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Sleep Apnea Monitoring Using Arduino

Vishal Ashok Kale, Sunil Kharade, Vrushabh Patil, Ganesh Ransing, Prof. Sudhir N Divekar
Department of Electronics & Telecommunication Engineering, HSBPVT'S GOI Parikrama College of Engineering Kashti, Maharashtra, India

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ABSTRACT

Sleep apnea cannot be diagnosed by the doctor and usually even the patient will not know that he is affected by this disease, so designing a device that can help the doctor to diagnose the sleep apnea is very important. The aim of our project is to designee a device that help the doctor to diagnose the sleep apnea and to alarm the patient and his family when the obstruction of the airways become so saver using a buzzer and LEDs. The device will contain 4 sensors; force sensor for monitoring the chest movement, temperature sensor for measuring the temperature, oximeter to measure the oxygen saturation, and accelerometer to monitor the patient position, these parameters will be displayed on the screen. And if there are any abnormal readings the alarm will turn on.

Keywords: Sleep Apnea, Sensors, Alarm

I. INTRODUCTION

There are many common respiratory diseases in the world like Pneumonia, Tuberculosis, HAY, fever, Asthma , Chronic obstructive pulmonary disease (COPD), Sleep apnea syndrome , Trachea infections, ...etc.) in which leads to death. The symptoms of some of these diseases can be a common phenomenon among the people like snoring and they are not considering it as much as a source of discomfort. But medically, in fact we consider it as a disease caused by a blockage of the airway. If you suffer from snoring or exposed to continuous sleep during the day, you are most likely to suffer from "Sleep apnea syndrome". It lacks early or appropriate diagnosis and that's why it's known as "hidden disease", when the cessations in breathing occurs several times an hour during night it will cause great pressure on the brain and heart even medical problems will begin to arise such as hypertension, arrhythmia, life expectancy and fatigue during the day. Hence the early diagnosis and treatment will help the sufferers to improve their quality of sleep and quality of life. In our project we will shed light onpatients who already have sleep apnea by observing their sleep states and development of the disorder from normal phases into danger phases to avoid any problems leading to death or disturbance. By building and designing an electronic model that diagnosis apnea in continuous manner especially in times of sleep, it will be placed on the patient chest dependingon measuring many vital signs/parameters such as sensing chest movement (heartbeat), oxygen saturation by pulse oximeter which is affected by breathing rate, and monitoring the temperature and humidity of the patient by using special sensors also

use it and design their own ventilator, even at the small scale.

II. Block Diagram

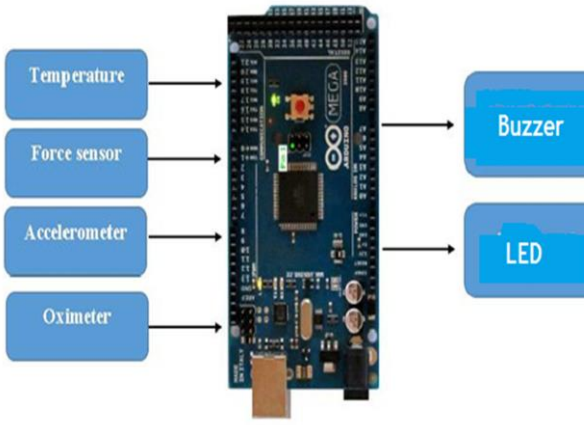


Fig 1. Block Diagram of System

2.1) BLOCK DIAGRAM DISCRIPTION:

The Arduino based on consists of six section namely power supply, sensing unit, Arduino, LCD display, stepper motor. The sensors sense parameter and give output to the Arduino will compare with standard value and output given to the display.

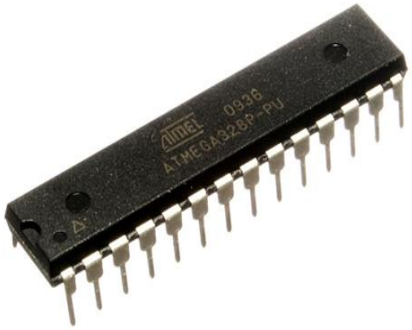
Arduino decodes the receive signal .LCD is provided for observing the parameters output signals.

2.2) HARDWARE REQUIRED

1. Arduino IC
2. Power Supply
3. Sensing Unit
5. Connecting Wires
6. Buzzer
7. led

III. HARDWARE DISCRIPTION

Atmega controller - The ATmega328 is a single-chip microcontroller created by Atmel in the megaAVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC procThe ATmega328 is a single-chip microcontroller created by Atmel in the megaAVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC processor core.



