McMaster University

Project Deliverable #3

EMG Capturing Software

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Course: 3RQ3 – Software Requirements and Specifications
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1 Introduction

This application will be designed to interface, capture and analyze electromyography (EMG) signals from a portable EMG device. EMG signals are biomedical signals that measure the muscle fiber potential (muscle action). These signals can be used for diagnosing muscle response for both medical and fitness purposes [3].

2 Description

2.1 Definitions

Noun	Definition
Electromyography (EMG)	diagnostic procedure to assess the health of muscles and the nerve cells that control them (motor neurons)
EMG signal	biomedical signal that measures electrical currents generated in muscles during its contraction representing neuromuscular activities
USB (Universal Serial Bus)	industry protocol for communication and power transfer from device to device
BT (Bluetooth)	industry wireless protocol for communication between devices
Filter (signal processing)	method for removing unwanted components of a signal and highlighting wanted components

Table 1: Definitions

2.2 System outline

The application will be composed of a graphical user interface that contains a suite of controls to manage and display the capturing of the data from the EMG device. The application will display data as it's being captured as well as provide the user with the option to save and recall the data for offline analysis.

2.3 Users

The end-users of the application will include:

- Private customer
- Trainer
- Nurse
- Doctor

2.4 Owners

The owners and maintainers of the application will include:

- Private customer (ex. a fitness practitioner or private clinic)
- Hospital
- Software company

The maintenance including bug fixes will be completed via automatic software updates.

2.5 Use Case Diagrams

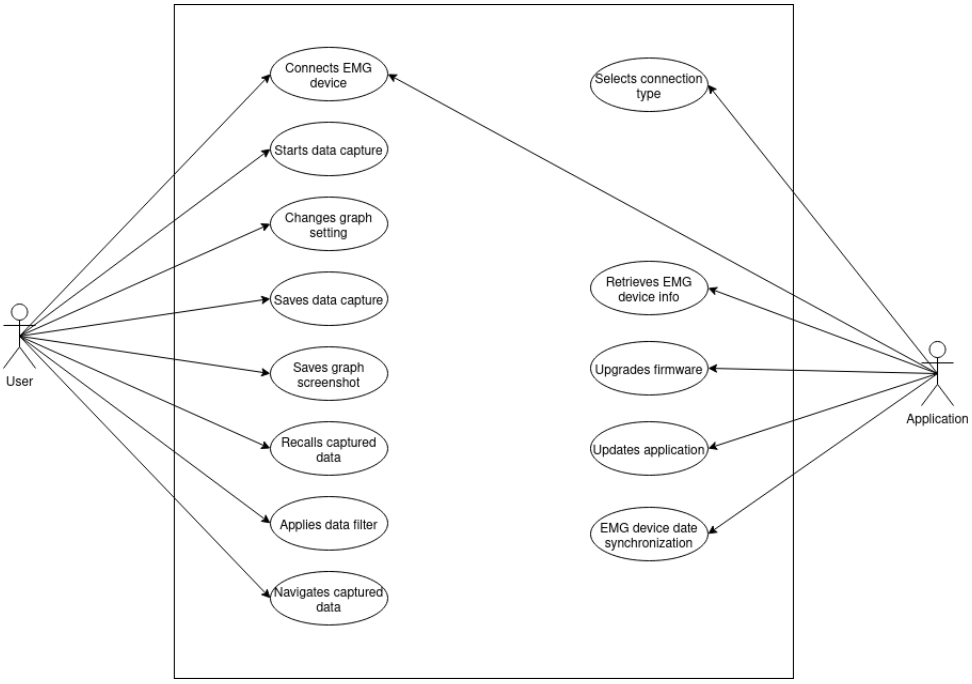

Figure 1: Use Case Diagram

3 Constraints

- The application must be available on both Windows and Mac operating systems
- The application must interface existing EMG devices on the market, few devices include:
  - Roam NXT by Laborie company
  - Goby IV by Laborie company
  - Solar Blue by MMS company
- Application host device must be connected to the internet for software updates

4 System features

4.1 Menu bar

The application must feature a menu bar from which common menu items will be available such as: help, settings, file open/close etc.

