

Erkundung von Softwarelandschaften mithilfe von HCI in ExplorViz

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1. Motivation
2. Foundations
3. Design
4. Implementation
5. Evaluation
6. Conclusions

- ▶ to gain knowledge about a new kind of interface
- ▶ to explore new ways of task comprehension and user experience
- ▶ to test, if a user would accept this kind of user experience

Foundations

- ▶ the Electroencephalography (EEG) is based on the works of Hans Berger from the year 1924
- ▶ the brain works through electricity and biochemical processes [1, 2, 3]
- ▶ EEG signal represents the voltage of the brain [3, 2]
- ▶ EEG signals represent ones mental state (sleeping, concentrating)

- ▶ a neuro-technical interface [6]
- ▶ based on EEG, fMRI or NIRS
- ▶ can convert brain signals into computer signals
- ▶ Emotiv Insight¹
 - ▶ made from the company *Emotiv Systems*
 - ▶ 5 EEG sensors and two reference sensors
 - ▶ use of Community SDK² and Java 1.6
 - ▶ no insight into device's working processes
 - ▶ user has to adapt to the device
 - ▶ writes into query
 - ▶ only one request per time to device, else crash

¹<https://emotiv.com/insight.php>:

²<https://github.com/Emotiv/community-sdk>

Design

- goal: implementation of BCI in ExplorViz to navigate through landscape
- ▶ we have to implement Java-code into the browser
 - ▶ our solution divides our software in a browser-internal as Ember.js plugin and -external part as Java-program
 - ▶ sustainable
 - ▶ browser not naturally able to use multi-threading
 - ▶ performance is a critical point
 - ▶ communication by WebSocket connection

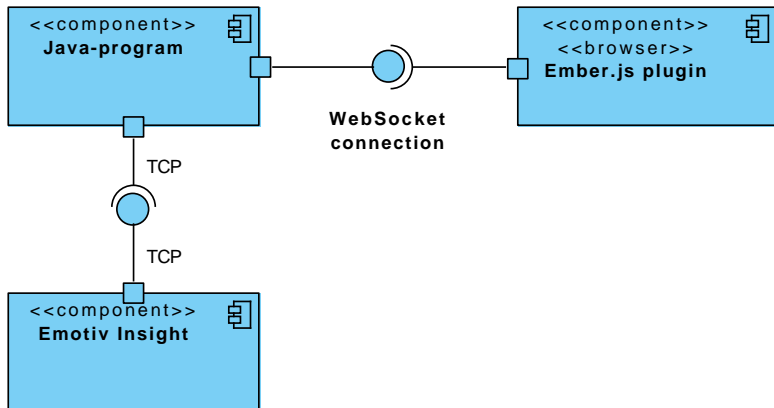


Abbildung: WebSocket Connection

- ▶ we want to implement our mental commands with best possible distinction
- ▶ relaxation and concentration => better distinction
- ▶ functionalities: zoom in and zoom out
- ▶ limited meaningful functionalities in 2D visualization
- ▶ BCI-mode

Implementation

- ▶ browser-external part written as standalone application in Java 1.6
- ▶ browser-internal part realized as Ember.js plugin
- ▶ WebSocket connection implemented with usage of libraries
- ▶ influenced by VR project
 - ▶ controller to trigger BCI-mode
 - ▶ rotation and lifting/lowering as functionalities

