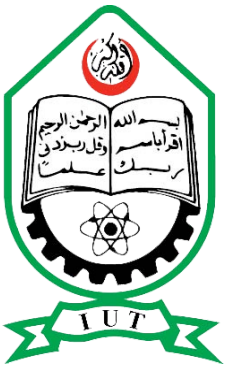
Sleep Quality Analyzer



Embedded System Lab

Team -05

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Table of Contents

Motivation 3

Overview 3

Features 3

Sensor 3

Workflow 6

Future Work 7

User Manual 7

Demonstration 8

Github 8

Motivation

Statistics from the World Sleep Society show that up to 45% of people are affected by disorders such as insomnia, sleep apnoea and narcolepsy, creating an increased demand for home-based sleep monitoring systems. These disorders can be a reason for people not getting enough rest, or having a generally poor quality of sleep, increasing the risk of cardiovascular diseases, high blood pressure, diabetes and stress. However, monitoring sleep can help to diagnose and tackle these problems and with new technologies, this can be done at home. The total amount of sleep, maximum and average heart rate, sleep disturbances and time spent awake, sleep latency, how long it takes to fall asleep and the various stages of sleep, from lighter phases all the way to deeper rapid eye movement (REM) can all be measured during the night to produce a sleep score.

Overview

We developed a Sleep Quality Analyzer that works while we are sleeping and analyzes the quality of it. It also informs us about the sleeping environment. Here we measured the heart beat of the sleeping person. Standard Heart Rate During Sleep: For non REM sleep 60-100 bpm, for REM sleep <60 bpm where REM stands for Rapid Eye Movement. REM sleep is considered as deep sleep.
For understanding the sleeping environment, we measured the lighting condition and room temperature and detected whether there is noise in the environment. Standard Lighting Condition for Sleep: Should be less than 180 lux.
We know that all those attributes (light, temperature, sound) can have an impact on a sleeping person's heart rate hence they might interrupt a quality sleep. Our system also depicts how those attributes can impact one's heart rate. Finally we show the user an overall report of his sleeping time with the maximum heart rate and in the end inform the user how qualityful his/her sleep was.
This will give the user an overall idea whether he/she needs to take any actions regarding this.

Features

- Observe lighting conditions of the environment using an LDR sensor.
- Measure the temperature of the room using LM35 temperature sensor.
- Detect sound of the surroundings Sound Sensor 3.
- Observes the heart rate of a sleeping person Heart Beat Sensor.
- Analyzing the data, gives a report on the quality of sleep of the person.

Sensor

1. Light Dependent Resistor (LDR) :
   The LDR sensor is the abbreviation of the Light Dependent Resistor and as the name implies the resistance of this sensor varies in relation to the intensity of light, greater the intensity of light lower will be resistance of the LDR sensor. It measures the lighting condition in Lux.

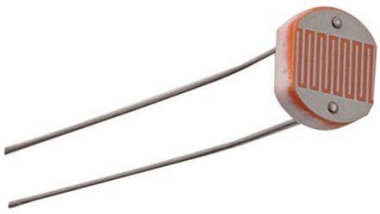


Fig: LDR sensor

2. Temperature Sensor:

   Temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor or signal temperature changes.

   LM35 is a temperature measuring device having an analog output voltage proportional to the temperature. It provides output voltage in Celsius. It does not require any external calibration circuitry.

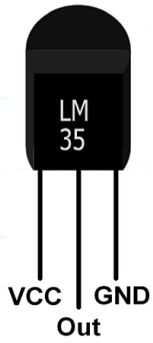


Fig: LM35 temperature sensor

VCC: Supply Voltage (4V – 30V)
Out: It gives analog output voltage which is proportional to the temperature (in degree Celsius)
GND: Ground

3. Heart Beat Sensor :

   Heartbeat Sensor is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat.

Fig: Heart Beat Sensor

For most people, their sleeping heart rate will fall to the lower end of the normal resting heart rate range of 60–100 bpm. In deep sleep, the heart rate may fall below 60 bpm, especially in people who have very low heart rates while awake.

4. Sound Sensor :

The sound sensor is a simple device which can detect the sound. Its output is 1 if it detects any sound otherwise it is 0. The sound sensors are very simple to use.

