

Cranial Electrotherapy Stimulation Device Simulator

Team 38

Adam Bishow, Martin Dimitrov, Daniel Totev, Emmanuel Olufelo

COMP 3004: Object-Oriented Software Engineering

2021 - 12 - 07

Table of Contents

Included Files	3
Contributions	4
Use Case Diagram	5
Use Cases	6-8
UML Class Diagram	9
UML Sequence Diagram	10
UML State Diagram	11
GUI Design (Prototype)	12
GUI Design (Actual)	13
Traceability Matrix (Use Cases → Tests)	14

Included Files

Headers	Source
autoshutdown.h battery.h cesdevice.h clips.h currentcontrol.h devicecontrolpadview.h devicescreenhistoryview.h devicescreenmenuview.h devicescreenoffview.h devicescreentreatmentview.h devicescreenview.h devicestatus.h deviceview.h frequency.h mainwindow.h recording.h screenview.h sidemenuview.h waveform.h	battery.cpp cesdevice.cpp clips.cpp currentcontrol.cpp devicecontrolpadview.cpp devicescreenhistoryview.cpp devicescreenmenuview.cpp devicescreenoffview.cpp devicescreentreatmentview.cpp devicescreenview.cpp deviceview.cpp main.cpp mainwindow.cpp recording.cpp sidemenuview.cpp

Ui	QT
devicecontrolpadview.ui devicescreenhistoryview.ui devicescreenmenuview.ui devicescreenoffview.ui devicescreentreatmentview.ui devicescreenview.ui deviceview.ui mainwindow.ui sidemenuview.ui	ces-device-simulator.pro ces-device-simulator.pro.user

Contributions

Adam Bishow**ID: 101146955**

- Designed use case model:
 - Use cases 1 - 4
 - Use case model
- Implemented treatment UI
- Created timer and current functionality for the treatment
- Debugged clip connectors and added shutdown after clip disconnection

Daniel Totev**ID: 101106190**

- Designed the GUI prototype using the application draw.io
- Designed component separation of UI to ensure separation of concern
- Fully implemented the GUI in Qt
- Styled the GUI in Qt to make it look like the prototype using CSS
- Contributed to the creation of interfaces to allow the model to be connected to the view
- Helped Debugging

