Sleeping Phase Determination Report

Data Acquisition Technologies and Sensor Network

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1. Summary

The aim of this project is to determine and analyze the sleeping phases of an individual. This analysis is based on factors such as body movement of the individual, temperature, humidity and light of the room. Arduino UNO microcontroller, motion sensors to record state of individual, photoresistor for light recording, temperature and humidity sensor for monitoring ambient heat and moisture, are the components used to build this model. The recorded information was viewed real-time using an Android application connected to the circuit via bluetooth. This data is then stored in a MySQL-PHP database. Thus this health-kit can help understand the optimum values of factors that contribute to sound sleep for an individual.

2. Introduction

In today's hectic lifestyle, sound sleep is of utmost importance for a healthy mind and body. This is due to the fact that during periods of sleep, our body rests and conserves energy, decreasing blood pressure and modulating breathing, heart rate and temperature. Thus, it is a vital component for a productive day ahead. It is proven that our brain restores the memory collected during day preparing ourselves to be active the next day.

Sleep is very important to maintain mental as well as physical health. One fourth of the population which is sleep deprived, suffers from sleeping disorders, depression, disturbed sleep, directly or indirectly affecting their mood, concentration and overall energy. There can be many factors such as health, environment, lifestyle that affect one's sleep pattern. Some of them are explained below [5] :

1) Health: ill health and medication affects sleep leading to irregular sleep and in worst cases it can cause depression.
2) Environment: Environmental factors like temperature, light, humidity of bedroom would also affect our sleep.

Sleep phase has three stages: Light sleep, deep sleep and REM (Random Eye Movement) Time factor distinguishes the above-mentioned stages of sleep. During light sleep, individuals heart rate and body temperature goes down. During deep sleep ,the body repairs itself from previous day activities. REM is a stage where there is increased heart rate and eye movement due to an active state of the brain, basically the time when we dream. It is observed that temperature, movement and humidity play an important role in sleep phase. So, it's essential to monitor these factors as they may differ from person to person in terms of being disturbed (wake) or being unaffected (sleep).
With this in mind, we have built a health kit which measures temperature, humidity, light at an interval of 2seconds and at the same time, records the state of the individual thus helping us understand the sleep phases. The data is recorded and continuously monitored through an online Android application (MIT App Inventor 2) and then stored in a database. This project has been adopted from an online source [1].

3.Procedure

3.1 Components Required:

This health kit was built using Arduino UNO microcontroller along with the following components:

1. Passive-Infrared sensor
2. Photoresistor
3. DHT 11 temperature and humidity sensor
4. Photo-resistor
5. Bluetooth module
6. Resistors
7. Jumper wires
8. Connecting wires
9. Breadboard
10. LED

3.2 Component Description:

1) Passive-Infrared sensor: This sensor detects movement of individuals by capturing the infra-red radiation reflected from the object which falls within its field of view. As it does not emit light of it's own, it is called passive. It is mainly used in security alarms as well as rooms with automatic lighting conditions.[2]

Fig 1: Passive Infrared sensor [4]

2) Photoresistor: It is also called Light Dependent Resistor (LDR) The intensity of light inversely affects the resistance.[2] It is made up of high resistance semiconductor. An important application of photo-resistors is in street lamps. During the daytime, when there is enough sunlight, it will cause the streetlamps to switch-off thus saving energy.

Fig 2: Photoresistor[4]

3) DHT 11 temperature and humidity sensor: It consists of a capacitive humidity sensor and a thermistor to measure the surrounding air and provides an output as a digital signal on the data pin. It is simple to use and captures data every 2 seconds.

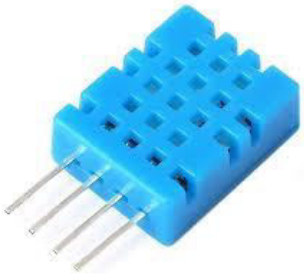

Fig 3: DHT 11 temperature and humidity sensor[4]

4) Bluetooth module: A bluetooth module for transmission of captured data to a smartphone application.

Fig 4: Bluetooth [4]

5) Resistors: Two 10k ohm resistors were used for model building

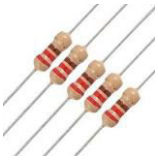

Fig 5: Resistor [4]

6) Jumper wires: These were used for building the circuit.

