

HSHL – Interactive Systems Engineering II

Sleep Apnea Implant Device

Device Documentation

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Interactive Systems Engineering II

Imad Chaar

imad.chaar@stud.hshl.de

I. Introduction

Obstructive Sleep Apnea (OSA) is a very common and serious condition that affects millions of patients worldwide. It occurs when the muscles in the airway relax during sleep resulting in airway narrowing depriving the reach of oxygen to the brain. This condition can result in high blood pressure, strokes, heart attacks, poor performance, fatigue, and several other dangerous side effects.

The standard treatment for OSA involves wearing a mask during sleep conducting pressurized air through the nose and/or mouth to the throat. This pressure keeps the upper airway open maintaining normal breathing. However, this treatment is not relaxing as the patient faces difficulties to fall asleep in the beginning and might also cause some sort of skin irritation or wounds on the point of contact between the mask and the face.

II. Concept:

In this document, I introduce the Sleep Apnea Implant Device, this device provides therapy through the neurostimulation (stimulation of neurons) and is designed to deliver stimulation to the tongue muscles through the hypoglossal nerve resulting in an open upper airway during sleep. This means that no masks or any other mousepieces are connected to the patient while asleep.

The device is only used while sleeping, where every time the patient takes a breath, the respiratory sensing lead detects the breathing and therefore send a stimulation pulse through the sensing lead to the hypoglossal nerve of the tongue. Thus, OSA patients do not have to use the device during the day or their nonsleeping times.

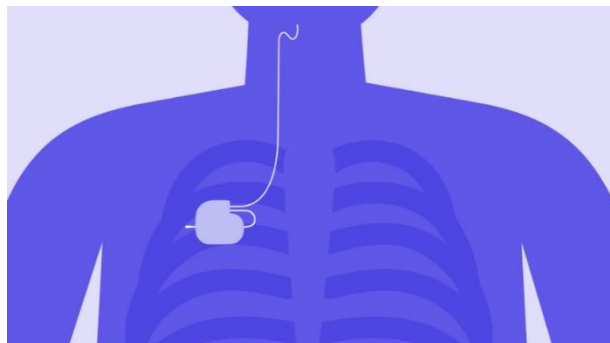


Figure 1: Implant Device Concept

III. Designing of the Concept:

1. Requirements:

The device is easily surgically implanted with 2 to 3 incisions into the patient's chest during an outpatient procedure (same-day surgery) done by an ENT surgeon.

Since this device is only used when the patient is asleep, or in other words, when the patient turns it on, the device's battery lasts up to 10 years and has a minimum lifespan of 7 years. Moreover, this device requires a small Bluetooth connection stick that is responsible for the communication between the stimulator (implanted device) and the external remote control.

2. Models:

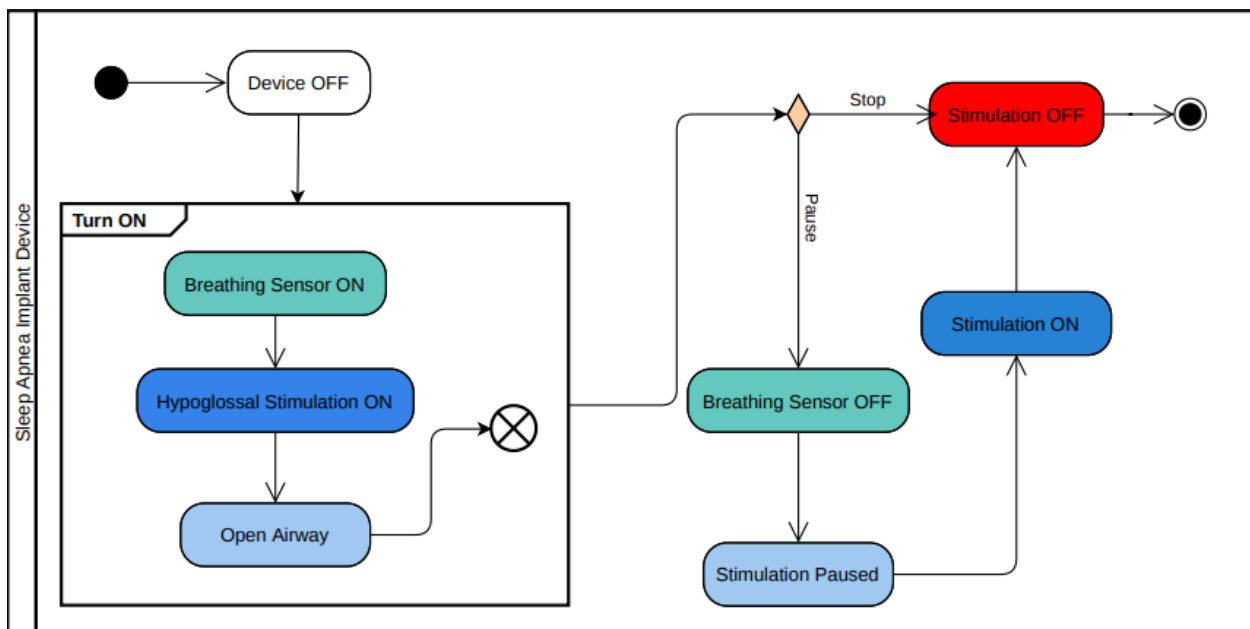


Figure 2: Activity Diagram of Sleep Apnea Implant Device

3. Main Elements:

- OSA patients
- Doctors and ENT surgeons

4. Hardware Components:

- Internal (Implanted):

- a. Stimulator: Battery-powered device that is responsible for generating neuro stimulation pulses.
- b. Stimulation lead: A cable that carries those pulses to the hypoglossal nerve.
- c. Respiratory sensing lead: A sensor that detects the breathing of a patient.
- d. Bluetooth communication system linked to the remote control.

