Team Project: Developing and testing a software-based prototype of a CES device[1]

Due Friday Dec 9th at 11:59pm
Grace period until Sunday Dec 11th at 11:59pm without late penalty
Late penalty starting Monday Dec 12th 12:00am at 5 marks per day

Team work submitted individually on Brightspace as a tar or zip file named teamX.tar or teamX.zip, where X is your team number. **Mandatory demos** will be **individual** starting on Monday December 12th. The scheduling details will be announced the week before and the project review-demo times will be arranged between you and your assigned TA. You are required to use GitHub: make sure your repository is private and that you provide access to your assigned TA. You are encouraged to check your progress on a weekly basis with myself and the TAs. Do not wait until the last minute.

Raven Microcurrent Biofeedback Inc. (RMB), a manufacturer of a variety of microcurrent biofeedback devices, has hired you to build them a software-based prototype of a device they are planning to add to their product line. RMB intends to use this prototype to explore different capabilities before deciding on the design of the physical product. Your team happily accepts the task, eager to impress your new employer with your development skills. RMB would like their device to have the same features as Oasis Pro from Mind Alive Inc. with the a few additional capabilities related to recording and replay of treatments. The implementation and testing are to be in C++ using the Qt framework on the COMP3004-F21 VM which has the Qt Creator IDE installed.

Oasis Pro is an example of a CES device which is a non-invasive neuro-stimulation medical device that delivers microcurrent via an electrode through the earlobes to stimulate the brain for the purpose of therapeutic intervention.

[1] This project has been inspired by conversations with Igor Radonjić who wrote the background material.

For details of Oasis Pro operation refer to the owner's manual on Brightspace (OASIS_Pro_Manual.pdf) and the video https://www.youtube.com/watch?v=PDgN03Fx6fg&t=2s

What features of Oasis Pro should be simulated?

1. Power: "Turn On/Turn Off" and "Ending A Session" as described on p4 of the manual.
2. Battery level: battery level and battery low warnings as per "Battery Level" section on p5 of the manual. Your simulation should handle battery depletion as a function of length of therapy, intensity, and connection to skin.
3. Selecting a session: as per "Selecting A Session" on p5 of the manual but only with 3 groups (20min, 45min and user designated) and 4 session types per group. You can choose any 4 types from p12 of the manual.
4. Connection test: as per "Connection Test" on p6 of the manual.
5. Intensity: as per "Adjusting Intensity" on p7 of the manual.

What additional features should be simulated?

1. Record: users can choose to record a therapy and add to treatment history. Therapy session information to be recorded: session type, duration and intensity level (if changed during therapy choose last selected intensity level). There would be additional interface needed beyond what Oasis Pro offers to implement this feature, and it is up to you design it.
2. Replay: users can replay selected treatments from history of treatments.
3. Note that both of the above features need to support different users.

Your deliverable should include the following:

1. Readme that includes the following:
    - Team number and member names.
    - Who did what in the project.
    - File organization of the deliverables.
    - Tested scenarios: ones that work and ones that don't.

2. A use case model based on given information about CES devices using the provided video and manual. A use case model includes use cases and the use case diagram. Name each use case, e.g. UC1, UC2, so that it can be referred to.
3. An OO Design model using UML Class, Sequence, Activity (if applicable) and State (if applicable) diagrams. For each design diagram identify which use case or use cases it is intended to realize. Your design models should include the Qt elements you used.
4. Source files for your implementation.
5. Traceability matrix from use cases to tests, design, and implementation.

For all of the above diagrams refer to the agile modeling link on cuLearn (http://agilemodeling.com/), specifically “Artifacts -> Introduction to UML 2.x”.

Background on CES Technology

Cranio-Electro Stimulation (CES) is a form of non-invasive electrotherapy proven to effectively treat conditions such as insomnia, anxiety, depression, as well as alleviate pain and improve cognition.

CES devices achieve this by delivering small electrical impulses, via small clips worn on the earlobes, through the brain to stimulate and modulate specific regions of neurons. The microcurrent is tiny, just millionths of an ampere, and so gentle that most people hardly feel it. The brain naturally produces electrical currents within this range.

There have been over 200 studies and decades of research proving the efficacy of CES, which has outperformed conventional antidepressants with no reported negative side effects.

Although there are various theories as to how exactly CES works, qEEG (quantitative electroencephalography), also known as brain mapping, suggests CES electrical waveforms modulate cells’ signals to return to baseline, that is normal functioning, serving as a kind of neural reset. CSF (Cerebrospinal fluid) analysis has also shown increased levels of neurotransmitters such as serotonin and endorphins which form the basis of drug therapy in the aforementioned conditions.

CES uses pulsed alternating current (AC) waveforms of up to 5 mA within a frequency range of approximately 0.5-to-500 hz. The polarity of these electrodes is irrelevant, meaning they can be placed on either temple and still produce the stimulation results desired by the wearer.

The most popular and researched frequencies are 0.5 and 100hz. However, the frequency is secondary to the overall effect of CES, as both frequencies produce similar results.

The market leader for CES devices is the Alpha Stim AID device. It uses a preset frequency of 0.5hz.

https://www.alpha-stim.com/

For more information on CES, explore the listed websites:

https://mindalive.com/pages/cranio-electro-stimulation-ces

https://www.alpha-stim.com/healthcare-professionals/clinical-research/

Documentary on Alpha-Stim technology:

https://www.stress.org/thebrainelectric