Fig 6: Jumper wires [4]

3.3 Circuit diagram:

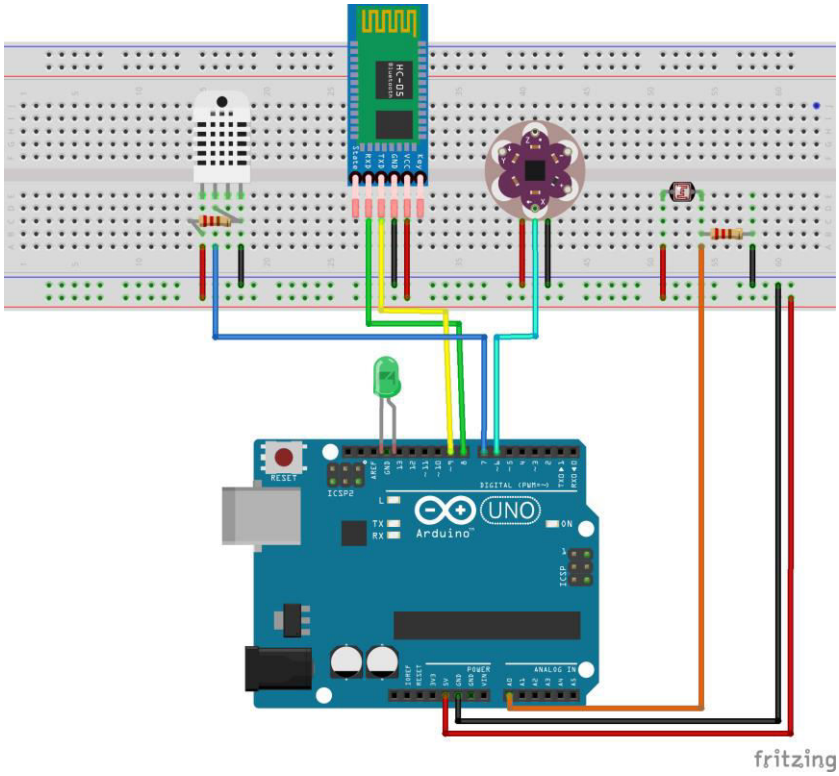

Fig. 7: Circuit diagram

3.4 Circuit Connection:

1. Right pin of photo resistor is connected to A0 pin and left pin is connected to 5V of Arduino board.
2. Middle pin of motion sensor is connected to pin number 6, left pin to 5V and right pin to ground of Arduino pin.
3. Middle pin of DHT 11 sensor is connected to pin number 7, right pin to 5V and left pin to ground of Arduino pin.
4. TXD and RXD pin of Bluetooth module is connected to pin 9 and 8 respectively of Arduino board and VCC and GND pin of Bluetooth module is connected to 5V and GND of Arduino board.
5. Big pin of LED is connected to pin 6 and small pin is connected to GND of Arduino pin.

4.Methods

We have used Arduino and PROCESSING IDE for data collection, data processing, MIT App Inventor 2 for real-time data viewing on Android phone and then stored data to database.

4.1 Arduino:

Arduino is an open source platform for electronics. It is a collaboration of Physical programmable board and software IDE which is used to write and upload code on to physical board. ARDUINO interacts with different sensors like Photo sensor, PIR, DTH etc., LED, speakers, camera, Bluetooth module etc. It takes input from different instruments and gives output in the form of LCD display, serial monitor, LED, speakers etc.

We have provided Arduino with input from photo resistor, DHT sensor, Motion sensor (PIR sensor) and output is obtained in the form of temperature, luminescence, humidity and sleep status. We need to first write code, verify it and then upload it to Arduino.