- External:

- a. Remote control that allows the patient to control the neurostimulation.

5. Critical-based parts of the system:

6. User Interface:

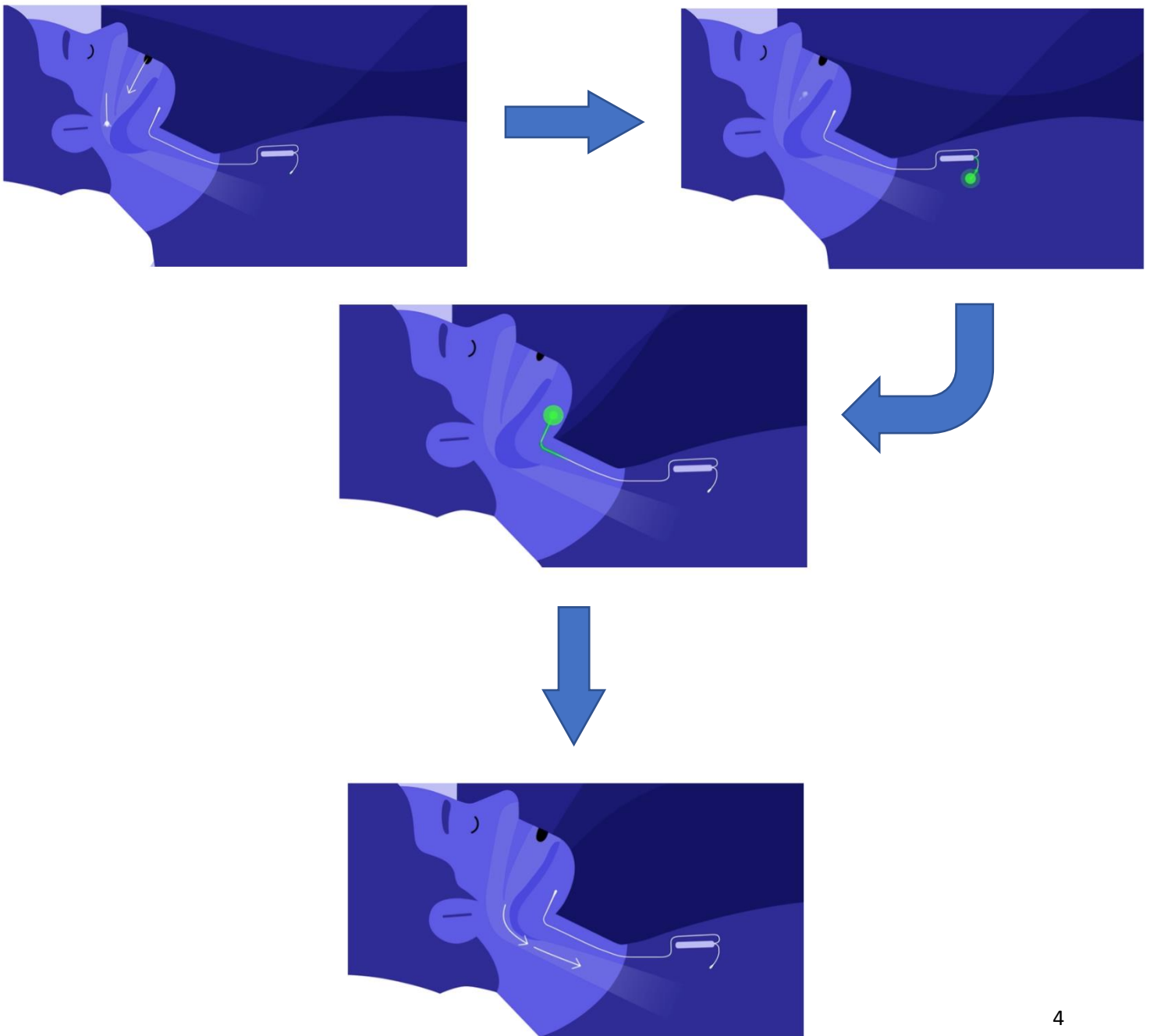
The patient controls the implantable device using a remote control allowing the user to start, pause and stop the therapy. Moreover, the patient can also increase or decrease the intensity of the stimulation through the plus and minus buttons on the remote. The device monitors the patient's breathing, and every time the patient takes a breath, a gentle pulse moves the tongue out of the way ensuring an open airway overnight hence, a peaceful sleep.

IV. Discussion:

The Sleep Apnea Implant Device introduces a solution OSA patients awaits, where this device provides them a peaceful overnight sleep without

the need to connect themselves to an external machine through a hose or a mask.

The idea I first had of this device included having a rechargeable battery, but after presenting and taking other colleagues' comments and after performing some research, I decided to have all of the stimulator replaced when it reaches low battery. And as I have previously stated, implanting this device in the patient's body is performed within an outpatient same day procedure, this means that replacing the device will be as easy as possible.



V. Conclusion and Future Work:

This medical device system looks and operates much like a cardiac pacemaker but instead of having action on the heart, it sends pulses to the hypoglossal nerve in the neck. We can call it “Pacemaker for the Tongue” with the goal of keeping the airway wide and open during sleep.