A Pilot study on audio induced pseudo-haptics

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Published in:
Proceedings of the 3rd International Haptic and Auditory Interaction Design Workshop

2008

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ABSTRACT

In this paper we describe a small pilot study designed to explore the possibility of spatial pseudo haptic effects induced by artificial audio feedback. Four basic audio designs were investigated: pan, continuous since tone, virtual harp and noise. For reference a visual pseudo haptic effect together with real haptic effects were also included. The results indicate noise and spatially distributed discrete sounds like in the virtual harp to be promising, while both pan and continuous frequency changes did not appear to be distinct enough for this purpose.

Author Keywords

Pseudo haptics, audio, haptic, interaction design

ACM Classification Keywords

H5.2 User interfaces

INTRODUCTION

It is well established that manipulation of the visual feedback may generate pseudo-haptic illusions [1]. Since visual pseudo haptics is by design something that cannot be experienced by somebody with impaired vision (or not able to use vision for other reasons) it is interesting to see if similar effects can be obtained from manipulating auditory gestural feedback. That pseudo-haptic illusions may be generated by manipulating contact sounds has been investigated earlier also within the ENACTIVE community [2]. It has also been known for a long time that manipulation of friction sounds can cause haptic sensations [3, 4]. These types of sounds have also been used for pseudo haptic interaction design in [5].

This type of effects could potentially be used for making interfaces more accessible/easy to use both for persons with visual impairments and persons using mobile devices with small screens, and thus we find it interesting to investigate if one can also induce more spatial pseudo-haptic effects (similar to the visual effects reported in [1]).

RESEARCH QUESTION

As a first step in this direction we did a small pilot test with 12 persons. This pilot test was designed to provide us with preliminary insights on non visual pseudo haptic effects. The basic question to be answered was:

⇒ Which type of audio feedback can make users report that they can feel a haptic difference between different areas in space?

TEST SETUP

Since this was very much a first exploratory pilot, we decided on a very simple setup where the user basically only explored one dimension (along the x axis) and where different combinations of visual, auditory and haptic feedback was given. The visual and haptic feedback was included to get some comparative information with visual pseudo haptics and with real haptic effects. All in all, we explored seven different designs. For each design there was one case where the feedback did not change and one where it changed resulting in a total of 14 designs to be tested. The different feedback designs were presented in random order. For simplicity we only investigated one dimension and we used a PHANToM 1.0 premium for the tests. The use of a PHANToM enabled us to provide real haptic effects, although it was also used as simply a position sensor. The environment is shown in figure 1. The blue block was a virtual slab which provided a surface for the test persons to slide the PHANToM stylus along.

Figure 1. The haptic environment. The red ball followed the PHANToM cursor horizontally in the visual and haptic designs. The yellow transparent area indicate a possibly different area.

The persons were instructed to slide the PHANToM along the virtual surface in the left-right direction and to tell if they thought things felt different to the right of the middle line (the yellow area in figure 1).

Seven different designs were tested. Four of these involved audio feedback where changes were made in the pan, the frequency of a since tone, the string locations of a virtual harp and silence vs. noise. The visual feedback involved manipulating a ball which moved horizontally and the haptic effects were changing inertial forces or changing friction. The different designs are summarized in table 1.

Nr	Sense	Feedback	Change
1	Hearing	A sine tone propotional to the logarithm of the position and increasing left to right. No ball.	The position dependence to the right is 10% of the position dependence to the left.
2	Hearing	A virtual harp where the invisible strings were quite close. No ball.	Twice as long distance between the strings to the right.
3	Hearing	Panning of a musical sound source (a source we had used earlier for navigational tests). No ball.	The change in the pan rate to the right is 10% of the change in the pan rate to the left.
4	Hearing	Noise/silence. No ball.	Noise played to the right.
5	Vision	Ball moving with the stylus	Slower movement to the right (the ball now moves only 30% of the stylus distance).
6	Touch	Weak inertial force/no force. The ball follows the stylus.	Inertial force (0.5 times the velocity) to the right.
7	Touch	Friction. The ball follows the stylus.	Increased friction to the right. The static friction increases a factor 3 and the dynamic friction increases a factor 1.75.

Table 1. Different test designs.

RESULTS AND CONCLUSION

The results are summarized in figure 2. One can see that for the noise feedback (4), the visual (5) and the haptic feedback (6 and 7) more persons judge the ones that really are different to be different. The sine tone feedback and the pan feedback appeared not to be distinct enough for people to really note the differences, while there are a few more persons who note a difference for the virtual harp (2). The number of users in this small pilot was not enough to draw safe conclusions (the statistical analysis we did despite this showed the only significant difference was between the cases when there really was a force and when there was no force and no manipulation of the feedback).

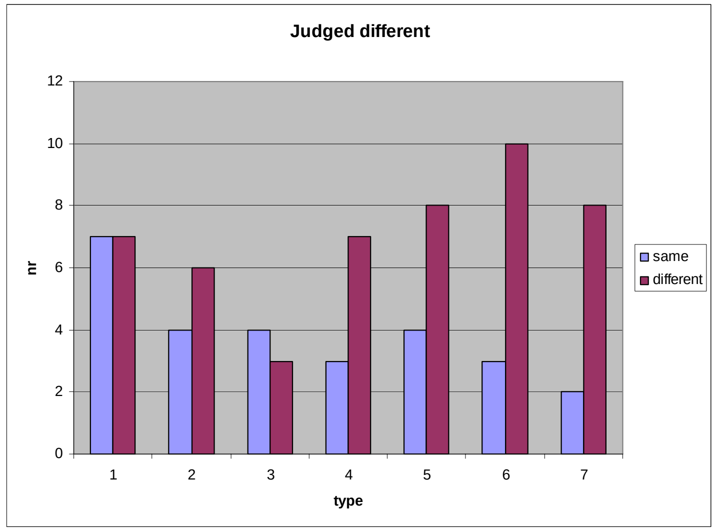

Figure 2. The number of persons judging things to feel different. For the blue bars the design did not actually contain any difference (same) while the red bars show the cases that really were different.

Still, the results combined with qualitative experience by the authors indicate that both playing noise (which has already been explored to some extent in [5]) and manipulating the distance between the strings of a virtual harp may be fruitful to investigate further. In this context it should be noted that eye-hand coordination is something all sighted persons train most of their lives. Experience also teaches us to associate sounds from impacts or touching to material properties, but to get some kind of spatial pseudo haptic effect for ear-hand coordination with artificial sounds, some training to establish the mapping is likely to be needed.

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