EMG Signal Simulator

This package contains routines for simulating normal and pathological EMG signals (Hamilton-Wright and Stashuk, 2005), a command-line user interface, and a graphical user interface. The routines are written in C and have been compiled for both the PC and the non-Intel Mac. The command-line interface runs in a Dos window (PC) or Terminal window (Mac). The graphical interface runs in Matlab.

To run the command-line version, run simtext from the MAC or PC folder. For more information on the command-line interface, see the enclosed file SimulatorGuide.pdf.

For more information on the theory of the simulator and the specific parameters, see: Hamilton-Wright A, Stashuk DW. Physiologically based simulation of clinical EMG signals. IEEE Trans Biomed Eng, 52:171–183, 2005.

Using the Graphical Interface.

To run the simulator from Matlab, cd to the simulator directory and then type "simulator" at the command prompt. This will bring up the main simulator dialog.

Select the muscle, type of electrode, and number of contractions to be simulated. Then press the "Run Simulation" button. Each simulation may take a minute or more. The status output from the simulation routines is displayed in a separate window.

The program creates the following files for each contraction:

rootnameNN.dat	EMG signal
rootnameNN.hea	WFDB header file (allows signals to be read by EMGlab)
rootnameNN.eaf	annotation file (in EMGlab format)

where "rootname" is the root filename (see below) and "NN" is the contraction number.

Simulator Panel Options.

Muscle: This popup shows the muscle being simulated. You can select from the list of already defined muscles or select "Custom..." to define a new one. Clicking the edit button allows you to modify the muscle parameters. The "Muscle" panel allows you to save new or modified sets of muscle parameters. See SimulatorGuide.pdf for more information about the parameters.

Electrode: This popup shows the electrode being simulated. You can select from the list of already defined electrodes or select "Custom..." to define a new one. Clicking the edit button allows you to modify the electrode parameters. The "Electrode" panel allows you to save new or modified sets of electrode parameters. See SimulatorGuide.pdf for more information about the parameters.

Selecting "Multiple Electrodes" allows you to simulate simultaneous recordings from more than one electrode. Select "Add" from the number popup to add a new electrode. Each electrode can be of a different type. If you specify multiple electrodes, then the program creates separate data files for each electrode. The signal from the first electrode is still named rootnameNN.dat, and the signals from the other electrodes are named rootnameNNcI.dat, where "I" is the electrode number.

Advanced: This allows you specify some advanced simulation preferences.
Include all units: This causes the firing patterns of all the active motor units to be included in the annotation file, not just the ones closest to the electrode.

Output directory: Specifies the directory in which to write the data files. The default directory is the Data subdirectory in the Simulator directory.

Output root filename: Specifies the root filename for the output files.

Signal duration: Specifies the length of each signal, in seconds.

Contraction: Selects a contraction. To add additional contractions select "Add" from the popup.

%MVC: Specifies the contractile level for the selected contraction.

Position: Specifies the x, y, and z electrode locations (in mm) for the selected contraction. The z coordinate is the distance from the muscle endplate along the muscle axis. Use the "electrode" popup to specify locations for multiple electrodes. Note that you can specify different locations for each electrode in each contraction.

Delete: Deletes the current contraction.

Run Simulation. Runs the specified set of simulations (one simulation per electrode per contraction). The simulations can take a fair amount of time, depending on the specified signal duration. The trace statements from the simulation routines are displayed in the command window.

Cancel. Quits the simulator and returns to Matlab.

Examples.

1. Simulate concentric-needle EMG signals at 10%, 20%, and 30% of MVC.

Select the generic muscle and electrode. Specify the desired output directory, root filename, and signal duration. With the contraction popup showing "1", enter "10" into the %MVC box. Then select "Add..." from the contraction popup. Enter 20 into the %MVC box for contraction 2. Select "Add..." again, and enter 30 into the %MVC box for contraction 3. Use the same electrode position for each contraction.

Now run the simulation. Suppose you chose "SIM" for the root filename. The program will produce 3 data files: SIM01.dat, SIM02.dat, and SIM03.dat. They will contain signals from the same site in the same muscle at the three levels of contraction.

2. Simulate multi-channel monopolar EMG signals.

Suppose you want to simulate monopolar signals from two points 10 mm apart along the muscle axis. Select the generic muscle. Click the multiple electrodes check box. For electrode 1, select "Custom...". In the Electrode Panel select "monopolar" for electrode type and "tip only" for the tip/cannula reference setup, and edit the name to be "monopolar". Then click "OK." Now select "Add..." from the electrode popup. The second electrode type will come up as monopolar by default.

Specify the desired output directory, root filename, and signal duration. For each contraction, use the electrode popup to enter the electrode positions for each electrode. The fiber axis is specified by the Z coordinate, so you could specify 0, 0, 15 for electrode 1 and 0, 0, 25 for electrode 2. If you want multiple contractions you must re-enter the electrode positions separately for each contraction.

Now run the simulation. If you chose "M" for the root filename and 2 contractions, then the program will produce 4 data files: M01.dat and M01c2.dat (channels 1 and 2 of the first contraction), and M02.dat and M02c2.dat (channels 1 and 2 of the second contraction.)