1. Motivation

Problem
Locked-in patients communicate with BCI systems. While much work is being done on increasing the information transfer rate, few useful BCI applications exist to this day.

Goal
Increase patients’ quality of life by enabling them to access the internet in a self-determined way.

Create an intuitive web browser which can be integrated with existing BCI software [1] and allows in-place link selection in contrast to [2].

Method
We extended the open-source browser Mozilla by a graphical link selection method and called it Nessi (Neural Signal Surfing Interface).

Challenge
The interface should be efficient, yet easy to understand and use. Patients could be distracted by the site’s content whilst navigating.

2. Implementation

Simple communication
Status data is transferred between BCI software and Nessi via sockets.

Flexible
Two types of decision trees (LSP, see [3], and direct choice) supporting any number of classes are implemented.

The decision tree is built with many options. For example, browser history information or manual settings for Huffman encoding can be used.

Extensible
CSS allows adaptation of interface to patient’s needs.

Internationalization is supported by DTDs.

Functionality is adapted with JavaScript, no compilation necessary.

Platform-independent open source project.

Maintenance
Five maintenance levels call for increasing user knowledge. The supervisor can work in the green and yellow levels. Programming experience is required for the red level.

3. Browsing

Feedback window
Menu and PAUSE button for supervisor

Navigation bar for patient (German version). The number of navigation elements can be reduced while the patient is learning.

Virtual keyboards
LSP decision tree.

Direct choice decision tree with Huffman encoding.

Keyboard to be used by a patient on an internet chat site (in Turkish).

Example
HTML excerpt for 5-letter virtual keyboard. Direct choice decision tree with letter probabilities specified in the HTML-tag.

4. Results and Discussion

Usability and patient motivation
Adjusting to the Nessi interface (selection of elements with colored frames around objects) involves a re-learning task for patients. To prevent frustration, the size of menus and virtual keyboards can be reduced. We also incorporated a puzzle game to help patients adjust to the new interface.

Comparison of decision tree types
A built-in simulation algorithm allows comparison of different decision tree types. Simulations for the virtual keyboard showed that LSP is more efficient than direct choice for error rates above 20%.

Patient’s experience with Nessi
At least four patients have used Nessi and are showing further interest. Some are still training on the puzzles as their error rate is still too high for web navigation. Others have managed to reach intended sites repeatedly.

Future work
More efficient spelling with bigrams and dictionaries. Increased display of machine affect (graphics, sound) [4]. Have subjects test webcam / chat / SMS communication. Automated scrolling / filling in of forms.

References