EPOC Simulink EEG Importer

User Manual

Version 1.2

Contents

1 Description

Simulink® developed by MathWorks, Inc. is a popular commercial tool for modeling, simulating and analyzing multidomain dynamic systems. The Epoc Simulink EEG Importer provides the real-time EEG data acquired by the Emotiv Epoc headset to a Matlab Simulink model.

A Simulink block receives the EEG data in a vector format and it can be used for further processing in the Simulink environment. The Simulink block is created out of a Matlab mex S-Function and has a double[22] data vector as output. Each call to the Simulink block returns with a data sample including the following data: COUNTER, AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4, GYROX, GYROY, TIMESTAMP, FUNC_ID, FUNC_VALUE, MARKER, SYNC_SIGNAL.

2 Setup

2.1 Requirements

- Microsoft Windows 7 (x86/x64) or Microsoft Windows XP (x86/x64 with SP3)

- Matlab R2012a, R2011a, R2011b, R2010a, R2010b, R2009b or R2007b

- Microsoft .NET Framework 4.x

- Emotiv EPOC Researcher Edition, Education Edition or Enterprise Plus Edition for raw EEG data access

2.2 Installation

1. After successfully purchasing the *Epoc Simulink EEG Importer* from the emotiv app-store go to the *MY EMOTIV* section and click on *MY PURCHASES*. In the displayed list of your application purchases you will find the *Epoc Simulink EEG Importer*. Click the download button and save the *EpocSimulinkImporter_v1.zip* file on your computer. Remember the location where you save the importer, it will be referred to as *EpocSimulinkImporter* folder.

2. Go to your Emotiv Epoc software installation directory (e.g. for the 1.0.0.5 Research Ed. go to: *C:\Program Files (x86)\Emotiv Research Edition SDK_v1.0.0.5-PREMIUM*). Copy the files: *edk.dll* and *edk_utils.dll*. Paste both files in the *EpocSimulinkImporter* folder.

3. Run the *EpocSignalServer.exe* from the *EpocSimulinkImporter* folder. Press the *START* button in the EpocSignalServer window. Make sure that the Server Status, User Status and Signal Status icons are highlighted in green. Compare with figure 1 for a correctly running EpocSignalServer. If any of those icons does not turn green, see section 4.2 for more information.
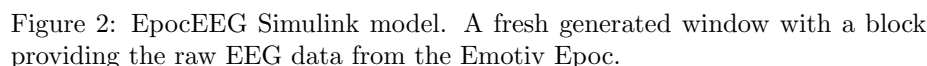
Figure 1: Epoc-Simulink SignalServer GUI. All three status icons must be high-lighted in green to provide EEG data for Simulink.

4. Run Matlab and change the current folder (or working directory) to the *EpocSimulinkImporter* folder. Load the *EmotivEpocEEG_workspace.mdl* Matlab workspace. If done correctly you should now see a variable called *def* in your Matlab workspace.

5. Enter the command: *legacy_code('slblock_generate', def);*

6. You should now have a *untitled ** Simulink model with a *EpocEEG(double y1[22])* block (see figure 2).

7. Open *Simulation → Configuration Parameters...* and change the Solver options Type from *Variable-ste*p to *Fixed-step*. Change the Solver from *ode3 (Bogacki-Shampine)* to *discrete (no continuous states)*. As *Fixed-step size (fundamental sample time)* enter: *1/128*.

8. **OPTIONAL:** For testing purposes you can attach a *Scope* block to the *EpocEEG(double y1[22])* block (see figure 3). Double-click on the *Scope* block and press the *Start simulation* button. You should now see 10 seconds of real-time data received from the Epoc headset in the Scope window.

3   Important Information

3.1   Data Format

The generated *EpocEEG(double y1[22])* block generated by the *legacy_code*– command provides a double vector of the size 22. The data vector contains

Figure 2: EpocEEG Simulink model. A fresh generated window with a block providing the raw EEG data from the Emotiv Epoc.

elements in the following order: COUNTER, AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4, GYROX, GYROY, TIMESTAMP, FUNC_ID, FUNC_VALUE, MARKER, SYNC_SIGNAL.

3.2   Package Size and Network Buffers

The EpocSignalServer collects EEG data samples and uses a TCP/IP socket to transfer the raw data to the Simulink S-Function. Since the Epoc samples with 128 samples per second (SPS) it may not be possible for the network stack to pack each sample in a single TCP/IP package and send it to the Simulink model. In the EpocSignalServer you can find an option called *samples per network package*. This number defines how many samples are collected by the server before it will generate a TCP/IP message and send it to the Simulink model. This value can be changed any time on the fly.
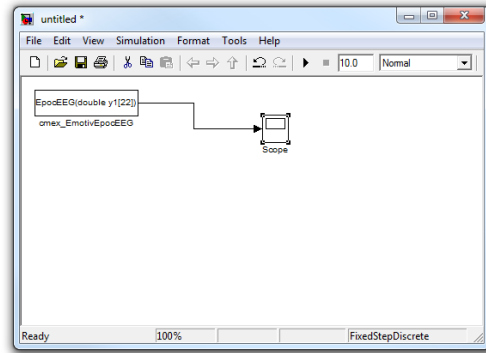
    The smaller the number the more real-time the Simulink model will be. If you have a package size of 1 sample, the Simulink model will run at the exact same rate as the Epoc headset (128 SPS). A smaller package size causes more frequent traffic on the network stack and may result in loss of data. Change the value to a higher number if you encounter any warnings about lost or incomplete data packages.
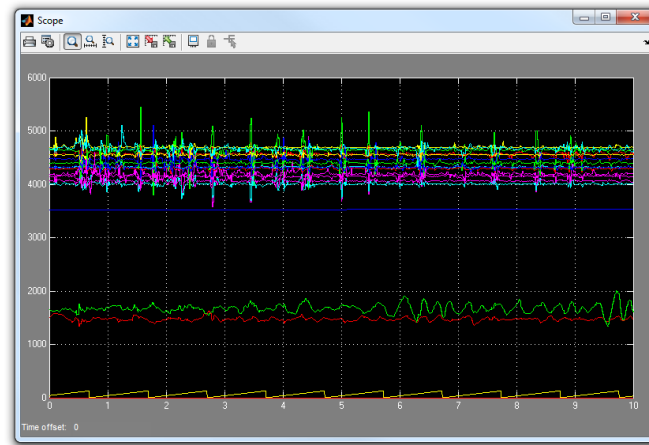
4   Troubleshooting

