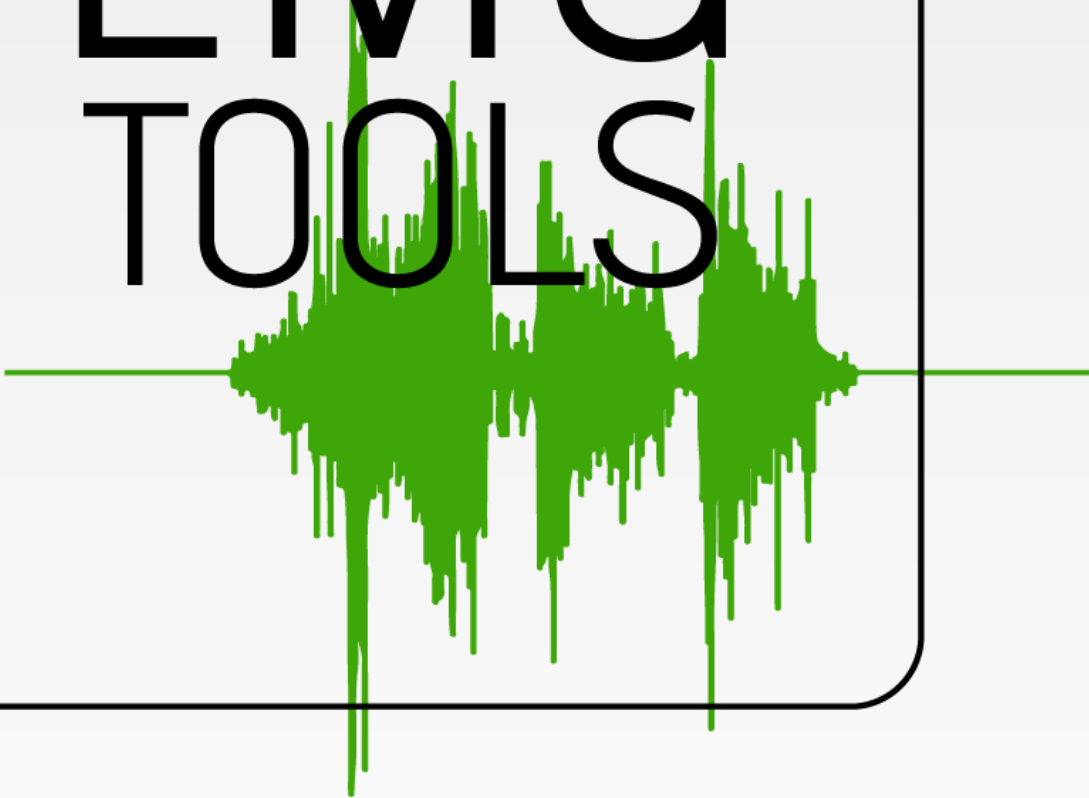# EMG TOOLS

Version 1.0
Program Manual

Introduction

EMG Tools is designed to be an easy to use, quick, and basic EMG processing program. Instead of spending time writing bespoke scripts and worrying about coding errors, EMG tools lets you process your data and get back to what's important.

In research, transparency is paramount. EMG Tools is a fully open-source project and the source code is freely available for inspection and/or modification. It has been programmed in the MATLAB language, a common data processing tool used by a wide audience.

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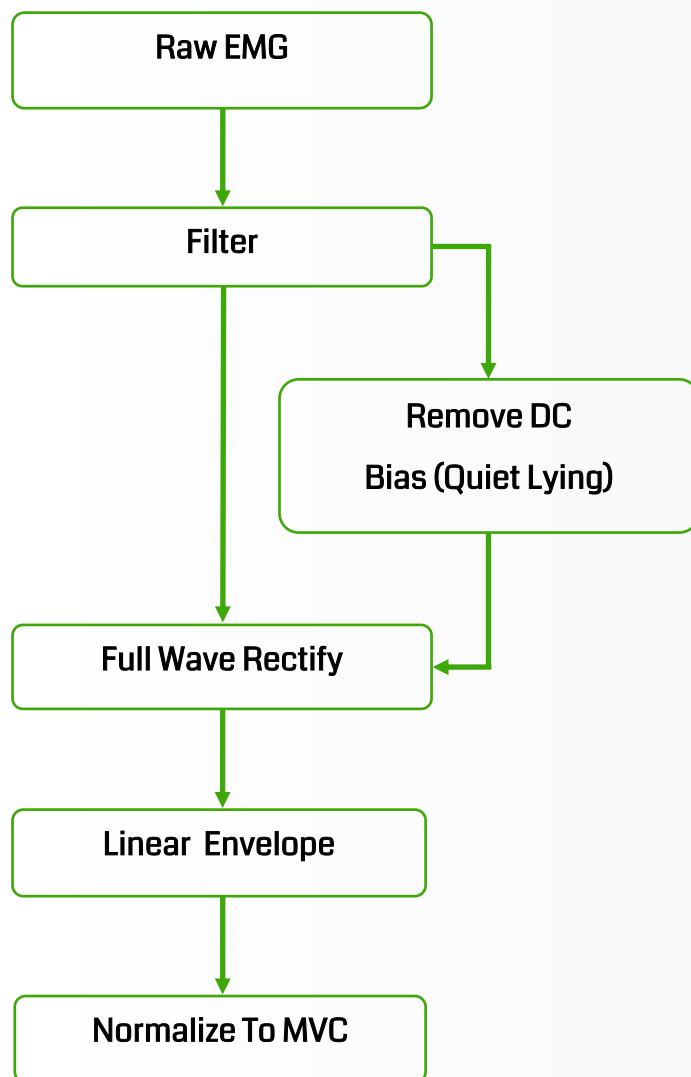You should have received a copy of the GNU General Public License along with this program. If not, see http://www.gnu.org/licenses/

