Emotiv Experimenter: an experimentation and “mind-reading” application for Emotiv EPOC

By: Michael Adelson, Computer Science ’11
Advisor: Ken Norman, PSY/NEU

The Emotiv Headset

- Consumer-focused EEG device
- Intended for brain-computer interface applications
- Produces lower-quality data than traditional EEG setups, but is much cheaper and easier to use

Project Goals

- Develop an application for running neuroscience experiments and collecting EEG data using Emotiv
- Incorporate offline and online analysis of collected data
- Validate experiment design, data quality, and application usability through experiments

The Basic Experiment

- In the Basic Experiment, the data is collected using Emotiv and delivered to various applications

The Faces vs. Scenes Experiment

- An experiment consists of trials, during which the subject viewed either a face or a scene
- The data collected consists of EEG data from each of these trials
- Subject choices are used to classify EEG data from unlabeled trials

Other Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Example Stimulus</th>
<th>Choice 1</th>
<th>Choice 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes Open vs. Eyes Closed</td>
<td>n/a</td>
<td>Keep your eyes open</td>
<td>Close your eyes</td>
</tr>
<tr>
<td>Artist vs. Function</td>
<td>“Cable”</td>
<td>Artist: Visualize the noun</td>
<td>Function: try to think of uses for the noun</td>
</tr>
<tr>
<td>Faces vs. Math Expressions</td>
<td>1 + (2 * 9) = 3</td>
<td>Focus on the face: is it male or female?</td>
<td>Evaluate the mathematical expression</td>
</tr>
</tbody>
</table>

Other Experiments

- The input features are derived from the raw EEG data collected during each trial
- The CLASSES are derived from the EEG data collected during each trial

Data Analysis

- Presentation
- Data Analysis
- Emotiv Data Stream

User Interface

- The User Interface is comprised of 4 modules (left). The black arrows show the flow of data between modules
- The Emotiv Data Stream formats the data recorded by Emotiv and delivers it to various components of the application in real time via a publish/subscribe system

Conclusion

- The Emotiv Experimenter application makes it easy for anyone to run a variety of interesting experiments with Emotiv
- The collected results suggest that Emotiv's data is of sufficient quality for this sort of work
- The Emotiv codebase provides useful modules for working with Emotiv which could be used in other research applications
- The Emotiv code, report, and documentation are available at http://www.princeton.edu/~madelson/experimenter