4.1.1 Status bar

The application must feature a status bar where information regarding the EMG device such as: connection type, connection status and device serial number.

4.1.2 Closing the application

The user shall be alerted if attempting to close the application during a capturing session.

4.1.3 Out of range data

The user shall be notified if the captured data falls out of range of the current graph setting.

4.2 Data capture

The application shall be able to capture the EMG signal from the device and save it onto the host of application.

4.2.1 Device connection methods

The device capture should be made via the following two means of device connection:

- Wired - via USB connection
- Wireless - via Bluetooth connection

4.2.2 Data capture properties

Property	**Limits**
Number of channels	up to 2 channels of EMG data
Signal amplitude	+/- 10mV
Signal bandwidth	1Hz to 5000Hz

4.3 Data capture length

The application shall be able to continuously capture up to 1 hour of data.

4.3.1 Live data capture

The application shall capture the live EMG signal form the connected device and display on the graph.

4.3.2 Filter library

The application shall feature filters implemented using an internal libraryf for noise and data filtering.

4.3.3 Filtering method

The filters shall be able to run in real-time as the data is being captured by the application. The filters shall also be able to be applied during on data that was recalled.

4.3.4 Noise filtering

The application shall be able to filter DC to low frequency noise (< 100Hz) and high frequency noise (> 5000Hz).

The following are some critical unwanted signals to filter:

- Signals (< 100Hz): 50/60Hz electrical utility frequency signals
- Signals (> 5000Hz): AM/FM radio signals

Refer to following link for more signal types: [4] Canadian Table of Frequency Allocations

4.3.5 Data filtering

The following filters shall be made available to be applied on the captured data:

- moving average - running average filter to smoothen the data
- peak - filter to highlight the peaks of a signal
- low-pass filter - filter to remove signal components beyond a certain cut-off frequency
- high-pass filter - filter to remove signal components below a certain cut-off frequency

4.3.6 Application graph

The application shall feature a graph that takes up majority of the screen on the main page.

4.3.7 Graph settings

The user shall be able to select the following settings of the graph:

- Horizontal scale (time measured in seconds)
- Vertical scale (amplitude measured in millivolts)
- Grid scale
- Adding and removing of x and y markers
- Background color of the graph

- Color of the grid
- Color of the trace (data)
- Color of the markers

4.3.8 Data navigation

The user shall be able to navigate the data along the time axis from start to finish.

Capture Complete	Graph mode	Navigation type
Yes	User view mode	Able to use navigation bar
No	Real time capture	Navigation bar disabled

4.3.9 Graph screenshot

The user shall be able to save the current screenshot of graph to a (.png) image format on the application host via a button.

4.3.10 Data saving

The user shall be able to save the raw captured data in (.csv) format along with information about the application version and EMG device (hardware/firmware version and serial number).

4.3.11 Data recall

The user shall be able to recall up to two saved captured data in (.csv) format simultaneously and display it on a single graph.

5 Interface

5.1 Connecting to an EMG device

The application shall allow the user to connect to an existing two channels EMG device.

5.1.1 Connection type

The application shall allow the user to connect to an EMG device via:

- Wired connection
- Wireless

5.1.2 Retrieving device information

The application shall allow the user to retrieve EMG device information such as:

- device local time
- battery status
- firmware version
- hardware version
- serial number

5.1.3 Firmware upgrade

The application shall be able to complete firmware updates automatically if available.

5.1.4 Date synchronization

The application shall automatically synchronize the EMG device local time with the local time of the application.

6 Quality attributes

6.1 User Interface

The application shall have an intuitive interface with support for a touch screen interface.

6.1.1 Application instances

The user shall be limited to opening only once instance of the application.

6.1.2 Touch intuitive controls

The controls of the interface shall be sufficiently large such that an user could access it via a touch screen.