Contents

What Does EMG Tools Do?

EMG Tools was built to process up to 16 channels of raw EMG in the time domain. It takes raw EMG files in .csv format and returns linear enveloped data that is normalized to a maximal voluntary contraction (MVC).

Output options include .csv files of the processed data both in fully sampled and downsampled formats.

```
          ┌─────────────────┐
          │     Raw EMG     │
          └────────┬────────┘
                   │
                   ▼
          ┌─────────────────┐
          │     Filter      │──────────┐
          └────────┬────────┘          │
                   │                   ▼
                   │         ┌───────────────────┐
                   │         │     Remove DC     │
                   │         │ Bias (Quiet Lying)│
                   │         └─────────┬─────────┘
                   ▼                   │
          ┌─────────────────┐         │
          │ Full Wave Rectify│◄────────┘
          └────────┬────────┘
                   │
                   ▼
          ┌─────────────────┐
          │ Linear  Envelope│
          └────────┬────────┘
                   │
                   ▼
          ┌─────────────────┐
          │ Normalize To MVC│
          └─────────────────┘
```

Running EMG Tools

There are two options for running this program, from a standalone application or within MATLAB.

In order to run this program as a standalone application, you first need to install it from the EMGtools.exe file. The installer will make sure that you have the Matlab Compatible Runtime installed on your computer. If you do not, you will be prompted to download and install it. Currently, the standalone version of this program runs on 64-bit Windows machines.

To run this program from within MATLAB, point the file directory to the EMG_Tools folder which contains all of the .m and .fig files required by the program. Double-click on the EMG_process.m file, then hit the green 'play' button on the menu bar at the top.

Program Overview

The interface is set up to be able to apply all settings in a single window.

Setting up all the desired parameters involves following a series of steps labelled at the top of each panel in the program. Simply follow the steps top to bottom, left to right.

At the far right is a channel selection feedback window. This shows the user which channels are to be normalized by the corresponding channel in the MVC files. It also shows which quiet lying trials are to be subtracted from which channel in the data files.

Step 1: Data Import

Step 1

select row/column to import:

R 6   C 3

import range:

R [ ] : [ ]   C [ ] : [ ]

import separate columns:

R [ ]

C [ ] [ ] [ ] [ ] [ ]

Select Number of Channels ⌄

Sample Rate:

2160

MVC File Directory:

QL File Directory:

There are three options for importing data from your .csv files. Data ranges start counting from 1 NOT 0.

select row/column to import:

R 6   C 3

The normal import option simply allows for the selection of the row and column in the raw data file to start importing from.

import range:

R [ ] : [ ]   C [ ] : [ ]

The range import option allows for the selection of a range of rows and columns to import from. Ranges are inclusive (eg. columns 3:5 includes column3, 4, and 5). It is important to note that even with this option MVC and Quiet Lying files are still imported using the normal fashion so that maximum contraction values are not skipped over.

import separate columns:

R [ ]

C [ ] [ ] [ ] [ ] [ ]

The separate column option allows for the import of anywhere from 1 to 5 separate columns from the raw data files.

Step 1

select row/column to import:

R [6] C [3]

import range:

R [ ] : [ ] C [ ] : [ ]

import separate columns:

R [ ]

C [ ] [ ] [ ] [ ] [ ]

Select Number of Channels [∨]

Sample Rate:

[2160]

MVC File Directory:

QL File Directory:

Select Number of Channels [∨]

The number of channels to process can be between 1 and 16. It is important to note that this is the number of channels being imported, not the number of channels total in your raw file. It should also be noted that if you were to import say, only the seventh and eighth channels from your raw data, they would be classified in the program as channels 1 and 2, be sure to normalize them accordingly.

Sample Rate:

[2160]

Enter the rate that the data was sampled at.

MVC File Directory:

QL File Directory:

The directory display shows where the program is pulling MVC and Quiet Lying files from. This allows the user to confirm that they are being taken from the correct directory.