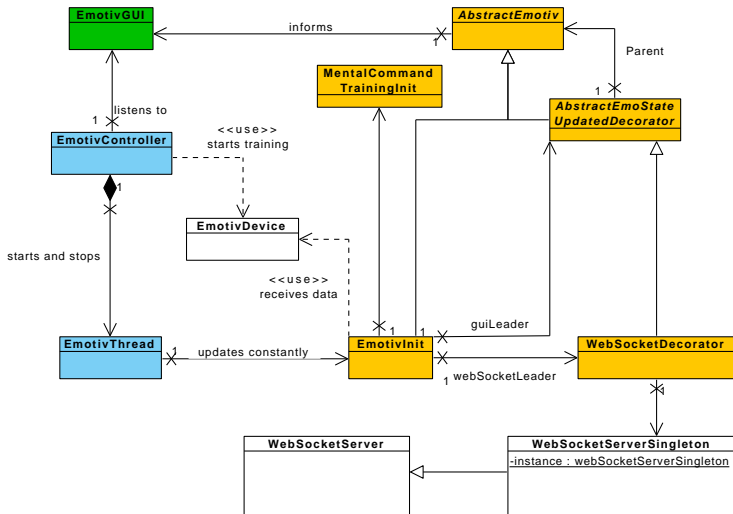


Abbildung: MVC pattern implementation

- ▶ Ember.js plugin
- ▶ service managing WebSocket connection
- ▶ Blackbox-problem solved by Eventlisteners with only use of JavaScript

```
triggerMentalCommand(mentalCommand){  
  let canvas = $("#threeCanvas")[0];  
  let event = new Event("bciaction",  
    {"bubbles": true,  
     "cancelable": false});  
  canvas.dispatchEvent(event);  
}
```

Evaluation

- ▶ research question: *Will a user accept our implementation in the context of VR*
- ▶ hypothesis:
 - h1: The user accepts the integration of the BCI into our VR room
 - h2: The user accepts the controller as additional tool
 - h3: The user is able to trigger at least one mental command to his/her satisfaction

- ▶ qualitative study in collaboration with VR bachelor thesis
- ▶ as additional tool a survey
- ▶ we take the ExplorViz demo-landscape³ visualized in VR room with closed systems
- ▶ only geometric tasks

³<http://samoa.informatik.uni-kiel.de:8181/>

- ▶ information paper
- ▶ survey regarding general questions
- ▶ VR part
- ▶ BCI part
 1. short introduction
 2. setup BCI + VR
 3. training phase: training of 3 mental commands (3 training sessions each)
 4. short introduction in controller functionality/BCI-mode
 5. 4 simple tasks
 6. final survey