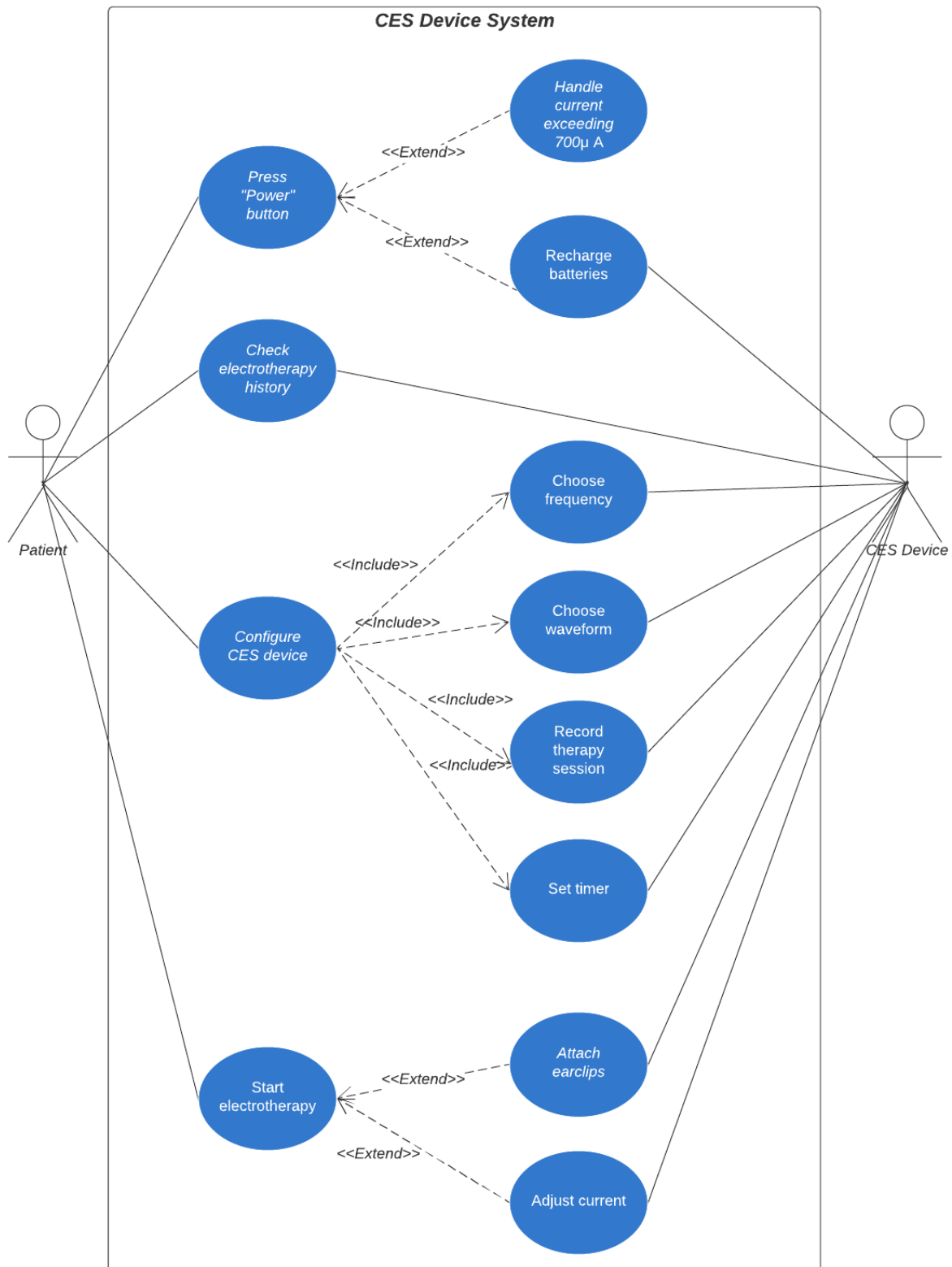
Martin Dimitrov**ID: 101111948**

- Setup git repo and issue tracking on GitHub
- Made UML class diagram and state diagram
- Built power delivery system (Battery)
- Setup recording feature and GUI display for recordings
- Built Tick / Timer functionality for treatment and idle events
- Built main CESDevice class, connecting all components together
- Helped to tie together View and Model
- Fixed various bugs in the system

Emmanuel Olufelo**ID: 101084104**

- Developed Requirement Traceability Matrix with Test Cases
- Developed Sequence Diagram
- Developed Clips Functionality in Qt

Use Case Diagram



Use Cases

Use case 1: Press “Power” Button

Primary Actor: Patient

Scope: CES Device System

Level: User level

Precondition:

The CES device is in working condition.

Success guarantees: The CES device will turn on and be operational.

Main success scenario:

- 1) Locate and “Power” on the CES device.

Extension:

- 1) If the CES device does not work and the patient does not see an interface:
 - a) Click “Recharge battery” to give the CES device 100% battery
 - b) The device has been shut off permanently since the device has exceeded 700 μ A during a previous electrotherapy session

Use case 2: Check electrotherapy history

Primary Actor: Patient

Scope: CES Device System

Level: User level

Success guarantees: The patient will be presented with a history of previously saved electrotherapy sessions

Main success scenario:

- 1) The patient presses the “History” option in the menu and is presented with a list of therapy sessions
- 2) The patient will have information on the date, duration, waveform, frequency and last recorded current of each session.

Use case 3: Configure CES device**Primary Actor:** Patient**Scope:** CES Device System**Level:** User level**Precondition:**

The CES device has been turned on.

Success guarantees: The patient has chosen the desired settings for an electrotherapy session before clicking the “Start” button

Main success scenario:

1. The patient will press the “Timer” button to find desired session time and the timer will begin
2. The patient can choose a frequency of either 0.5 hz, 70 hz, and 100 hz
3. The patient can choose different waveforms: Alpha, Betta, and Gamma
4. The patient can choose to record the next session by pressing the “Record” button

Use case 4: Start Electrotherapy**Primary Actor:** Patient**Scope:** CES Device System**Level:** User level**Precondition:**

The CES device has been turned on.