Step 2: MVC and Quiet Lying

This button brings up a file selection window that prompts the user to select all of the MVC files they would like to import for processing a particular set of data files.

After selecting the desired MVC files, this drop-down menu becomes populated with the imported filenames.

The channel list box contains all of the channels being processed and is used alongside the MVC file drop-down menu. Highlight the channel to normalize to a particular MVC file and then click on the filename in the drop-down menu. This updates the visual feedback window on the far right to indicate the choice made.

☑ Remove Quiet Lying?

Check this box to enable controls for quiet lying data.

Import Quiet Lying

This button brings up a file selection window that prompts the user to select all of the quiet lying files they would like to import for processing a particular set of data files.

Pick QL Trial for Selected Channel(s):

Quiet Lying on Back 1.CSV
Quiet Lying on Back 1.CSV
Quiet Lying on Front.CSV

After selecting the desired quiet lying files, this drop-down menu becomes populated with the imported filenames.

The channel list box contains all of the channels being processed and is used alongside the quiet lying file drop-down menu. Highlight the channel to normalize to a particular quiet lying file and then click on the filename in the drop-down menu. This updates the visual feedback window on the far right to indicate the choice made.

Step 3: Filter Parameters

There are two filter options, a bandpass filter and a butterworth filter. Select the desired filter.

Frequencies below this cutoff will be removed if you are using a bandpass filter, if you are using a butterworth filter this is not used.

Frequencies above this cutoff will be removed. This value is used for both the bandpass and butterworth filters.

Sets the order of the filter selected above.

Sets the desired cutoff frequency of the linear envelope filter (built from a butterworth filter).

Sets the order of the linear envelope filter.

If downsampled data is desired, the downsample frequency is set here.

Step 4: Export Options

□ Export Files

Checking this box will prompt the program to export your processed data as .csv files.

□ Export Downsampled Files

Check this box if you want your processed data downsampled. Downsampled files will be created alongside your normal processed files if both options are selected.

□ Graph Data

Checking this box will produce quick graphs of your processed data. It can be used as a quick 'gut check' to just have a look at your data as it is being processed to see if it makes sense.

Run

Hitting this button will first prompt you to select all of the data files that you want processed and then it will run the main program and process all of the data files that you have selected.

Clear Figures

Clears any figures created during processing (Graph Data option).

Reset Fields

Reset everything in the program to default values.

Text written underneath imported data

One of the most common errors is having text underneath the data that is being imported in the raw files.

).05127	-0.0148	0.01648	0.005341	0.000687	0.007477	0.036774	-0.00366	-0.00443	-0.0235	0.008545	-0.0(
).05234	-0.01099	0.018463	0.001984	-0.00679	0.011063	0.028076	-0.00816	-0.01251	-0.01434	0.00473	-0.(
).05188	-0.01373	0.018158	0.006409	-0.00153	0.027466	0.037079	0.005569	-0.0103	-0.0116	0.000381	0.00:
).05188	-0.01343	0.014648	0.004425	-0.01183	0.028305	0.032501	-0.01091	-0.01007	-0.01236	0.00061	0.00:
				Box 1 - Voltage							
2'	Mx2'	My2'	Mz2'	mrUES'	mrLES'	mrLD'	mrRA'	mrEO'	mrIO'	mrGMax'	mrBF'
5	V/s	V/s	V/s	V/s	V/s	V/s	V/s	V/s	V/s	V/s	V/s
7.25098	-7.91016	2.30713	-6.92139	-0.1648	15.4907	-4.28467	-16.6443	5.43823	18.9514	-0.49439	4.7:
2.30713	-0.65918	2.30713	11.2061	4.61426	-13.0188	-2.30713	15.1611	21.0938	18.1274	9.22852	-5.2:
3.95508	6.92139	-0.98877	-12.5244	-11.2061	-2.96631	7.41577	0.65918	-28.1799	17.7979	-10.0525	-3.:
7.58057	-5.27344	-8.89893	1.64795	16.9739	-1.97754	-8.40454	-5.60303	-9.8877	0	-3.62549	19.4

Ensure that there is only numerical data in the region being imported.

Using the range import option and specifying a range that is larger than some of your files

If you attempt to use the range import method, it is very important that you ensure that within the range you have specified there are enough data points in ALL of your files. If some of your files are shorter than others and there isn't enough data in them to span the entire range you've told the program to import, the program will throw an error. Usually this import option is not the best choice, it is recommended to choose one of the other options for all but the most specific processing applications.

Wrong rows and columns selected:

Please double-check the rows and columns you've selected to import, the program starts counting the first row/column as row/column 1 and the second row/column as row/column 2, etc.

Troubleshooting

Further Issues

Further problems with the program or any bugs can be reported to Christian Balkovec at: cbalkovec@gmail.com

Acknowledgements

During the initial development of this program's predecessor, a great deal of assistance was provided by Dianne Ikeda. This process was (and still is) a learning experience and I would like to thank her for all the guidance and help.