6.1.3 Data display

The application shall display the captured date from the EMG device with a delay $\leq$ 0.5s

6.1.4 Data Recall

The application shall be able to recall saved data (up to 1 hour long) in no less than 1 minute.

6.2 Device connection

6.2.1 Device connection

The user shall be able to connect to the EMG device within 1 minute of opening the application.

6.2.2 Device wireless disconnection

In case of EMG device wireless disconnection the application shall be able to re-connect and continue capturing within 15 seconds.

6.2.3 Device unresponsiveness

In case of EMG device becoming unresponsive the application shall make the user aware within 30 seconds.

6.3 Standards compliance

The application must be compliant with IEC 62304:2006 standard.

7 Data Requirements

7.1 Overview

- EMG device - will track the EMG devices that are connected to the application. User can potentially connect many devices to host however, only one device can be connect to application and capturing. This class will only be useful for firmware updates.
- Data capture - will contain and track the EMG data that is being captured by the application
- Data recall - is a relationship with the data capture inheriting all of its methods and attributes. Additional attributes such as date of capture and total length of data captured are added as useful information
- Graph - will track the main graph along with its possible two channels and different settings of each individual channels. Since there is only one graph, some settings of individual channel like scales and colors are common, however each channel could have individual markers and marker colors as well as trace color
- Channel - since we have two channels we need to track the settings to each individual channel
- Settings - contains the many settings that can be applied to a channel within the single graph
- Filter - contains information about the filter types and orders (how intense the filter is). Multiple filter types can be applied to the data capture (high, low-pass etc.)
- Filter types (low, high, average, peak) - is a relationship with the filter class. Each filter type in itself can branch to many subtypes and have different properties such as cut-off frequencies, amplitude, weight