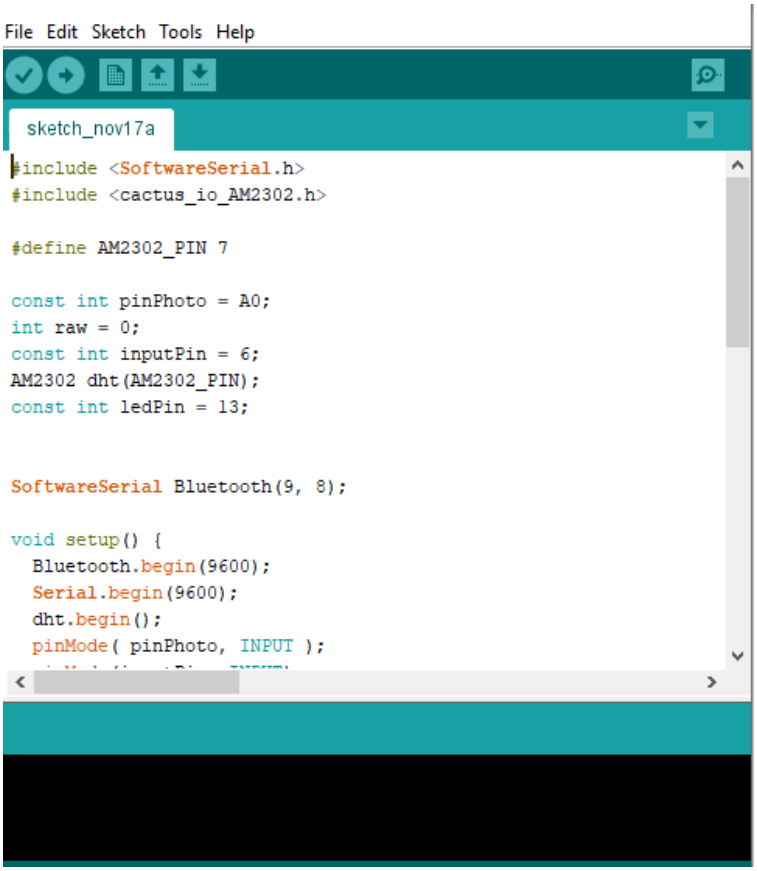

Fig. 8: Snapshot of Arduino software

4.2 Processing IDE:

Processing is used to create graphics. Processing IDE communicates with ARDUINO IDE using serial communication, thus capturing data from Arduinos serial monitor. Using Processing IDE, we are transforming the data obtained from Arduino and saving it to database.

4.3 MIT App Inventor 2

MIT App Inventor is a visual programming environment for easy application development for smartphones and tablets.[3]

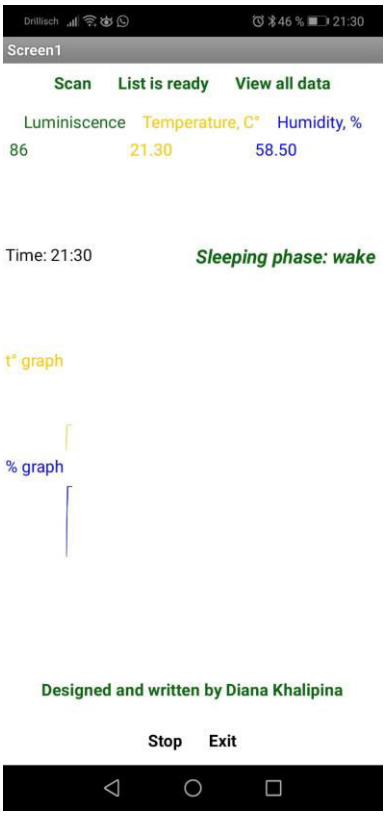

Fig 9: A snapshot of the MIT App Inventor for real-time data viewing

4.4 phpMyAdmin:

Database development using phpMyAdmin - a free software tool for handling the administration of MySQL database. A table with the columns and data types (mentioned below) was created in ‘user12’ database to store the sensor information.

CREATE TABLE ‘Sleeping_phase’ (Ser.No INTEGER (20) PRIMARY KEY AUTO INCREMENT,
Temperature FLOAT (10), Luminescence INTEGER (20), Humidity FLOAT (10), Status STRING (20))

5. Observations

Table 1 below is sample output data collected from sensors.

Sr. No.	Luminescence(cd/m2)	Luminescence (cd/m2 Log 10 transformed)	Temperature (°C)	Humidity (%)	Status
1	595	2.77452	23.9	34.9	wake
2	586	2.7679	23.9	34.4	wake
3	578	2.76193	23.9	34.2	wake
4	610	2.78533	23.8	34.1	wake
5	610	2.78533	23.9	35.3	wake
6	609	2.78533	23.9	35.9	wake
7	613	2.78746	23.9	35.8	wake
8	613	2.78746	23.9	35.3	wake
9	610	2.78533	23.8	34.3	wake
10	611	2.78604	23.8	34.3	wake
11	502	2.7007	23.8	34.3	wake
12	508	2.70586	23.9	34.4	wake
13	612	2.70586	23.8	34.4	wake
14	610	2.78533	23.9	35.5	wake
15	539	2.73159	23.9	35.1	wake
16	544	2.7356	23.9	35.6	wake
17	568	2.75435	23.9	36.4	wake
18	577	2.76118	23.9	35.8	wake

Table 1: Observation values obtained from sensors.

