Sleep Tight

MCS-4833

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Design Document

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1. Introduction

The following document provides an in-depth look at the system requirements of the Sleep Tight, at-home Sleep Apnea test. This document helps guides the developers when creating this product; it also serves as a measurement of the product is progressing. The document supplies the client a way to keep track of progress made and can be used as a way to validate what the client is asking for in the Sleep Tight. Sleep Apnea tests done within hospitals may have the vulnerability of having skewed data; a study done in 2016 by Masako Tamaki, Ji Won Bang, Takeo Watanabe, and Yuka Saski found that when people sleep in a new environment, they experience what is called the first-night effect (FNE) which means that one hemisphere of the human doesn't allow for a good night's rest. One half of the human brain stays half awake and on guard in case of dangerous circumstances that may happen in the night. The First-Night Effect could skew the data collect if the patient is sleeping at a sleep clinic or hospital for the first time. The Sleep Tight is an inexpensive solution to this problem by providing patients the option to take the Sleep Apnea test in the comforts of their own home.

1.1 Purpose

The Sleep Tight provide suspected patients suffering from Sleep Apnea a way to take the Sleep Apnea test at home; this would provide doctors with accurate readings of the patient's vital signs and recordings of the patients snoring, if any. Sleep Tight gathers and saves data collected on the Raspberry Pi to be used for research for doctors. Sleep Tight gives patients a cheaper and accurate method to test for sleep apnea at home compared to the sleep apnea test apps on their phones which most require the patient to have an Apple Watch. Sleep Tight can be run on older models of the Raspberry Pi and uses Arduino sensors that don't cost more than $10 each. The overall cost of the device is significantly cheaper than an Apple Watch or the other at home sleep apnea devices out on the market right now. The Sleep Tight will give patients the give the patient a good night's rest while giving them peace of mind that the data from their sleep will be analyzed by their doctor.

1.2 Scope

Sleep Tight has many intricate pieces that contributes to the whole.

The Arduino software must collect heart rate data and recordings from the microphone which would be ran by one Arduino program.

The Raspberry Pi collects the data from the Arduino and starts the data collection that is controlled by the Arduino. The Raspberry Pi must provide a user interface to gather patient information.

The Sleep Tight must be easy to setup so that the data collected is not skewed; the patient must be able to set up the device in the matter of minutes.

1.3 Definitions, Acronyms, and Abbreviations.

FNE – First-Night Effect: the effect of a new environment to the human brain where one hemisphere will stay awake and on guard as a precaution in case of a dangerous event were to happen.

Sleep Apnea: sleep disorder in which breathing repeatedly stops and starts. Symptoms include loud snoring, moments where the patient stops breathing, gasping for air, dry mouth in the morning, headaches that occur in the morning, difficulty staying asleep, excessive daytime sleepiness, difficulty paying attention during the day, and irritabilty.

1.4 References

Sleep apnea. (2018, July 25). Retrieved January 19, 2020, from https://www.mayoclinic.org/diseases-conditions/sleep-apnea/symptoms-causes/syc-20377631

SSMTP. (2019, November 22). Retrieved January 19, 2020, from https://wiki.archlinux.org/index.php/SSMTP

Tamaki, M., Bang, J. W., Watanabe, T., & Sasaki, Y. (2016). Night Watch in One Brain Hemisphere during Sleep Associated with the First-Night Effect in Humans. *Current Biology*, *26*(9), 1190–1194. Retrieved from https://www.cell.com/current-biology/fulltext/S0960-9822(16)30174-9

2. The Overall Description

Many of the requirements stem from the fact that Sleep Tight needs to be as user friendly as possible. We also want the patient to feel safe and comfortable while the test is being carried out. Sleep Tight must provide the doctor with accurate vital signs and clear recordings of the patient's sleep for them to accurately diagnose sleep apnea in the patient. Sleep Tight must be made to be as easy for the patient to setup as possible which means limiting the wires and sensors as possible and with detailed instructions of how to set up the device.

3. System Architecture

3. 1 Architectural Design

There are five separate components of the system which include patient, doctor, and approved persons information collection, heart rate collection, audio collection, and saving all of the information and data collection. Once the patient enters all of the patient, doctor, and approved persons information, that data gets saved to a text file, and the system will give the option to start the heart rate and audio recording. The patient manually starts the heart rate and audio recording component of the system. The patient has to then manually stop the recording of the heart rate and audio recording when the patient wakes up. When the patient stops the recording, all the data collected will be then save to a text file for the heart rate and the decibels for the audio.

