Easy wake up Device

Team Number: 21

Team Members:
Han Chen
Melech Lapson
Weipeng Wang

TA: Dean Biskup

Feb 18, 2021

Course: ECE445

1. Introduction

1.1 Objective and Background

Many people have struggles waking up in the morning. Most people will feel very tired even though they have had enough sleep, and it is very embarrassing to be late because they just hit the snooze button, so it would be awesome if people could wake up easily and feel energetic. Even with an alarm clock, many people still feel tired or just hit the snooze button and go back to sleep. if we can use the band to detect when it is the best time to wake the person and using the light is more efficient and comfortable to wake the person up.

Currently, the most common way to wake up is to set alarm on the phone, and the problem with it is that people often snooze their alarm unconsciously and wake up late, and also when people are suddenly woken up by the alarms, they often feel uncomfortable and they still want more sleep.

Some new technologies nowadays attempt to track a user's sleep cycle to know the optimal time to wake them up with an alarm. Other studies show that using light instead of sound to wake up in the morning makes it easier to wake up, Our plan is to combine these technologies to create a device that will track your sleep cycle and then trigger a lightbulb to turn on. This will allow us to leverage the benefits of both technologies to help people wake up.

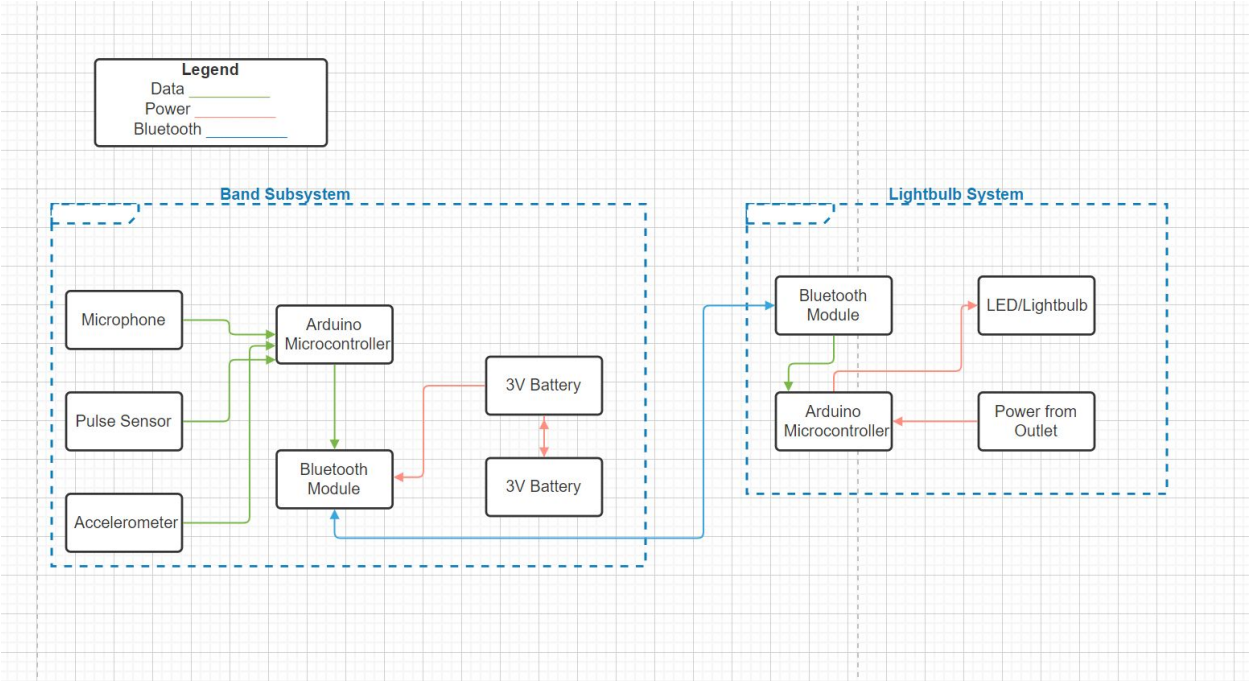
We plan to make this device fit on a band/watch which a user will wear and will use a microphone, pulse sensor, and accelerometer to measure the user's noise, heart rate, and movement respectively. These will help us determine what sleep cycle they are in. Additionally, we plan to use a bluetooth module to connect the device with the lightbulb and signal the light bulb when to turn on. We expect that this will require users to buy these specific lightbulbs to use the band.