4.1   EpocSignalServer does not start

4.1.1   Firewall or Antivirus warning

The EpocSignalServer.exe uses the localhost (127.0.0.1) to send the raw EEG data to Simulink. No internet connections are required for the importer, yet

(a)

(b)

Figure 3: Simulink test model. (a) shows the Simulink model to display the raw EEG data. (b) shows the Scope displaying 10 seconds of real-time EEG data.

firewall programs may consider the EpocSignalServer.exe as harmful since it uses TCP/IP on your local PC. Make sure that the access to the localhost is not blocked by any firewall or antivirus software.

4.1.2   MSVCR100.dll missing

Error Message: The program can't start because MSVCR100.dll is missing from your computer. Try reinstalling the program to fix this problem.

Solution:

1. Go to `http://www.microsoft.com/en-us/download/details.aspx?id=5555`

2. Download the "Microsoft Visual C++ 2010 Redistributable Package (x86)"

3. Install the "Microsoft Visual C++ 2010 Redistributable Package (x86)"

4.1.3   edk.dll missing

Error Message: The program can't start because edk.dll is missing from your computer. Try reinstalling the program to fix this problem.

Solution:

1. Go to your Emotiv software installation directory
   For example the 1.0.0.5 Research Edition is found in (x86/x64):
   C:\Program Files\Emotiv Research Edition SDK_v1.0.0.5-PREMIUM
   C:\Program Files (x86)\Emotiv Research Edition SDK_v1.0.0.5-PREMIUM

2. Copy the edk.dll from your Emotiv software installation directory

3. Paste the edk.dll in the EpocSimulinkImporter directory

4.1.4   edk_utils.dll missing

Error Message: The program can't start because edk_utils.dll is missing from your computer. Try reinstalling the program to fix this problem.

Solution:

1. Go to your Emotiv software installation directory
   For example the 1.0.0.5 Research Edition is found in (x86/x64):
   C:\Program Files\Emotiv Research Edition SDK_v1.0.0.5-PREMIUM
   C:\Program Files (x86)\Emotiv Research Edition SDK_v1.0.0.5-PREMIUM

2. Copy the edk_utils.dll from your Emotiv software installation directory

3. Paste the edk_utils.dll in the EpocSimulinkImporter directory

4.1.5   .NET Framework: v4.0.30319 missing

Error Message: To run this application, you must first install one of the following versions of the .NET Framework: v4.0.30319 Contact your application publisher for instructions about obtaining the appropriate version of the .NET Framework.

Solution:

1. Go to `http://www.microsoft.com/net/download`

2. Download and install the *.NET Framework 4 Client Profile.*

4.2   EpocSignalServer Status Icons

These icons represent the connectivity of the EpocSignalServer. To properly acquire and send EEG data to a Matlab Simulink model it is necessary that all of these three icons are highlighted in green.

4.2.1   Server Status

This icon indicates if the EpocSignalServer is able to connect to the EmoEngine and establish a listening TCP/IP socket. By pressing the START button in the EpocSignalServer the icon should highlight green. If the EpocSignalServer is not able to connect to your EmoEngine, please refer to the Emotiv Epoc manual for installing the EmoEngine correctly.

    If any network related errors are displayed in the System Messages box, please check your firewall or antivirus settings. These programs may block the EpocSignalServer from establishing a network connection on your local machine. **NOTE:** No internet connection is established by the EpocSignalServer! The network traffic is completely limited to your loacalhost (127.0.0.1) and no data is sent or received from external sources!

4.2.2   User Status

The User Status indicates if a user is connected to the EmoEngine. Currently only data import from one single user is supported by the EpocSignalServer. If the Emotiv Epoc USB transceiver dongle is attached and installed correctly, the User Status icon is highlighted in green. First make sure that the EpocSignalServer is running and the Server Status icon is highlighted in green. If the User Status icon remains gray, try unplugging the Epoc USB transceiver dongle from your system. Plug in the USB transceiver dongle and wait a few seconds for your machine to recognize the device correctly.

4.2.3   Signal Status

The Signal Status indicates the wireless connection quality between the Epoc headset and the USB transceiver dongle

4.3   Matlab lost or incomplete packages

Warning Message: Warning: incomplete or empty data package received!

Solution:

1. Make sure your network stack and processor is not occupied by any other applications. Stop all CPU intense applications and downloads.

2. If the problem remains, try increasing the number of *samples per network package* in the EpocSignalServer GUI window. For more information about the *samples per network package* option, see section 3.2.

5   Further Information

5.1   Contact

For further information and support contact us per e-mail under: info@xcessity.at. For further materials by Xcessity, visit our website: *http: // www. xcessity. at* .

5.2   Legal Notice

The software is provided "as-is," without any express or implied warranty. In no event shall Xcessity be held liable for any damages arising from the use of the software.