Minimal guarantees: Electrotherapy will begin and the CES device will start emitting current

Success guarantees: Session timer has ended and electrotherapy has been completed

Main success scenario:

- 1) The patient will press the “Start” button and a timer will begin counting down from the configured shutdown time and begin emitting current.
- 2) The patient will press the up/down arrows to change the current from the default 100 μA in increments of 50 μA and decrements of 100 μA
- 3) The patient will slowly change current to find a tolerable current that does not cause vertigo

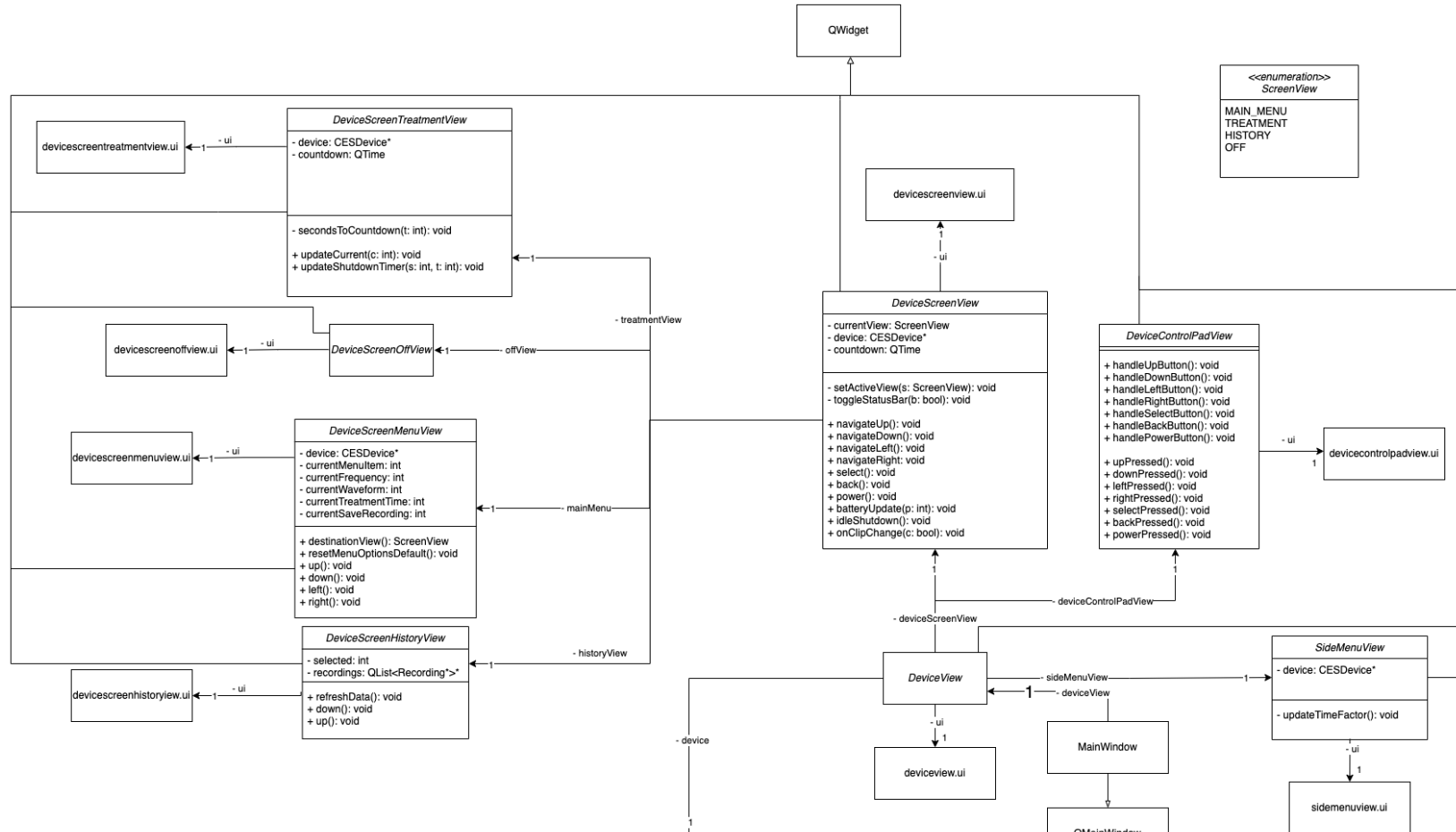
Extension:

