Haptic differentiation between different scales

Mounia Ziat¹, Olivier Gapenne¹, Aimerick Delwarde², Marie-Odile Rouze²

¹ University of Technology of Compiègne (UTC), Department of Technology and Humans Sciences, Centre Pierre Guillaumat, K102, 60203 Compiègne, France
{mounia.ziat, olivier.gapenne}@utc.fr
² {aimerick.delwarde,marie-odile.rouze}@etu.utc.fr

Abstract. In this fundamental study, subjects have to recognize 2D graphical objects of different scales. The results show that: i) the scale change is felt by subjects only for extreme sizes of shapes, i.e. subjects make easily the distinction between the smallest and the biggest sizes among those explored but have difficulties to differentiate between two adjacent sizes. ii) Arm movements depend on shape orientation.

1 Introduction
ZUI (Zoomable User Interfaces) has an infinite space and it allows the user to manipulate infinite pans and zooms in order to navigate in this multi-scale space [1]. How can a human subject estimate the crossed distance and navigate in the scale space? How can he feel the scale change when he manipulates ZUI? Except for some works of Guiard [2] and Hightower [3], no fundamental study was carried out on ZUI. In order to give a beginning of answer and to understand how humans being work with multi-scale interfaces, we conducted an experimental study by using a tactile feedback as an output modality. In interaction with ZUI, the system Tactos [4] allows the recognition of 2D numerical objects via a stylus on a graphics tablet and a tactile feedback. It includes tactile stimulators which, when they are in contact with the shape on the screen, transform it by means of actuators into stimulations (figure1). Therefore, the aim of the following experiment is to define subjects’ capacities to distinguish different sizes.

2 Experiment
27 subjects (students of the UTC) divided in 3 groups took part in this study. This last was realized with ellipses and circles and with matrices (sensors) (Table1).

Table 1. Different sizes of shapes and matrices

<table>
<thead>
<tr>
<th>M (matrix size)</th>
<th>Shape height (ellipse great axis and circle radius)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm (Group 1)</td>
<td>T1 2 cm   T2 2.5 cm   T3 3.33 cm   T4 5 cm</td>
</tr>
<tr>
<td>15 mm (Group 2)</td>
<td>T1 3 cm   T2 3.75 cm  T3 5 cm    T4 7.5 cm</td>
</tr>
<tr>
<td>20 mm (Group 3)</td>
<td>T1 4 cm   T2 5 cm    T3 6.66 cm  T4 10 cm</td>
</tr>
</tbody>
</table>

Fig. 1. Experimental device: Tactos
3 Results
Concerning size responses and as show in the figure 4, performances for the smallest (T1) and the biggest (T4) sizes are better than the others sizes. Indeed, the ANOVA indicates that the effect of the size is significant [F(3,104)= 12.23, p<0.01] and post-hoc tests indicate that the mean of size T4 is significantly more important than the other sizes. For size T1 performances are not significant but not negligible. This goes in the sense of our hypothesis because we expect that performances are better for T1 and T2.

Concerning the orientation and as shown in figure 4b, subjects recognize circles as well as ellipses but performances for O1 (horizontal ellipses) are slightly better than O2 (circles) and O3 (vertical ellipses).

![Figure 4](image-url)

**Fig. 4.** % of correct answers a) for the size according to C values, b) for the orientation

4 Discussion and Conclusion
The results show that the extreme sizes are better recognized then the others. Indeed, sizes T1 and T4 (the smallest and the biggest sizes), have respectively a recognition rate of 70 % and 85 % whereas performances for T3 reaches 62% and doesn’t exceed the 52 % for T4. These results lead us to think that subjects can distinguish a difference in scale if this difference is relatively big. The other result concerns the orientation of shapes. Subjects recognize circles as well as ellipses with performances slightly better for horizontal ellipses. This is the result of movement production by the subjects. Indeed, to produce horizontal movements subjects put their forearm on the working surface and they only displaced they forearm or wrist. In the case of circle or vertical ellipse, shapes being magnified on a vertical axis, subjects must stick up their forearm on the working surface to access to shape extremities and thus they move their entire arm to reproduce the gesture of orientation.

References