Effects of visual variables on the perception of distance in Off-screen landmarks: Size, color value, and crispness

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GPS Mix-Up Brings Wrong Turn, and Celebrity, to an American in Iceland

http://nytimes.com
http://dailymail.co.uk
Navigation and wayfinding

WHERE AM I GOING?
Using landmarks?

**Turn-By-Turn**

1. 2.2km
2. 3.7km
3. 1.0km
4. 553m

**Orientation Wayfinding**

- go towards city center
- turn left at
- circumnavigate city center
Acquisition from small display

- Fragmentation of spatial knowledge
- Poor wayfinding performance
Outline

• Background
• Previous work
• Current approach
• Evaluations
• Discussion and outlook
Displaying distant info

Halo

Wedge

(Baudisch & Rosenholtz 2003)  (Gustafson et al. 2008)
Outcome: spatial knowledge

Average directional errors

\[ F(1, 20) = 5.01, p = .04 \]
Outcome: interaction

Zooming

\[ F(1, 20) = 10.39, p < .001 \]
Problems

• Distance information is not visualized
• Acquisition of spatial knowledge is limited
Embedding distance in symbols

• Goal: Direction + Distance
• Consideration: Visual variables
Visual variables

(Roth 2015; Robinson 1995; MacEachren 2012)
Question 1

• Level of measurement?
  – Nominal
  – Ordinal
  – Interval/Ratio (quantitative)
Question 1

• Level of measurement
  – Nominal
  – Ordinal
  – Interval/Ratio
Visualizing distance

- Ratio vs. Ordinal size
Evaluation

• Judging closest location
Results

• Distance comparison

- On vs. On
  \[ t(1, 97) = 77.79, \ p < .001 \]

- On vs. Off
  \[ t(1, 97) = 25.22, \ p < .001 \]
Summary 1

- Ordinal symbols yield higher accuracy in comparing relative distances.
- Both ratio and ordinal symbols have challenges in indicating the furthest distances.
Current study

• Other visual variables?

- color value
- crispness
Symbols for off-screen landmarks

- **Ordinal size**
  - Nearby
  - Middle
  - Far

- **Color value**
  - Nearby
  - Middle
  - Far

- **Crispness**
  - Nearby
  - Middle
  - Far
All three scenarios

Ordinal size

Color value

Crispness
Evaluation

• Categories of tasks
  – Closest & furthest locations
  – On-screen landmarks comparison
  – On- vs. off- screen landmarks comparison
  – Off-screen landmarks comparison
Evaluation

• Participants
  – 51 out of 58 in color value
  – 51 out of 57 in crispness
  – 50 out of 55 in ordinal size
Results: Time

![Bar chart showing time (sec) for ordinal size, color value, and crispness]
Results: selecting landmarks

Selecting landmark according to distance

\[
F(2, 149) = 21.31, \ p < .001
\]
Incorrect landmarks

• Ordinal size

![Bar chart showing the ordinal size of different landmarks: Gas station, Gym, Hospital, Soccer field, Supermarket, Train station. The chart indicates the relative size of each landmark with Hospital being the largest and Supermarket being the smallest.]
Incorrect landmarks

- Color value

<table>
<thead>
<tr>
<th>Location</th>
<th>Color Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gym</td>
<td>0</td>
</tr>
<tr>
<td>Bus stop</td>
<td>10</td>
</tr>
<tr>
<td>Gas station</td>
<td>15</td>
</tr>
<tr>
<td>Supermarket</td>
<td>5</td>
</tr>
<tr>
<td>Classroom</td>
<td>2</td>
</tr>
<tr>
<td>Train station</td>
<td>20</td>
</tr>
</tbody>
</table>
Incorrect landmarks

- Crispness

![Bar chart showing the crispness of different landmarks: Bus stop, Classroom, Hospital, Supermarket, Train station. The Train station has the highest crispness.](image)
Results

• On-screen landmarks comparison

![Bar chart showing comparison of ordinal size, color value, and crispness](chart.png)
Results

- **On- vs. off screen comparison**

\[ F(2, 149) = 10.52, p < .001 \]
Results

- Off-screen landmarks comparison

\[ F(2, 149) = 8.10, \ p < .001 \]
Summary

• **Color value** seems to be the least effective in supporting perception of distance.

• **Ordinal size** and **crispness** seem more effective.

• Challenges still exist in comparing off-screen distances.
General issues

• Off-screen landmarks are not fully understood
• Comparison of off-screen landmarks based on actual distance between symbols on screen
• Evaluation takes place online, not in real environment
Next step?

- another visual variable?
- Influences with individual differences?
- Assessments in real environments?
- Approach of distinguishing on- and off-screen landmarks?

(transparency) (Olivieri 2012)
Acknowledgement

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Vielen Dank!

Questions or comments?