- 1) If skin contact is not present in with device is lost than 5 seconds at any time during the treatment the device will power off.
- 2) If a circle-backslash symbol appears on the device it could be caused by:
 - a) Earclips are not connected to the patient
 - b) Batteries are low and must be replaced
- 3) If the device exceeds 700 μA at any point during therapy then the device will shut off permanently
- 4) If the battery is at 5% a warning will be issued to the patient and at 2% the device will shut down after issuing another warning

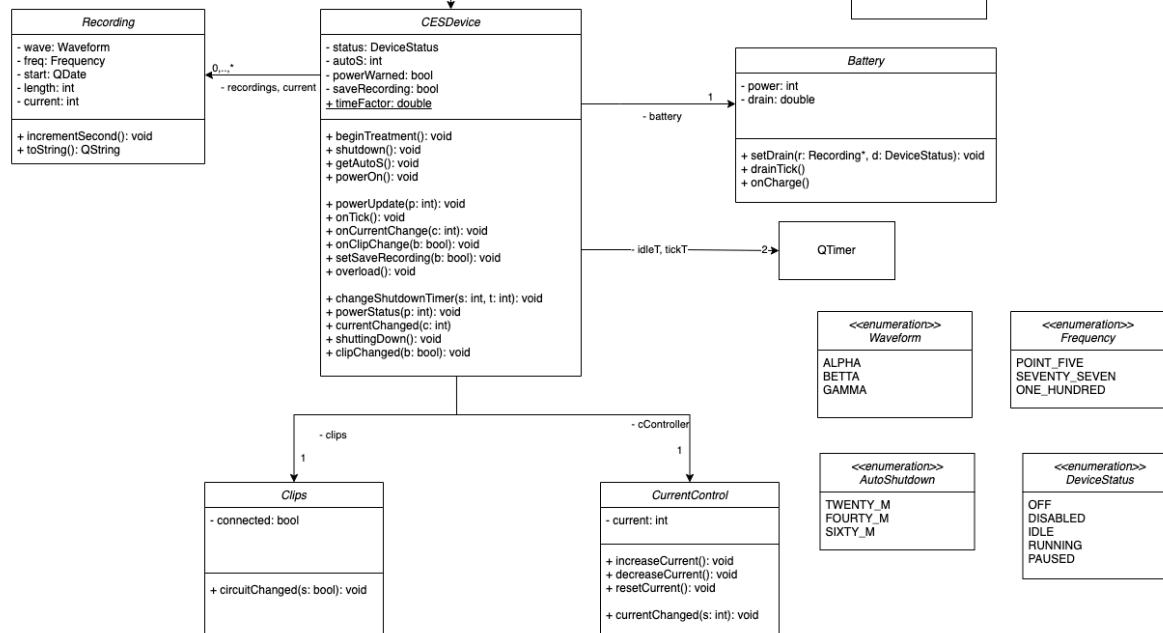
UML Class Diagram

(Attached)

