

Online Combination of Matlab and Somnologica for Polysomnography

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Abstract

We have developed a preliminary setup for online combination of programming environment Matlab with the commercial polysomnography software Somnologica. With the setup Matlab algorithms can be used within the polysomnography software. We also demonstrate how the setup is used for sleep and drowsiness analysis.

1. Introduction

Area of polysomnography has recently changed with the widespread use of digital technology. Most dramatic changes have occurred in the software development. Currently most polysomnography systems support some analysis either online or offline.

For the often needed custom visualization and analysis it has been common in biomedical field to use e.g. Matlab independently of the recording software [1]. It is also possible to use Matlab online together with e.g. data acquisition card [2].

Some polysomnography systems, like Somnologica, provide a tool programming interface (TPI) for custom analysis within the software [3]. The programming language is usually C++ which increases programming efforts and slows down development time compared to Matlab.

We have developed a setup where custom Visual C++ and Visual Basic programs provide an interface between a commercial polysomnography software Somnologica (www.flaga.is) and a programming environment Matlab (www.mathworks.com).

Within the Somnologica any trace can be selected for analysis and wanted Matlab commands are evaluated online by Matlab. Results of analysis are added into Somnologica as new traces for visual inspection and for further analysis.

2. Methods

In this study we used Matlab 5.3 and Somnologica 2.0.1 (396) in computers running Windows NT 4.0 ENG (SP5). For interface program we used Microsoft Visual Basic Professional 6 (SP3). Tool Programming Interface 2.0 for Somnologica 2 and Microsoft Visual C++ 6 (SP3) were used for custom DLL tool called "Remote Trace 1.4

Matlab"

For demonstration we used signal from one of the ongoing sleep studies. The 200 Hz signal was electroencephalography (EEG) from occipital region O2 referenced to left mastoid A1 with ground in forehead. Recording equipment was 16 bit Embla together with Somnologica software.

3. Description

The Windows based setup contains Somnologica running in online (recording data) or offline (reviewing data). Using TCP/IP Somnologica tool "Remote Trace 1.4 Matlab" connects to Interface program. Trace path and settings are passed to Interface program.

The Interface program can be in the same computer or on any computer over TCP/IP network. Custom Matlab program uses DDE to read setting information and to write calculated values through the Interface into Somnologica, figure 1.

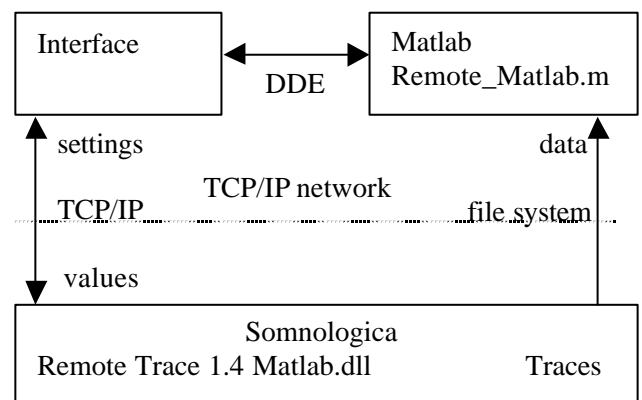


Figure 1. Schematic description of software components and interfaces between them.

Figure 2 shows the custom tool "Remote Trace 1.4 Matlab" appearing in the Somnologica software View menu.

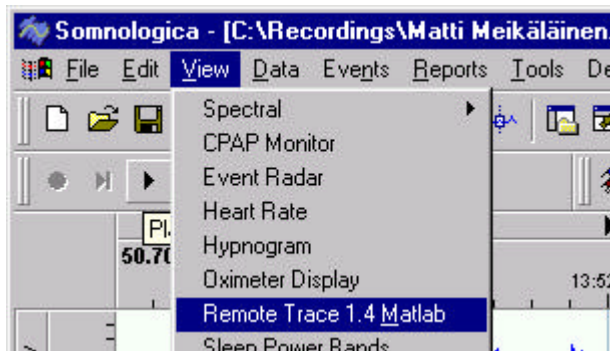


Figure 2. Screen showing "Remote Trace 1.4 Matlab" appearing in Somnologica menu.

4. Results

For demonstration of described setup we calculated two new traces: relative power in alpha band (8-12 Hz) in respect to 0-20 Hz band and peak frequency in alpha band. Following commands were typed into Somnologica analysis tool:

```
p=abs(fft(Y.*hanning(P))).^2;a=round(8*P/S:12*P/S)+1;t
=round(0*P/S:20*P/S)+1;D=100*sum(p(a))/sum(p(t));#512#A
lpha%#1##0#100#Alpha%##
```

```
p=abs(fft(Y.*hanning(P))).^2;a=round(8*P/S:12*P/S)+1;[m,
i]=sort(p(a));i=flipud(i);D=(a(i(1))-1)*S/P;#512#PeakA#1#
Hz#0#100#PeakA##
```

Matlab commands are in the beginning of each line. After the first # it is indicated how many data points are needed, variable P. Other variables are: trace array Y, sampling rate S and returned data value D. Rest of the line consists setup information for corresponding Somnologica trace, figure 3.

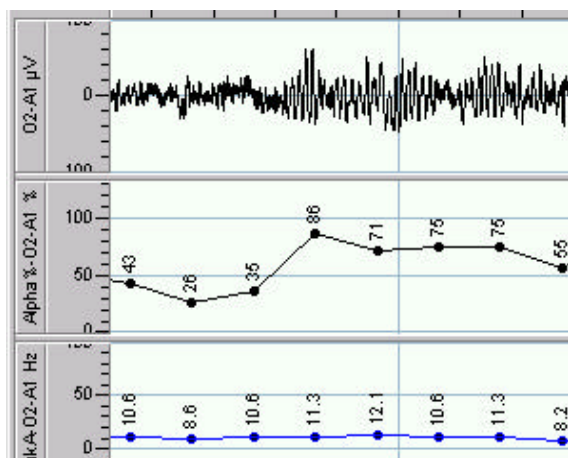


Figure 3. Transition from eyes open to eyes closed state. Vertical ticks indicate seconds. In relative Alpha% a clear increase in 512 point FFT (2.56 seconds) can be noticed.

5. Discussion

In some daytime sleepiness tests it is necessary to detect the sleep onset online. This usually makes the tests expensive and more variable because the technician must decide online if the test subject has fallen asleep.

With the described system Matlab based algorithms for sleep and drowsiness studies can be tested and used within the polysomnography system either online or offline. When relatively easily implemented Matlab algorithms are combined with original polysomnography traces the benefits and restrictions of each algorithms can be noticed to further improve the computer-assisted sleep and drowsiness analysis [4].

In future development the separate interface program between Somnologica and Matlab will be replaced by MEX file or ActiveX based TCP/IP Server. The tools described here and their further versions can be downloaded for evaluation from authors homepages.

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References

- [1] Virkkala J, Karjalainen P, Kaipio J. NeuroScan and Macro Utilities for Matlab V1.0. In: Matlab Conference 1995. Stockholm.
- [2] Virkkala J, Karjalainen P, Ylikoski J, Kaipio J. Matlab Application for Auditory Physiology. In: Matlab Conference 1997. Stockholm.
- [3] Himanen S-L, Saastamoinen A, Hasan J. Increasing the temporal resolution and stage specificity by visual adaptive scoring (VAS) – a preliminary report. *Sleep and Hypnosis* 1999; 1:22-28.
- [4] Hasan J. Past and future of of computer-assisted sleep analysis and drowsiness assessment. *J. Clin. Neurophysiology* . 1996; 13:295-313.

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