1.2 High-level Requirements

- the user should be able to select mode for the band, and in manual mode, the user should be able to select the time to wake up
- In automatic mode, the user should select a period time and the project should be able to wake up the user at the best time in the period
- the band should detect the sleep cycle using data, and use an algorithm to control the brightness of the light bulb using the collected data

2. Design

2.1 Block Diagram



2.2.1 Band Subsystem

Microphone

We plan to use a Maxim MAX9814 Electret Microphone Amplifier to measure the sound the user is making. We will use it to send data to the microcontroller to figure out what stage of sleep the user is in.

Requirements: Must have a max gain of 40-60dB and interface well with our microcontroller.

Pulse Sensor

We will be using a pulsesensor.com standard pulse sensor to measure the heart rate of the user to help determine the state of sleep the user is in. This data will be sent to the microcontroller to help determine whether to turn on the light.

Requirements: Must take an input voltage of 3-6 volts and a low supply current of <5mA. Must be able to easily interface with our Arduino microcontroller.

Accelerometer

For an accelerometer, we are choosing to use an ADXL322 accelerometer. It will interface with our arduino and report movement of the user while they sleep, giving us more information to help determine what stage of sleep they are in.

Requirements: Must have a supply voltage range between 3-6V and a low power consumption of 340uA at 2.4V.

Microcontroller

For our band's microcontroller, we plan to use an Arduino nano as it's small size will be easier to fit in a band on the user's arm. It also has enough I/O ports to take in data from all three sensors and we will program it to use that data to determine what state of sleep the use is in.

Requirements: Has at least 8 analog and digital input pins and is small enough to fit in a band on someone's wrist (<2x5cm). Must also have a significant amount of memory (1KB RAM and 16 KB of Flash) to store data from the user.

Bluetooth Module

We have decided to use an Hc-05 bluetooth module to communicate between our band and lightbulb subsystems. They will allow us to send signals to the lightbulb subsystem to turn on or off the bulb.

Requirements: Must have an operating voltage between 3-6 volts and be able to interface with our Arduino microcontroller. Must also be relatively small so as to fit in the band (<2x5cm).

Batteries

We plan to use two Lithium ion button batteries to power our band as they are small and compact and can produce the necessary voltage for the microcontroller and sensors.

Requirements: Relatively small and can produce 5-6 volts total.

2.2.2 Lightbulb Subsystem

Microcontroller

For our band's microcontroller, we plan to use an Arduino nano as it's small size will be convenient. It will control the bluetooth module and send the signal to turn on the light.

Requirements: Has at least 4 analog and digital input pins and is relatively small (<3x5cm).

Bluetooth Module

We have decided to use a second Hc-05 bluetooth module to receive signals from the bluetooth module in the band subsystem to turn on or off the bulb.

Requirements: Must have an operating voltage between 3-6 volts and be able to interface with our Arduino microcontroller. Must also be relatively small as well (<3x5cm).

Lightbulb/LED

We will need a light source to be connected to our microcontroller to light up when the use is in a lighter sleep cycle. We plan to use an LED for proof of concept, and if we have extra time and money, get a dimmable lightbulb to use for the demo.

Requirements: must be relatively inexpensive and have a turn on voltage of less than 6 volts.

Power Supply

To power our Lightbulb subsystem, we plan to use a standard wall outlet or power generator to power up our Arduino and the rest of the components.

2.3 Risk Analysis

We believe our most difficult task will be to program the band subsystem to take in data from the pulse sensor, accelerometer, and microphone and interpret that data as a stage of sleep. We will have to do more research to figure out how to use the data we collect to determine the stage of sleep and also to ensure the user is indeed asleep and not awake.

3. Safety and Ethics

Before developing our project, we weigh the safety of our users as the most important thing as we include many electrical parts in our product. There are two major safety and ethics concerns for the end users, first is the data manipulation, because the device is constantly measuring biological data of the end user, so it is very important to use the data correctly and prevent it from leaking, according to the 8th rule of IEEE Code of Ethics, we promise to our end user that we won't record the data measured from our end user in any means, and the data is only transmitting to the smart light bulb subsystem.

The second concern is safety of the battery. We are using 3 Volt Lithium ion batteries to support the band which could create hazards of overheating and exploding. Referring to the first rule of IEEE Code of Ethics, we will follow the general battery safety documents and ensure the battery is stored in a secure location in our subsystem with terminals covered by insulating material to ensure that there are absolutely no short circuits. Additionally, during the usage we will ensure our users avoid swelling the batteries by adding documents to teach them how to charge the batteries correctly to avoid overcharging.