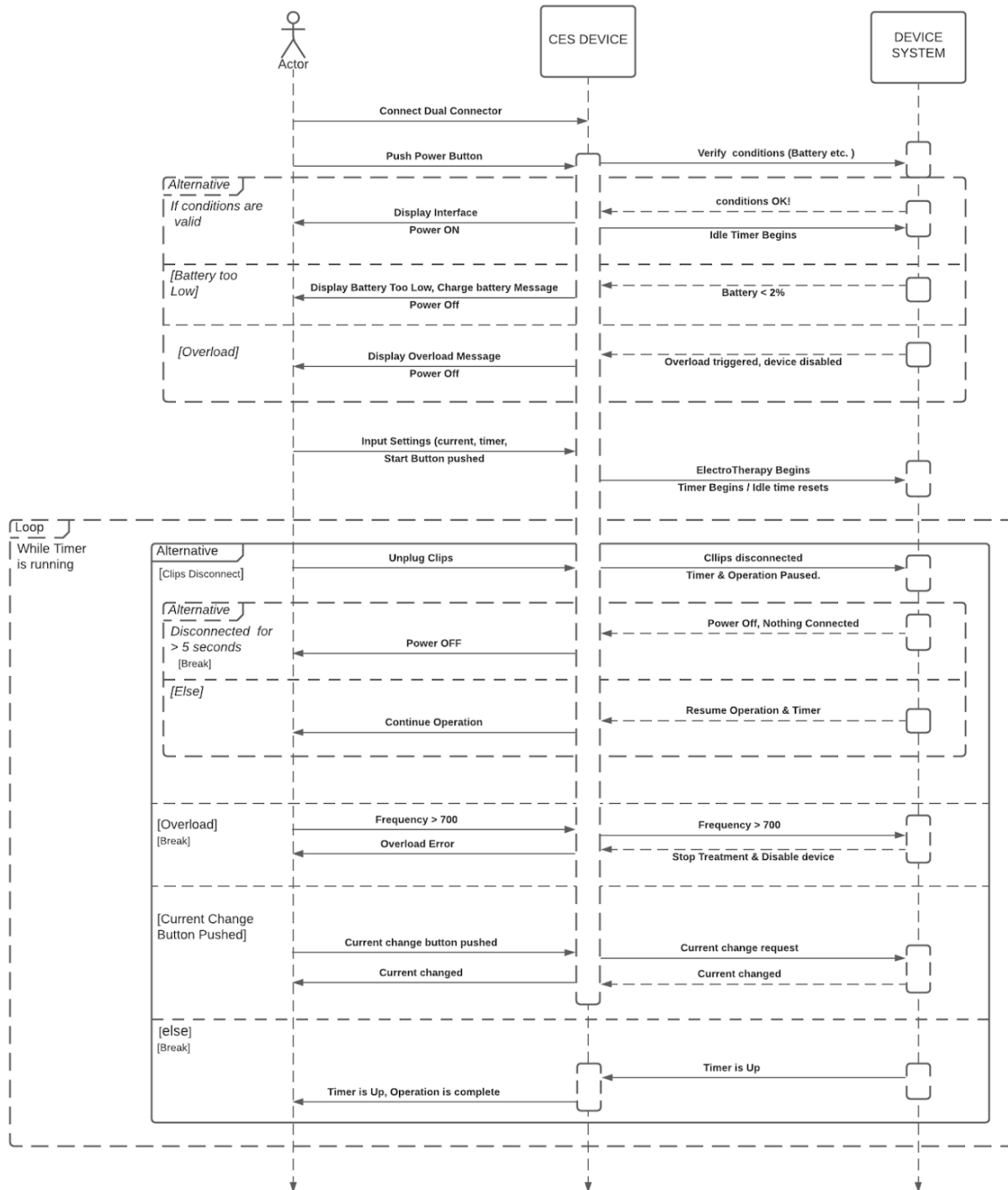
View



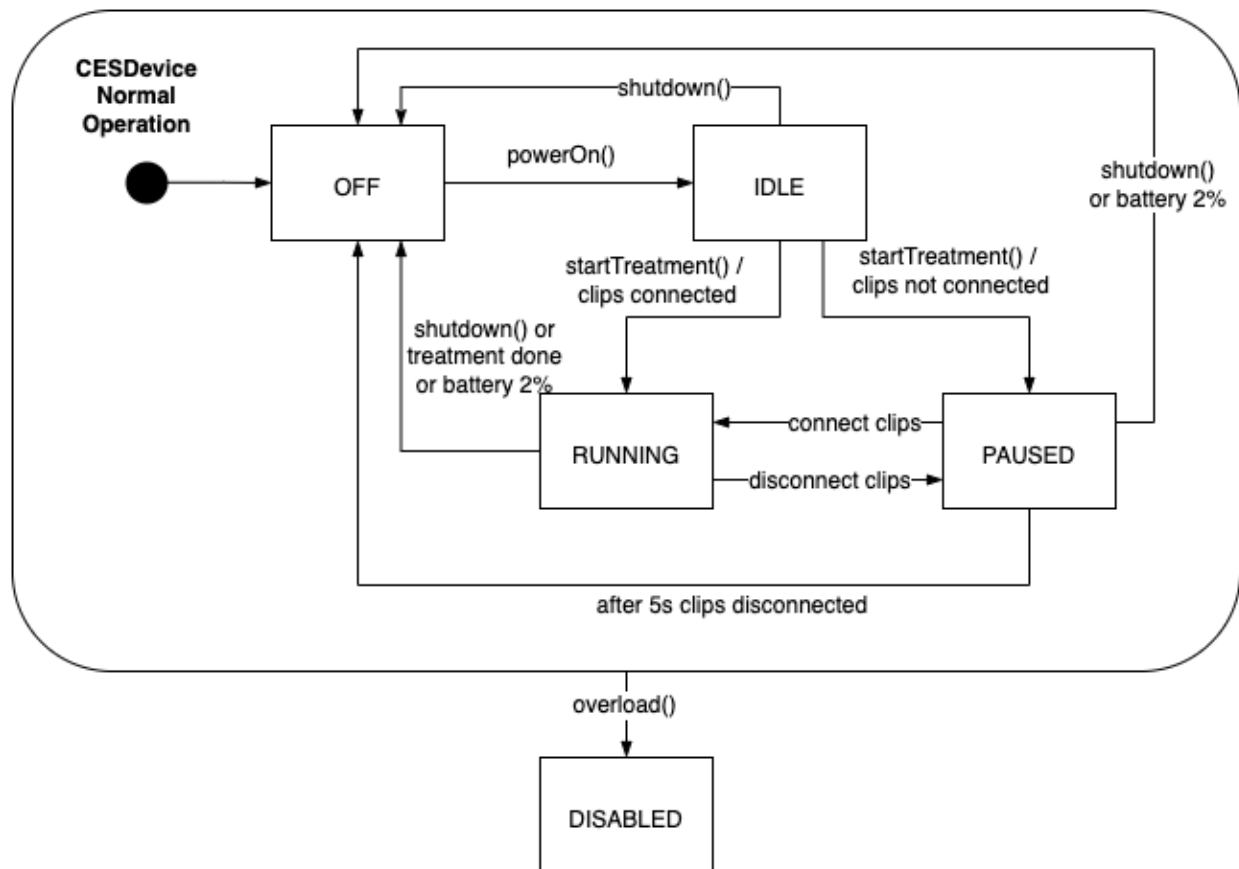
Model



UML Sequence Diagram



UML State Diagram



GUI Design (Prototype)

ON/OFF (1)

- There will be a "Push Button" wherein the beginning will display "On", and after being pressed, that button will display "Off". The user can turn the device off wherever they want.

Circuit check (2)

- There will be a "QIcon" which will be enabled if the device is not treating

Two frequency options (3, 4)

- There will be 3 "RadioButton" buttons where one will have the option of having a frequency of 0.5 Hz and the other 100 Hz. When one is enabled the other button will be disabled.