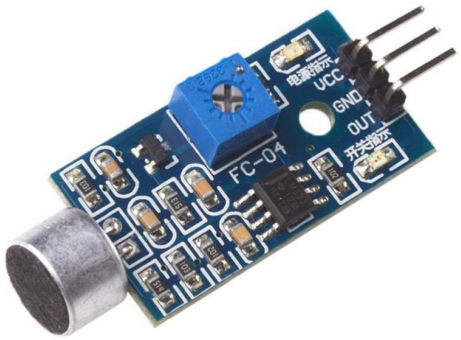


Fig: Sound Sensor

This sensor includes 3 pins and they are:

Pin1 (VCC): 3.3V DC to 5V DC

Pin2 (GND): This is a ground pin

Pin3 (OUT): This is an output pin. It provides high signal when there is no sound and goes LOW and it goes High when sound is detected.

Workflow

To build a sleep quality analyzer we used Proteus simulation tool and for the coding part we used Arduino application.

- First, we use the temperature sensor LM35 to measure the temperature of the room where the person will sleep. For this, we connected pin 3 of the sensor with the Arduino UNO with analog pin A0 and pin 2 with Ground and also added a DC generator U1(+VS) with pin 1 of the sensor.
- Then, to measure the lighting intensity of the room, we connected the LDR sensor with analog pin A2 of Arduino UNO using wires. To detect any noise in the room we used a noise sensor. We connected A2 pin with sound sensor and by changing the logic state HIGH and LOW we produce sound.
- Finally after changing the value of temperature, light intensity and sound, we find out the heart rate. And show it on a virtual terminal. We also give a verdict in the terminal that his/her sleep quality is good or bad analysing his heart rate.

Here is the Design of the project in proteus simulation tool.

