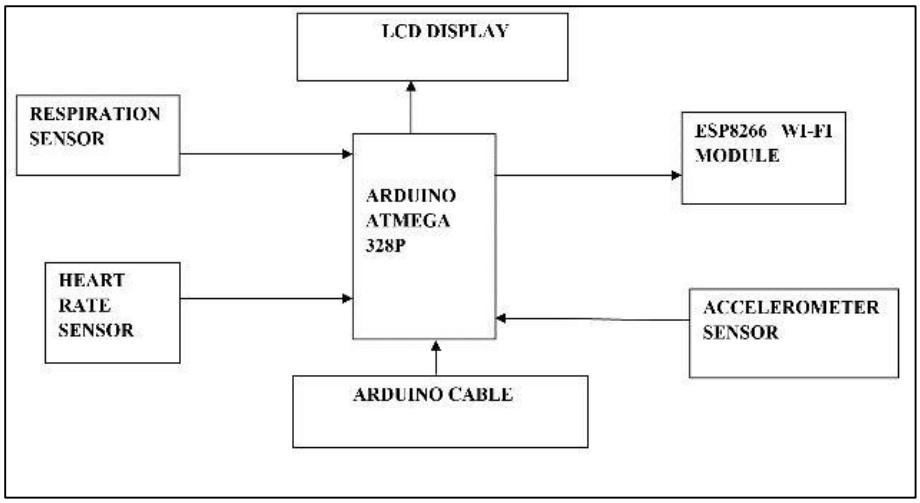

Fig.1. Block diagram

Arduino

Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open-source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a booloader that executes on the microcontroller

Microcontroller ATmega328 has operating voltage of 5V, its recommended input voltage is 7-12V, input voltage limits are 620V, flash memory is 32 KB, SRAM is 2KB, clock speed is 16MHz.

Heart Rate Sensor: Ky05

The sensor is made to shine an infrared led through your finger. The infrared sensor on the other side can then pick up slight changes in the light transmittance through your finger when blood is pumped in. When the sensor senses light, it becomes more resistant, causing the voltage reading in the serial monitor to go down. However, if your sensor is anything like mine, the LED is not bright enough to be detected by the sensor even when nothing is obstructing it, so the

sensor constantly reads 5v. I tried replacing the LED with a stronger one and got slightly better results, but I don't think the sensor itself is sensitive enough to be able to detect a heartbeat over random noise and movements. The sensor is a simple 3-pinned analog sensor. Plug the ground in the -, the 5v to the middle pin and A0 to the S pin.

Accelerometer Sensor:GY521

Accelerometer sensor is used for motion processing in sleeping time. Internal Digital Motion Processing™ (DMP™) engine supports 3D Motion Processing and gesture recognition algorithms. The MPU-60X0 collects gyroscope and accelerometer data while synchronizing data sampling at a user defined rate. The total dataset obtained by the MPU-60X0 includes 3-Axis gyroscope data, 3Axis accelerometer data, and temperature data. The MPU's calculated output to the system processor can also include heading data from a digital 3-axis third party magnetometer. The FIFO buffers the complete data set, reducing timing requirements on the system processor by allowing the processor burst read the FIFO data. After burst reading the FIFO data, the system processor can save power by entering a low-power sleep mode while the MPU collects more data

Respiration Sensor: LM358

LM358 is a dual op-amp IC integrated with two op-amps powered by a common power supply. It can be considered as one half of LM324 Quad op-amp which contains four op-amps with common power supply. The differential input voltage range can be equal to that of power supply voltage. The typical supply current is 500uA independent of the supply voltage range and a maximum current of 700uA. The operating temperature ranges from 0˚C to 70˚C

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Esp8266 Wi-Fi Module:

ESP8266 is Wi-Fi enabled system on chip (SoC) module developed by Es press if system. It is mostly used for development of IoT (Internet of Things) embedded applications.

6. RESULT AND DISCUSSION

The device was tested with the volunteers (normal subjects) and acquired the relevant parameters. The relevant parameters observed more or less meet the accuracy of the same parameters (with normal value) obtained through the polysomnography method. The following tabulation shows the parameters obtained through the test conducted.

S.No	*Sub*	*Gender*	*Age*	*Respiration Rate*	*Heart Rate*	*Sleeping Disturb*
1	Sub1	Male	49	21	78	5
2	Sub2	female	42	30	79	2
3	Sub3	male	24	10	78	0
4	Sub4	male	47	21	74	5
5	Sub5	female	42	10	78	0
6	Sub6	male	57	9	76	8
7	Sub7	female	29	14	85	1
8	Sub8	male	46	18	79	2
9	Sub9	female	35	15	85	0
10	Sub10	male	25	9	76	0

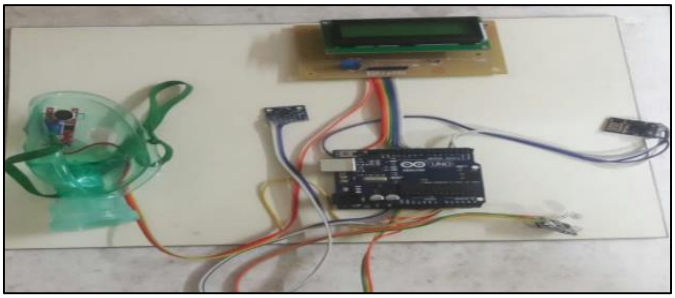

Fig.2. Experimental Setup of Sleep Apnea Monitoring Device

6. SUMMARY AND CONCLUSION

In this proposed study, smart sleep apnea monitoring device was developed which can measure respiration rate, heart rate and movement detection using accelerometer sensor by real time. This monitoring device overcomes the complexities of the other commonly used portable sleep apnea device. The observational values obtained through the device shows high compactness with polysomnography results. This brought the capability of sleep apnea monitoring is a cost-effective, power-efficient manner. The developed device extents the screening capacity of sleep apnea syndrome which can be used for the further treatment process. Sleep apnea monitoring device is portable and designed to be the wearable for continuous monitoring of patients. The parameters such as heart rate, respiration rate and movement detection during sleeping using accelerometer sensor. As a future work, we include CPAP parameter obtained from the prototype device will be transferred to the smart phone by Bluetooth/Wi-Fi using the Wi-Fi module for the further analysis.

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