Patient/Doctor/Approved Persons Information Collection:

Python program that the patient inputs all of the asked information. Once the patient inputs all of the data the system saves the information to a text file on the Desktop.

Heart Rate Sensor:

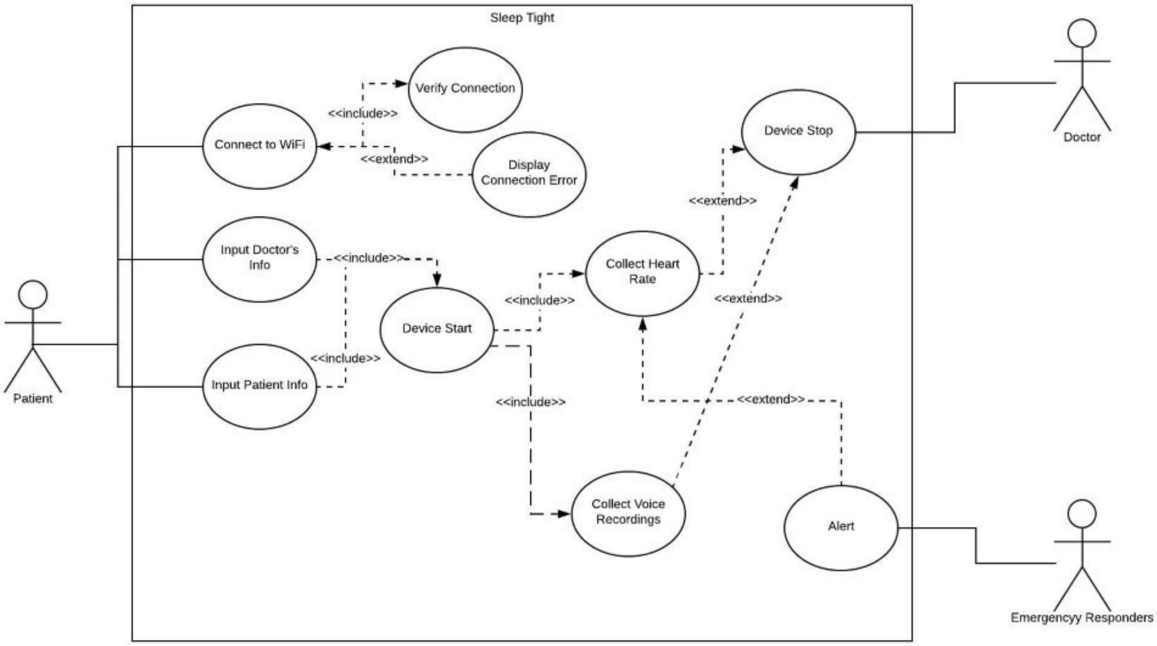
The heart rate sensor is a Grove Finger Heart Rate sensor with Shell; this is connected to the Arduino. The heart rate is collected from the Arduino Sketch program and displayed in Python. The Arduino is connected to the Raspberry Pi through a Serial to USB cable. The heart rate sensor program stops recording when the patient presses the ESC key on the keyboard. Once the ESC key is pressed, the system saves all the data collected.

Audio recording:

The audio recorded is done through the Arduino using a microphone and audio sensor. The audio sensor tells the microphone when to start and stop recording the sound. The audio has to be above 60 decibels before the microphone will start recording. The microphone records 10 seconds of sounds and then saves the recording on the Raspberry Pi as a .WAV file. A python program will trigger the Arduino program to start and stop.

Email:

Once the data is collected and saved when the patient presses ESC in the python program, the system will take the save email address and input them in the email template. The system will also attach the saves files of the heart rate and audio recordings to the email.


Sleep Tight
Verify Connection
<<include>>
Connect to WiFi
<<extend>>
Display Connection Error
Device Stop
Doctor
Input Doctor's Info
<<include>>
Device Start
<<include>>
Collect Heart Rate
<<extend>>
<<extend>>
Patient
Input Patient Info
<<include>>
<<include>>
<<extend>>
Collect Voice Recordings
Alert
Emergencyy Responders