- If there are more frequencies added later, there can be a drop-down "QComboBox" box which has many more options for frequencies to choose from.

Countdown cycles (5)

- There will be 3 countdown cycles which will be individually displayed into 3 different boxes where the user can click either the "Push Button" for 20 minutes, 40 minutes, or 60 minutes.

Large timer Display (6)

- There will be an "LCD Number" timer where it will start when electrodes touch the skin

Microampere current control (7)

- There will be a "Horizontal Line" slider which will increment (1-10)

Battery charge indicator (9)

- There will be a "Progress Bar" indicating the amount of battery left.

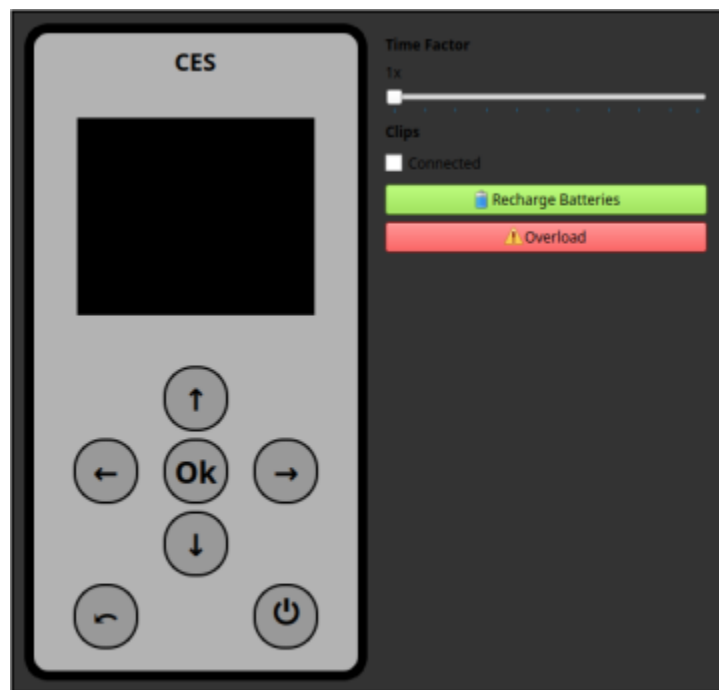
Recording (10)

- There will be a Record button and a list with all the pre-recorded history.



