g.tec Lectures

g.tec introduces lectures for biosignal recording and analysis. The lectures are divided into a manual which contains the theoretical background, hands-on examples and several tasks to solve. The second part is a manual which contains only the solutions for the tasks.

The lectures allow researchers to get a quick start in the specific field and to perform already state of the art experiments after just a few hours. The lectures are also perfectly suited for teaching because of the separation of tasks and solution manuals.

Lecture 1: The Electroencephalogram

The Electroencephalogram (EEG) is a tutorial which introduces the reader into EEG recordings and analysis methods. The reader will learn how to assemble electrodes correctly, how to setup the recording equipment appropriately and how to make high-quality EEG recordings. Furthermore several EEG experiments have to be performed which give already a deep insight into state-of-the-art EEG analysis topics.

Objectives

- Learn to assemble electrodes according to the 10-20 system
- Learn to assemble electrodes with EEG caps and screwable electrodes
- Test the impedance of the EEG electrodes
- Learn how to connect the electrodes to the amplifier to make monopolar and bipolar recordings
- Learn how to test the recording setup
- Learn to recognize alpha and beta rhythms
- Learn to recognize artifacts in the EEG recording
- Learn to eliminate artifacts from the EEG recording
- Investigate the alpha block during a mental task
- Investigate hemispheric differences during language and spatial processing
- Learn how hyperventilation affects the EEG
- Learn the EEG differences of introverts and extraverts

Average time to perform the lecture:	*450 min*
Pages of lecture:	*47*
Pages of solutions for lecture:	*24*

Lecture 2: Brain-Computer Interface

The Brain-Computer Interface (BCI) is a tutorial which introduces the reader into BCI experiments and analysis methods. The reader will learn how to analyze BCI data in off-line and on-line mode and to set up real-time Simulink models for BCI experiments. Experiments will be introduced which can be used to acquire EEG data for training the computer on subject specific patterns and also for real-time feedback in order to control a cursor on the screen. Several examples of parameter extraction algorithms like bandpower, Hjorth and adaptive autoregressive models (AAR) will be explained. Classification algorithms like linear discriminant analysis (LDA) and neural networks (NN) are also subject of the lecture. The reader has to perform several tasks which give a deep insight into state-of-the-art BCI processing steps.

Objectives

- Learn pre-processing steps for BCI data analysis
- Calculate the power spectrum and event-related desynchronization of EEG data
- Extract features of the different EEG channels
- Train different classifiers to discriminate the features
- Compare feature extraction and classification algorithms
- Contact BCI experiments without feedback to get data for pattern recognition
- Perform real-time BCI experiments with cursor feedback
- Learn to write processing batches for fast off-line analysis
- Extract reactive frequency components out of the EEG data
- Modify real-time analysis models for optimal performance
- Train yourself to reach a high BCI classification accuracy

Average time to perform the lecture: *465 min*
Pages of lecture: *89*
Pages of solutions for lecture: *28*

Lecture 3: The Electrocardiogram

The ECG lecture is intended to give a practical entry to state-of-the-art ECG processing. In the course of 6 lessons, the reader is confronted with common tasks of modern ECG analysis and it is shown how to practically solve the problems. Each lesson starts with a theoretical part to provide enough knowledge to solve the tasks.

Objectives

- Measure Einthoven-, Goldberger- and Wilson-derivations
- Perform 12 lead derivations
- Learn to identify and avoid artifacts in the ECG signals
- Calculate single beat intervals and amplitudes
- Perform automatic QRS complex detection
- Program an off-line and on-line QRS complex detector
- Analyze tilt table experiments
- Detect arrhythmias and abnormalities

Average time to perform the lecture:	*700 – 760 min*
Pages of lecture:	*58*
Pages of solutions for lecture:	*71*

Lecture 4: Evoked Potentials

The Lecture Evoked Potentials explains the recording and analysis of auditory steady-state responses (ASSRs), the auditory P300 response and brainstem auditory evoked potentials (BAEP). Each of these methods is important in clinical Electroencephalography. The auditory P300 response furthermore can be used as interaction method within a Brain Computer Interface (BCI).

Objectives

- Configure the auditory stimulator correctly for EPs
- Record and analyze P300 responses
- Record and analyze MMN
- Record and analyze ASSRs
- Record and analyze BAEPs
- Record and analyze SEPs
- Perform step-by-step the off-line analysis
- Run analysis batches to evaluate the captured EPs

Average time to perform the lecture: *430 min*
Pages of lecture: *85*

Lecture 5: Physio Observer

This lecture explains the recording and evaluation of physiological and cognitive parameters. With biosignals like ECG, GSR, Respiration, EEG, physiological parameters like heart- rate and cognitive like the EEG band power it is possible to recognize various mental and physical states of a person in real-time. This leads to a better human- computer interaction and human- robot cooperation.

Objectives

- Configure the physio observer to run experimental paradigms
- Perform a circle training experiment
- Perform high altitude medicine experiments

Average time to perform the lecture: *240 min*
Pages of lecture: *65*
Pages of solutions for lecture *19*

Lecture 6: g.Nautilus Sports

This lecture demonstrates how the g.Nautilus wireless biosignal amplifier can be used to record EEG signals during sports exercise. It users an auditory paradigm similar to the ones presented in the Evoked potentials lecture to demonstrate the stability and low number of artefacts achievable with the g.Nautilus device during physical exercises.

Objectives

- Configure the g.Nautilus device to run experimental paradigms
- Record the EEG while the subject simultaneously performs physical exercise and follows EP paradigm
- Calculate the jitter in displaying the auditory stimuli and display the observed EP signals.

Average time to perform the lecture:	*120 min*
Pages of lecture:	*39*
Pages of solutions for lecture	*15*