Objectives

Gaze-based text spellers have proved useful for people with severe motor diseases but lack acceptance in general human computer interaction. Traditional dwell- and blink-based selections have major drawbacks like the need for high calibration accuracy which is not suitable for unguided interaction, e.g. with public displays. To tackle these problems we aimed at developing the first gaze speller that explicitly utilizes the properties of smooth-pursuit eye movements and achieves sufficient accuracy with a one-point calibration. Using these relatively slow and regular eye – movements, that occur when a moving object is followed by gaze, has already shown its potential for gaze interaction (Vidal et al. 2013, Cymek et al. 2014). In a user study 24 participants tested the developed system at four speed-levels of moving elements to determine an optimal interaction speed regarding acceptance and performance.

Geometry and Interaction Concept

Figure 1: The interface of the speller consists of six clusters of characters that are arranged in a hexagonal shape. Besides the alphabetic and special character tiles, two functional tiles were implemented for the correction (<) of an entered character and the confirmation (>) of a word. The colored lines represent the criteria for the gaze path recognition and are not present in the actual speller.

Experimental Validation

Method

Sample: $N = 24$; Age: $M = 25.4$, $SD = 3.41$

Design: Randomized within-subjects design

- IVs: Object Movement Speed in px/s (OMS)
  - 220 px/s | 260 px/s | 300 px/s | 340 px/s
- DVs: Words per Minute
  - Number of Completed Gaze Gestures per Minute
  - Number of Corrections per Sentence
  - Number of Discontinuations per Sentence
  - Subjective Measures

Task: Participants were asked to enter an automatically dictated holalphabetic german sentence (Pommerening, 2013) including special characters to ensure that each implemented gaze gesture is performed at least once for every OMS level.

„Zwei Boxkaempfer jagen Eva quer durch Sylt. Nein, oder? Ja!”

Results

<table>
<thead>
<tr>
<th></th>
<th>220 px/s</th>
<th>260 px/s</th>
<th>300 px/s</th>
<th>340 px/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Words per Minute</td>
<td>$M = 2.90$, $SD = 0.69$</td>
<td>$M = 3.05$, $SD = 0.84$</td>
<td>$M = 3.34$, $SD = 0.75$</td>
<td>$M = 3.04$, $SD = 0.83$</td>
</tr>
<tr>
<td>Number of Completed Gaze Gestures per Minute</td>
<td>$M = 18.12$, $SD = 2.06$</td>
<td>$M = 19.95$, $SD = 3.18$</td>
<td>$M = 22.31$, $SD = 3.07$</td>
<td>$M = 22.79$, $SD = 3.87$</td>
</tr>
<tr>
<td>Number of Corrections per Sentence</td>
<td>$M = 8.21$, $SD = 5.72$</td>
<td>$M = 9.88$, $SD = 6.25$</td>
<td>$M = 10.63$, $SD = 5.72$</td>
<td>$M = 16.50$, $SD = 8.40$</td>
</tr>
<tr>
<td>Number of Discontinuations per Sentence</td>
<td>$M = 36.50$, $SD = 16.99$</td>
<td>$M = 38.08$, $SD = 25.77$</td>
<td>$M = 31.33$, $SD = 13.85$</td>
<td>$M = 42.42$, $SD = 21.17$</td>
</tr>
</tbody>
</table>

Table 1: Performance results for the text entry task

Subjective measures like ease, effort and comfort of pursuing the characters with the eyes as well as the perceived efficiency, speed and performance of the system indicate a preference of the users for 260 px/s and 300 px/s object movement speeds.

Summary and Conclusions

- Results from a pre-test revealed that a one-point calibration is sufficient and could even be implemented implicitly in future versions of the speller.
- Combination of performance and subjective measures indicate that an object movement speed of 300 px/s is well suited for the actual implementation of the gaze speller.
- Improvement of the WPM rate could be achieved by longer training periods as well as by implementing dictionary and probability based functionality, such as adaptive saliency or word completion.

References