Features:

- High performance, low power AVR® 8-bit microcontroller
- Advanced RISC architecture
- 131 powerful instructions – most single clock cycle execution
- 32 8 general purpose working registers
- Fully static operation
- Up to 16MIPS throughput at 16MHz
- On-chip 2-cycle multiplier
- High endurance non-volatile memory segments
- 32K bytes of in-system self-programmable flash program memory
- 1Kbytes EEPROM
- 2Kbytes internal SRAM
- Write/erase cycles: 10,000 flash/100,000 EEPROM

Peripheral features

- Two 8-bit Timer/Counters with separate prescaler and compare mode
- One 16-bit Timer/Counter with separate prescaler, compare mode, and capture mode
- Real time counters with separate oscillator

- Temperature measurement
- Programmable serial USART
- Master/slave SPI serial interface
- Programmable watchdog timer with separate on-chip oscillator
- On-chip analog comparator
- Special microcontroller features
- External and internal interrupt sources
- Six sleep modes: Idle, ADC noise reduction, power-save, power-down, standby, and extended standby
- I/O and packages:
- 23 programmable I/O lines
- 32-lead TQFP, and 32-pad QFN/MLF
- Operating voltage:
- 2.7V to 5.5V for ATmega328P

Temperature range:

- Automotive temperature range: –40°C to +125°C
- Speed grade: 0 to 8MHz at 2.7 to 5.5V (automotive temperature range: –40°C to +125°C)
- 0 to 16MHz at 4.5 to 5.5V (automotive temperature range: –40°C to +125°C)
- Low power consumption
- Active mode: 1.5mA at 3V - 4MHz
- Power-down mode: 1μA at 3V

IV. SENSING UNIT

Blood Oxygen Sensor

All pulse oximeter probes (finger or ear) have light emitting diodes (LEDs) which shine two types of red light through the tissue. The sensor on the other side of the tissue picks up the light that is transferred through the tissues. of arterial blood in the peripheral circulation . When doctors test blood oxygen, they often use sensors on fingers called pulse oximeters. These devices shine light through the skin and nail to detect the colour of the blood as a measure of how much oxygen is there. They produce a measure called SpO2; most healthy people range between 95 percent and 100 percent.

General Description:

The MAX30100 is an integrated pulseoximetry and heart rate 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.

Applications:

a. Wearable Devices
b. Fitness Assistant Devices
c. Medical Monitoring Devices

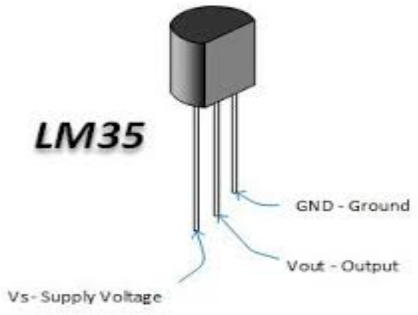
Benefits and Features:

1. Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design
2. Integrated LEDs, Photo Sensor, and High-Performance Analog Front -End
3. Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically Enhanced System-in-Package
4. Ultra-Low-Power Operation Increases Battery Life for Wearable Devices
5. Programmable Sample Rate and LED Current for Power Savings
6. Ultra-Low Shutdown Current (0.7μA, typ)

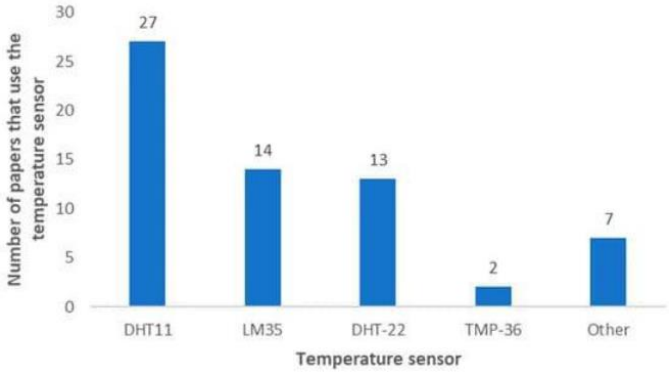
Advanced Functionality Improves Measurement Performance

7. High SNR Provides Robust Motion Artifact Resilience
8. Integrated Ambient Light Cancellation
9. High Sample Rate Capability
10. Fast Data Output Capability

A) Temperature Sensor LM35



The LM35 is precision IC temperature sensor. Output voltage of LM35 is directly proportional to the centigrade/Celsius of temperature. The LM35 does not need external calibration or trimming to provide accurate temperature range. It is very low cost sensor. It has low output impedance and linear output. The operating temperature range for LM35 is -55˚C to +150˚C. With rise in temperature, the output voltage of the sensor increases linearly and the value of voltage is given to the microcontroller which is multiplied by the conversion factor in order to give the value of actual temperature.