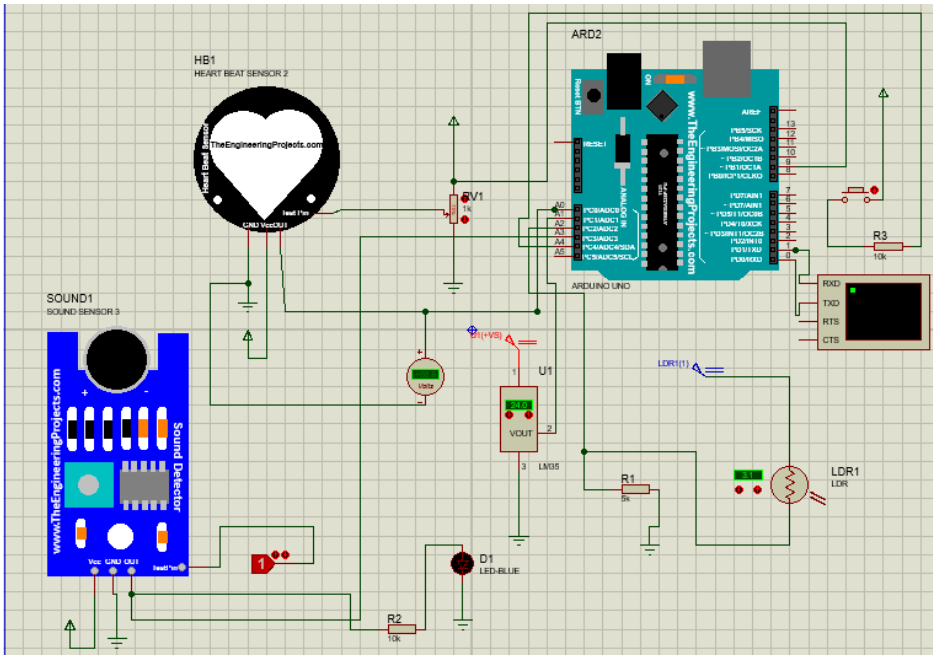


Fig: Design of Sleep Quality Analyzer

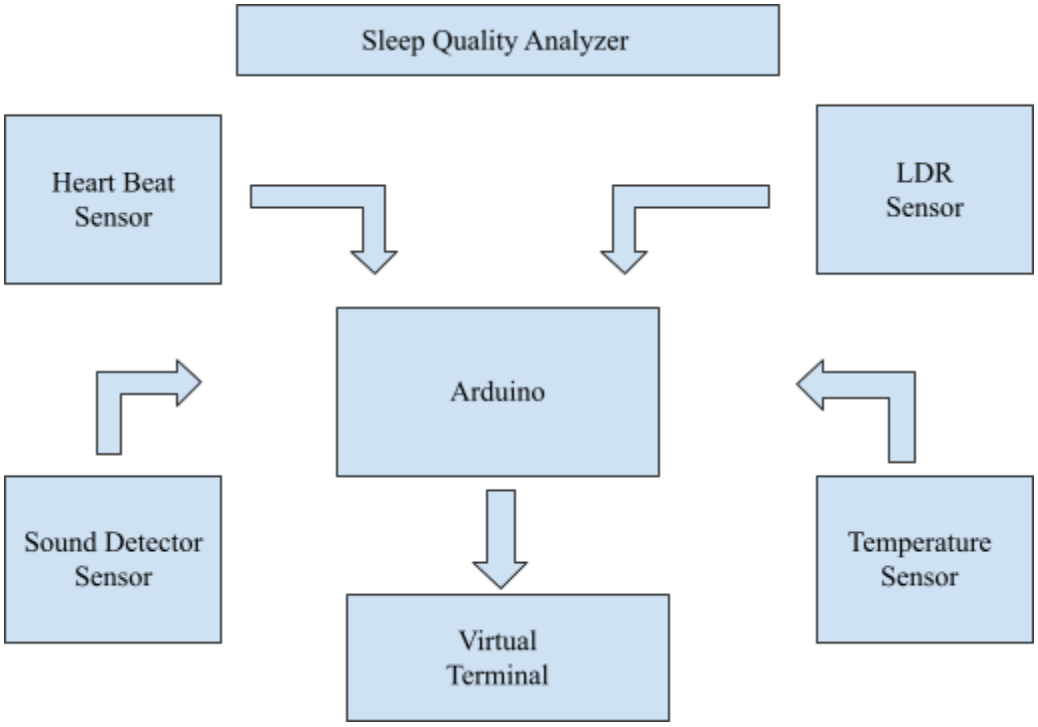


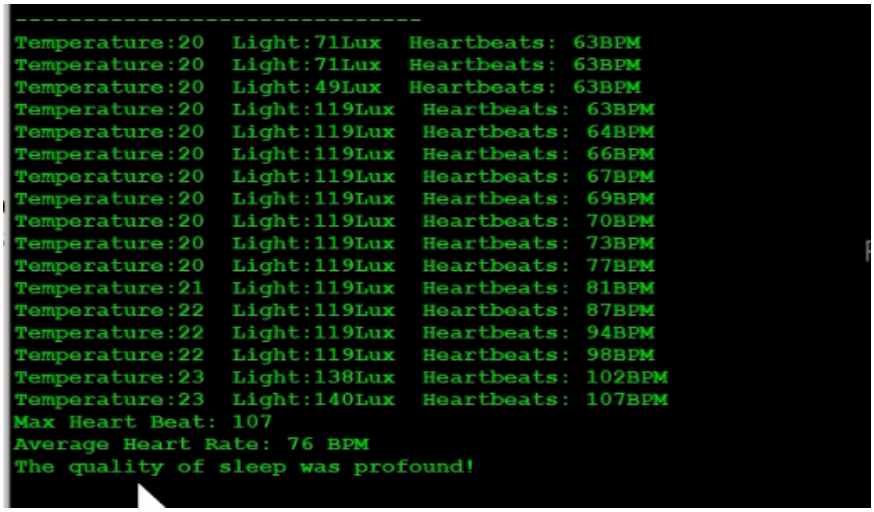
Fig: Workflow of sleep quality analyzer

Future Work

- Implement Hardware of the simulation project.
- Measure Blood pressure, breathing rate of a sleeping person.
- Save the report for future use.

User Manual

1. Firstly, before sleep, the user has to turn on the system using the push button.
2. Then the heart rate sensor will measure the heartbeat of the user which is dependent on other factors such as temperature, sound and lighting conditions of the environment.
3. The temperature sensor, LDR and sound sensor will measure temperature, light and detect sound respectively.
4. After waking up, the user will push the button to stop the sensors from taking inputs and to show the result in output.
5. The result will be displayed on an LCD display. An user can see a table where heartbeat, temperature, sound and lighting condition will be displayed. Also the user can see the maximum and average heartbeat. Based on the average heartbeat, the user can conclude if his/her sleep quality was good or bad.



Here, we can see that a summary of the sleep quality is displayed as a result. The user is also able to see the verdict from which he/she is able to decide if the sleep quality was good or bad.

Demonstration

Video Link:
https://drive.google.com/file/d/1yVy1lOhdTMI3MgDwA4vwxCmnO7Tz0IIU/view?usp=sharing

Github

https://github.com/rizwan19/sleep-quality-analyzer