6. Results

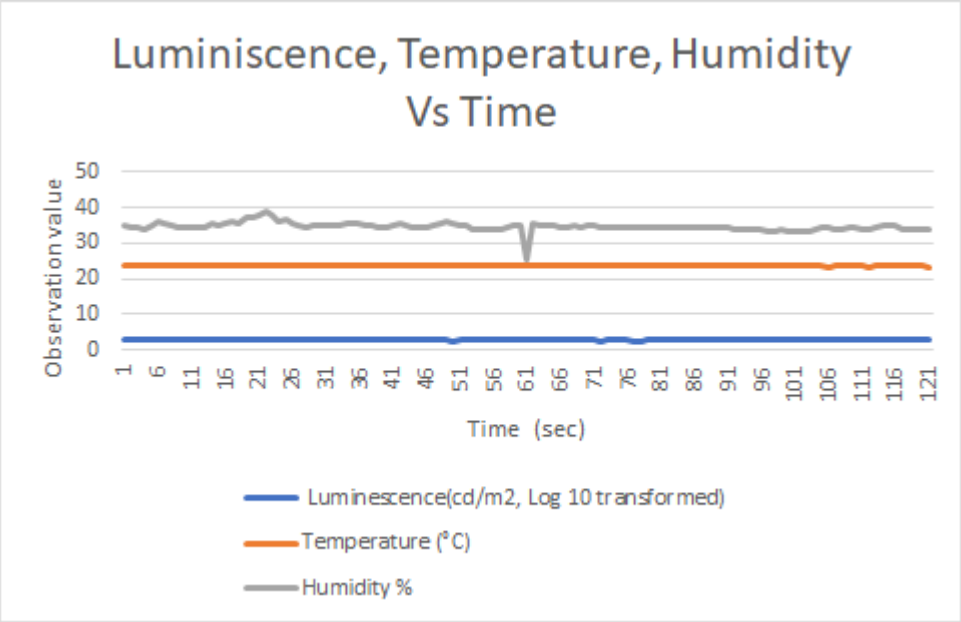

Fig 10: A line graph of temperature, luminescence and humidity data plotted against time.

In Fig. 10 we observe that there is not much variation seen in the data values. This is due to the short timeframe for which the data was recorded. Data was collected at every 2 seconds and thus the sleep phase is always observed to be wake, given time constraints. We may observe larger fluctuation in values for a longer time frame that is record information for increased period of time.

7. Conclusion

Thus, using the above mentioned external factors we can keep track of factors that affect our sleep pattern and adopt safety measures to maintain good sleeping habits and thus improving mental health.In future, this project can be extended or improvised by using heart rate sensors to measure optimum heart rate.

8. References

1) *Diana Khalipina ,2019 retrieved from* *https://create.arduino.cc/projecthub/dianakhalipina/sleeping-phases-determination-60be4f?ref=tag&ref_id=bluetooth&offset=53*

2) Sensor network manual retrieved from campusnet Jacobs university.

3) Massachusetts Institute of Technologz,2012 - 2019 retrieved from http://ai2.appinventor.mit.edu/

4) https://www.google.com/search?biw=1517&bih=730&tbm=isch&sxsrf=ACYBGNQlM-uJ6FYChJ_0lNQWBhFVLCYSFA%3A1575135254341&sa=1&ei=FqjiXZSZFMjWwQLLnYW4Bg&q=jumper+wires&oq=jumper+wires&gs_l=img.3..0j0i30l9.85966.89495..90443...0.0..0.116.1216.9j4.....0....1..gws-wiz-img.....35i39j0i7i30j0i131j0i10i30.2iDjb5hScpQ&ved=0ahUKEwiU_LqKvJLmAhVIa1AKHctOAWcQ4dUDCAc&uact=5

5) WC Dement, MM Mitler - Jama, 1993 retrieved from https://www.mentalhealth.org.uk/blog/importance-sleep

9. Annexure

The code files have been saved on git-hub (https://github.com/Tanvi-Phaltane/Data-Acquisition-Technology-and-Sensor-Network---Sleeping-Phase-Determination)