LM35 Regulator Features:

- Minimum and Maximum Input Voltage is 35V and -2V respectively. Typically 5V.
  can measure temperature ranging from -55°C to 150°C
- Output voltage is directly proportional (Linear) to temperature (i.e.) there will be a rise of 10mV (0.01V) for every 1°C rise in temperature.
- ±0.5°C Accuracy
- Drain current is less than 60uA
- Low cost temperature sensor
- Small and hence suitable for remote applications
- Available in TO-92, TO-220, TO-CAN and SOIC package

LM35 Temperature Sensor Applications:

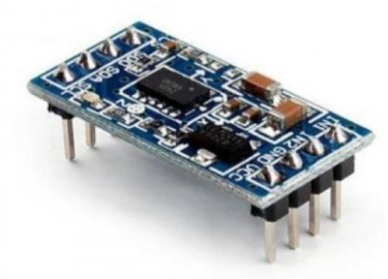
1. Measuring temperature of a particular environment.
2. Providing thermal shutdown for a circuit.
3. Monitoring battery temperature.
4. Measuring temperature for HVAC application.

C) force sensor

The force sensitive resistor (FSR) which uses a strain gage to monitor the chest movement which is an indication for the patient breathing process. The sensor will be placed between patient's chest and the belt to measure the applied pressure of the chest on the strain gage. This sensor uses the voltage division concept which state that the voltage on each resistor in a series connection will be equal to the voltage source, so when the pressure increase on the strain gage (inhalation) its resistance will increase which will lead the voltage on the strain gage to increase, and when this pressure decrease (exhalation) the strain gage resistance decrease will decrease which will make the resistance decrease. We use this type

of sensor because of its high sensitivity, low cost and durability,

B) Accelerometer



An electromechanical device, we used it to measure the acceleration position (inclination/orientation) of the patient in three orthogonal axes (dimensions) during the sleep, it depends on the change of pressure, acceleration and strain of the patient body. The direction of the patient during his sleep may cause breathing disorder. When the patient moves from his side to his back it may cause obstruction in breathing because of gravity and this information can be stored and sent to the doctor And it is important for detecting false readings from the strain gage for when the patient lay on his belly and this will cause the pressure to increases exponentially and by detecting the patient's position we will know whether if our force sensor is working without any problem or if there is false readings in the sensor. That means the accelerometer important to monitor the position of the patient

V. SOFTWARE REQUIREMENT

Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, mac OS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version 2.The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program *argued* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware..

VI. WORKING

Light emitting diodes which are the light source which convert an electrical energy into light; we use it in issuing an alert when the patient's condition changes from moderate to severe. It's easy to be programmed, cost effective and it comes with different types of light colours. It's a device which beeps noise whenever the parameters being measured exceed the normal rates we set. We are using buzzer in our project to alarm the patient's family if there is any problem occurred with the patient while he is sleeping

ADVANTAGES

1. Cheap and affordable when compared with other devices
2. Monitors more than one parameter.
3. Non-invasive.
4. Doesn't need a high voltage.
5. Alarms in severe conditions of the patient
6. Detects sever cases of the disorder

Application

a. Hospitals
b. Clinics
c. First Aid Centers

VII. FUTURE SCOPE

The sleep apena device of the future may not look very different from today, but several features will clearly separate them from the current generation of device.

Nowadays, this evolution is still rapid, with new devices and an increased number of parameter and strategies being introduced to improve outcomes, patient–device interactions, and patient care. Engineering has played and is still playing a relevant role in this process, not only in improving the technical performance of the sleep device but also in contributing to a better understanding of respiratory physiology and pathophysiology, and of how different sleep device strategies interact with the respiratory system.

VIII. CONCLUSION

Sleep apnea is a chronic disease that happens when the muscles in the throat become relaxed and block the air ways passage to the lungs due to gravity. Sleep apnea will affect the patient sleeping quality and it will make him wake several times in the night which will make him tired, sleepy and inactive during the day. Sleep apnea can happen due to relaxing in throat muscles, or it can happen due to neural problems in the brain, or it can be mix between the tow. Sleep apnea is impossible to be diagnosed in the laboratory and the patient himself may not know that he has sleep apnea, so it is important to make a device that monitor the patient sleeping continuously. While making such device its essential to take some points in consideration like temperature, humidity, acceleration, heart rate and chest movements of the patient. Combination these parameters measurements will make us capable to continuously monitor and observe the patient's level of severity related to apnea disease. By the usage of these measurements and observations we can be sure that the patient's condition is under our control so we can deal with any changes occurs to the patients once they're detected. The ability to diagnose such disease will provide a whole new degree of comfort and health assistance for those who are suffering especially from snoring in their sleeping periods. To sum up, appreciating the value of human life will lead us to unlimited range of creativity! and upon that we worked on our idea in order to add something that can affect positively and support the health of our society.

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