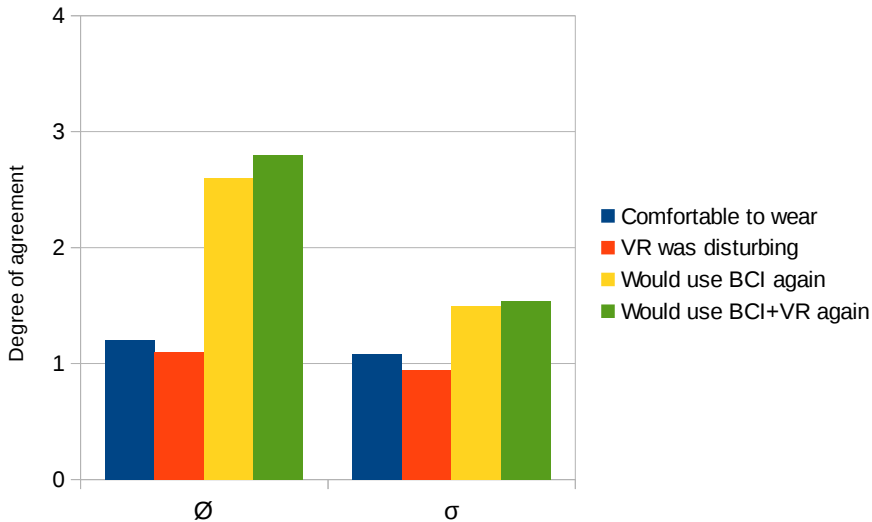
parts inspired by hypothesis

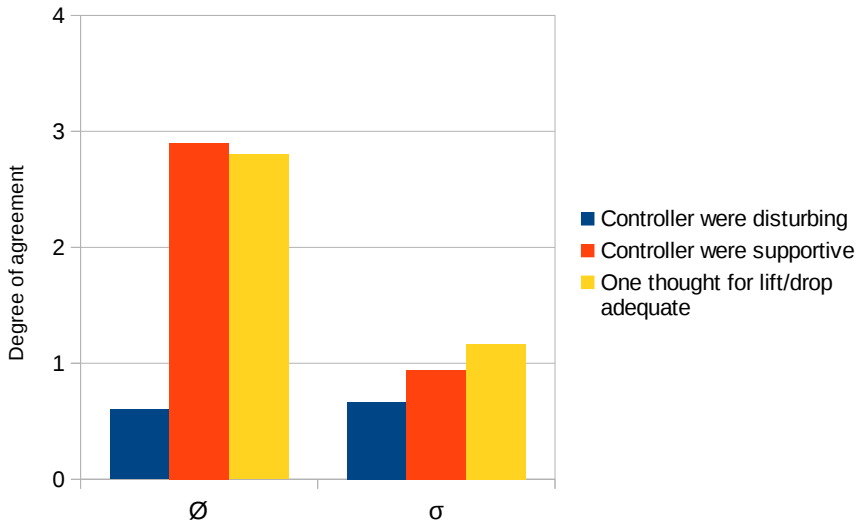
h1: user's evaluation in term of VR + BCI

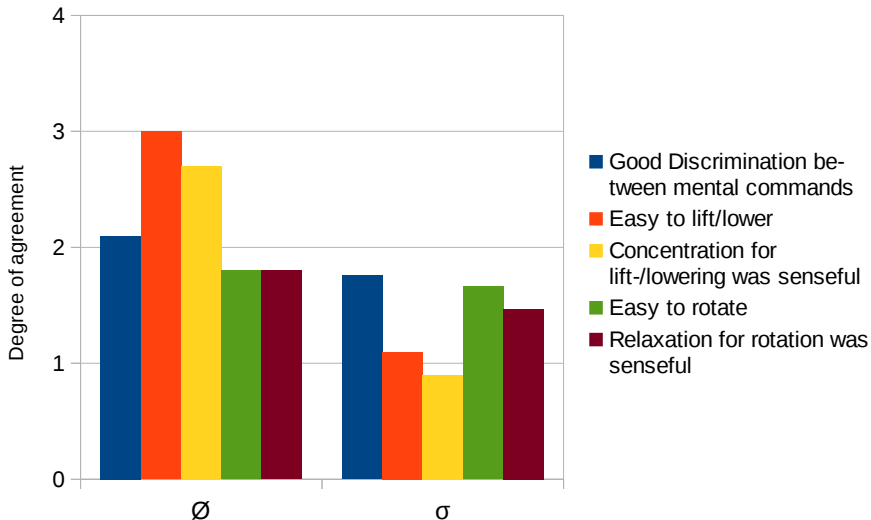
h2: user's evaluation in term of controller usage

h3: user's evaluation in term of mental commands

- ▶ 10 participants
- ▶ broken sensor tips => loss of two participants
- ▶ the setup of our device very different
- ▶ training phase very individual



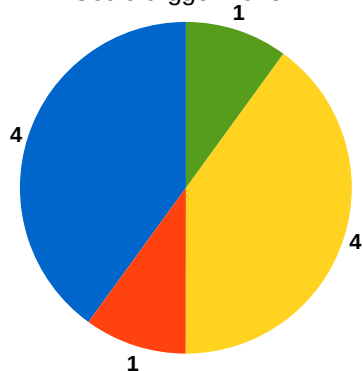




h1: user would use BCI and VR again despite of low comfort => **yes**

h2: user mostly described controller not as disturbing but supportive and accepted using of controller for two mental commands => **yes**

- Could trigger lift/lower
- Could trigger rotation
- Could trigger both
- Could trigger none



- ▶ training always different
- ▶ environment
- ▶ VR part exhausted
- ▶ broken sensor tips
- ▶ bad evaluation of mental commands

Conclusions

- ▶ browser-external part for processing necessary
- ▶ long-term studies could be needed
- ▶ adequate results in controlling the device with only 80 seconds training
- ▶ our tool should provide more possibilities for individualization
- ▶ future work:
 - ▶ individualization => configuration of MC
 - ▶ long-term studies regarding regular training sessions
 - ▶ Better user GUI



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