GUI Prototype

GUI Design (Actual)



CES Device (Powered Off)



CES Device (Configuration Screen)

Traceability Matrix (Use Cases → Tests)

(Test scenarios included in traceability matrix)

(Attached)

sno	Requirement ID	Requirement Description	Test Case						Test Excecution		Notes
			TC ID	TC Case	Test Steps	TC Design	TC Data	Expected TC result	Test Env	Prod Env	
	Req 1	Attach Earclips onto CES device	TC01	Connect Clips	1) Plug in dual connector into CES device	Completed	N/A	Clips Connected	Success	No run	
	Req 2	Push Power Button on CES Device	TC02	Power On Device with	1) Push Power Button	Completed	Battery: %100	Device Powers on	Success	No Run	
			TC03	"Power On" on Low Battery (<= 2%)	1) Push Power Button while battery is Low	Completed	Battery: %0, Battery : %2	Error Message Appears, Powers OFF	Success	No Run	
			TC04	"Power On" on Low Battery (5%)	1) Push Power when Battery is at %5	Completed	Battery: %5	Displays Low Battery	Success	No Run	
			TC05	"Power On" while device is overloaded	1) Push Power after Device is overloaded and disabled	Completed	N/A	Device is disabled and Does not work	Success	No Run	
			TC06	Recharge Battery and Power On	1) Push power button whilst battery is low 2) Error message displays 3) Recharge Battery 4) Push Power Button	Completed	N/A	Device Powers on	Success	No Run	
			TC07	Start While Clips not Connected	1) Push Start	Completed	Frequency: 0.5 Hz WaveForm: Alpha Time: 20Mins Save: ON	Treatment does not start	Success	No Run	
			TC08	Start While Clips Connected	1) Push Start	Completed	Frequency: 0.5 Hz WaveForm: Alpha Time: 20Mins Save: ON	Treatment Starts	Success	No Run	
			TC09	Enter Time into Timer	1) Select Time With slider 2) Press Start	Completed	Time: 20 mins, 40 mins and 60 mins.	Timer is Set to Time of choice	Success	No Run	
			TC10	Select Frequency	1) Choose a frequency of either 0.5 hz, 75 hz, and 100 hz 2) Press Start	Completed	Frequency: 0.5 Hz, Frequency: 75Hz and Frequency: 100Hz	Frequency is set to hz of Choice	Success	No Run	

	Req 3	Electrotherapy In Progress	TC11	Select Waveform	1) Choose a waveform between Alpha, Beta, and Gamma 2) Press Start	Completed	Waveform: Alpha, Waveform: Beta and Waveform: Gamma	Waveform is set to waveform of choice	Success	No Run	
			TC12	Record Data After Use	1) Choose to record by pressing the "Record" button 2) Press Start	Completed	Session: 3Mins waveform: Alpha Freq: 75hz Current: 100uA	Data is Recorded	Success	No Run	
			TC13	Change Current	1) Press the up/down arrows to change the current	Completed	N/A	Current is changed. From the default 100 μ A, the up arrow increments of 50 μ A and down arrow decrements of 100 μ A	Success	No Run	
			TC14	Device Overloads	1) Device exceeds 700uA	Completed	Custom Overload Button	Device Disables and shuts off	Success	No Run	
			TC15	Clips Disconnect	1) Disconnect Clips after treatment has begun	Completed	N/A	The device will pause. If the clips are not reconnected in 5 seconds, the device will shut off	Success	No Run	
			TC16	Battery gets to 2%	1) Device is running and battery gets down to %2	Completed	Battery : %2	Device Powers OFF	Success	No Run	
			TC17	Battery gets to 5%	1) Device is running and Battery gets down to %5	Completed	Battery: %5	Displays Low Battery Signal	Success	No Run	
			TC18	Timer Runs Out	1) Allow Timer to Run down to Zero	Completed	Time: 20 mins, 40 mins and 60 mins.	Device Powers OFF	Success	No Run	
			TC19	Battery Drains faster on Higher Current	1) Increase Current during procedure	Completed	Current: from 250ua to 500ua	Battery Level Drains faster	Success	No Run	
			TC20	Idle Timer Runs Out	1) Allow device to remain idle for 30 Mins	Completed	N/A	Device Powers OFF after being idle for 30 Mins	Success	No Run	