7.2 Class Diagrams

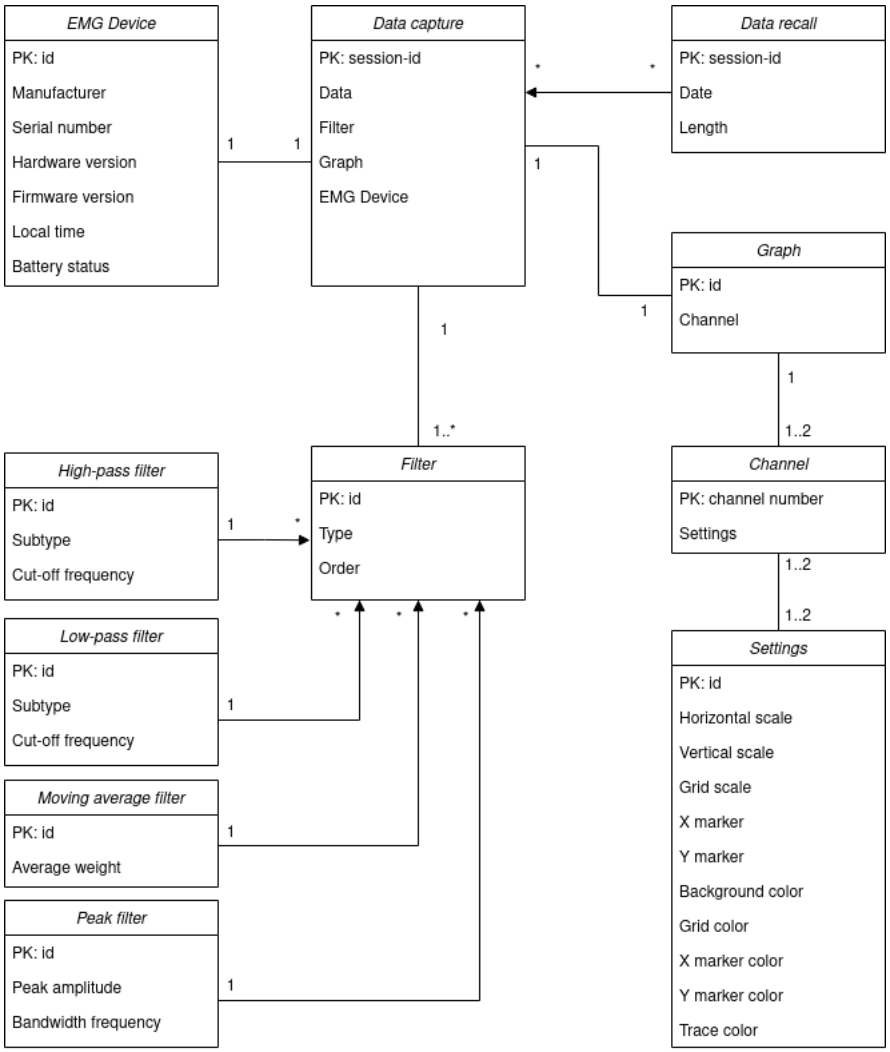

Figure 2: Data Classes

Appendix

A Background Research

My background research is mostly due to my industry experience in the field. However, I heavily referenced [1] and [2] to draw some ideas for the most critical features that an EMG capturing application would have. Obviously, graphing is the most important feature which both of the applications provided by Biometrics and Laborie do. Along with that they offer the ability to customize the graph in terms scale, colors and ability to add markers for measurements. Additionally, both offered the ability to save the capture data and recall for later analysis with optional features of saving a quick image capture of the graph. Another optional feature that each offer is the ability to filter the data using standard array of filters. I decided to include the basic array of filtering for now, but other types can always be added in later revisions of the application.

B Scenarios

B.1 Adding a new EMG device

B.1.1 Positive Normal

1. User connects to a new EMG device
2. Application retrieves EMG device information
3. EMG device confirmed acceptable
4. Date is synchronized with the device
5. Device is ready to be used to capture data

B.1.2 Positive Normal

1. User plugs in device into host computer via USB cable
2. Application automatically connects to device
3. Date is synchronized with the device
4. Device is ready to be used to capture data

B.1.3 Positive Normal

1. User pairs EMG device with host computer via Bluetooth
2. Application automatically connects to device
3. Date is synchronized with the device
4. Device is ready to be used to capture data

B.1.4 Postive Abnormal

1. User connects to a new EMG device
2. Application retrieves EMG device information
3. EMG device confirmed unacceptable
4. Error message is displayed that the device is not compatible

B.1.5 Postive Abnormal

1. User does not pair EMG device via BT or connect via USB connection
2. User tries to connect EMG device
3. After 1 minute of waiting time, the connection times out
4. Warning message displayed that the device could not be found

B.1.6 Negative

1. User connects an unsupported EMG device
2. Application does not recognize EMG device information
3. Error message is issued to user that device might not be supported

B.2 Capturing data

B.2.1 Positive Normal

1. User clicks on "Start Capture" button
2. Application triggers the EMG device to start capturing
3. Application graph is updated with incoming data from EMG device

B.2.2 Positive Normal

1. User selects filter type from a list
2. Application applies filter onto the captured data

B.2.3 Positive Abnormal

1. Application is capturing from EMG device via Bluetooth
2. A Bluetooth disconnection occurs
3. Application recovers and reconnects to EMG device
4. Application continues capturing EMG data

B.3 Graphing data

B.3.1 Positive Normal

1. User starts capturing data from EMG device
2. Application starts displaying data on the graph
3. User adjusts the graph vertical and horizontal scales
4. User adds markers to the graph
5. Data is captured up to 1 hour in length

B.4 Saving and recalling data

B.4.1 Positive Normal

1. After a capture user saves data onto local disk
2. Application saves data in (.csv) format onto disk

B.4.2 Positive Normal

1. User recalls saved data set from local disk
2. Graph is populated with data in channel 1
3. User recalls another saved data set from local disk
4. Graph is populated with data in channel 2

B.4.3 Negative

1. User tries to open a file format different than (.csv)

References

[1] Biometrics Ltd, *"Biometrics Analysis software."*, Accessed 2020-10-28, www.biometricsltd.com/emg-software

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[4] Laborie Medical Technologies, *"Canadian Table of Frequency Allocations"*, Accessed 2020-11-18, www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10759