Common Experience Sample 1.0: Developing a sample for comparing the characteristics of haptic displays

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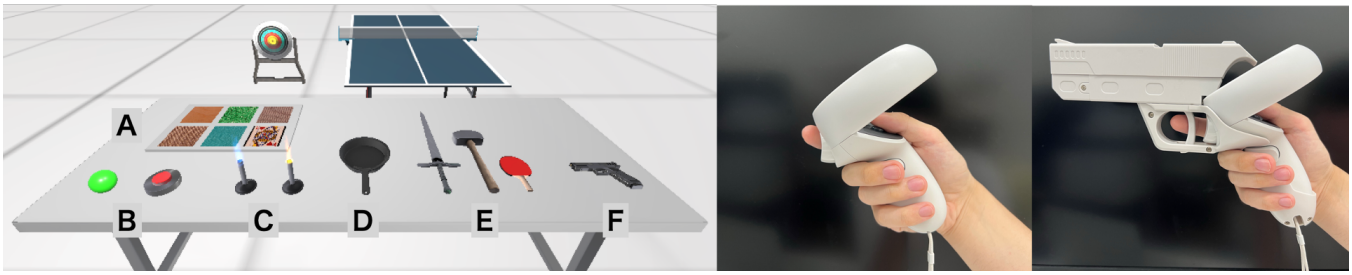

Figure 1: Common Experience Sample 1.0 and two controller displays to be evaluated for comparison.

ABSTRACT

Many haptic displays that provide haptic feedback to users have been proposed;however, differences in experimental environments make comparisons of displays difficult. Therefore, we categorized the characteristics of feedback based on existing research, and developed a common experience sample that includes virtual objects necessary for the expression of each characteristic. Additionally, we will study the methods of evaluating displays using the proposed sample, and aim at comparative evaluation of multiple displays.

CCS CONCEPTS

• **Human-centered computing → HCI design and evaluation methods**.

KEYWORDS

virtual reality, haptic, evaluation, crossmodal, multimodal, sample

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1 INTRODUCTION

VR requires an immersive experience in a virtual body. In addition to visual information, there has been active development of haptic display devices for multimodal and crossmodal experiences has [1, 5]. Such haptic displays are often used to evaluate the experience and the representational performance of devices through interaction in a virtual space. However, currently, the virtual environments used for evaluation are created by each study, and there is no common de facto standard among studies. Therefore, comparisons of displays and experiences between studies are not possible.

Therefore, in this study, we propose a common experience sample that evaluators can use to compare and evaluate haptic displays [3]. To design our sample, we surveyed existing studies, and classified the characteristics and requirements of the virtual environment to be used for the evaluation of haptic displays and represent. Based on this, a prototype of the common experience environment was developed. Furthermore, through experimental use cases, we evaluate the effectiveness of the proposed sample .

2 PROPOSED METHOD

The common experience sample is a virtual experimental environment that enables comparative evaluation between haptic displays, and was created with the aim of being used experimentally as a de facto standard. It is an open sample that is universally accessible to evaluators, and dedicated applications can be developed based on the basic interactions. The sample is subject to further updates in

Table 1: Correspondence between object characteristics and items in the common experience sample

characteristic	object
texture	material board (A)
hardness	ball, button (B)
temperature	flame, mist (C)
weight	frying pan (D)
shape	sword, table tennis racket, hammer (E)
motion	hand gun (F)

consideration of the validity of the sample. This paper refers to the Common Experience Sample 1.0 (figure1).

A number of haptic displays have been proposed in studies. A survey of these studies shows that the required virtual environment can be defined by learning the characteristics of the objects represented by the haptic displays, and representing these in the environment. Based on the research by Lederman et al.[2], we categorized the characteristics of objects represented by haptic displays into six dimensions: texture, hardness, temperature, weight, shape (total, detailed), and motion. We mapped existing studies to the six dimensions and selected samples with virtual objects or scenes that were frequently used in each dimension. The objects corresponding to the six dimensions are listed in the table1.

While this sample is intended to be commonly used as a de facto standard, it can be modified to meet the specific needs of each researcher. Therefore, we made possible to adjust parameters that are in high demand in evaluation experiments. For example, by making the parameters related to shape adjustable, it is possible to easily prepare visual stimuli of various shapes in an experiment that maps visual shape to haptic shape [4]. Information on adjusted parameters can be recorded in JSON format and shared with other researchers to reproduce the experimental environment.

3 CASE STUDY

We compared using the common experience sample of a gun with the experience with a standard Meta Quest 2 controller and with a gun-shaped attachment (figure1). The standard controller expresses gun recoil by vibrating when shooting, whereas the controller with the attachment produces feedback via the elasticity of the spring when the trigger is pulled. In the experiment, participants were asked to freely interact in a sample environment with a gun and a target, followed by a haptic display and a questionnaire to evaluate the experience. The following seven questions were selected for the evaluation of haptic displays, based on the Presence Questionnaire by Witmer et al. [6].

(1) How natural did your interactions with the environment seem? (2) How much did your experiences in the virtual environment seem consistent with your real world experiences? (3) How easy was it to identify objects through physical interaction, like touching an object, walking over a surface, or bumping into a wall or object? (4) How quickly did you adjust to the virtual environment experience? (5) Were there moments during the virtual environment experience when you felt completely focused on the task or environment? (6) Was the information provided through different senses in the virtual environment (e.g., vision, hearing, touch) consistent? (7) How much delay did you experience between your actions and expected outcomes? According to the classification of the questions, scores were obtained for Involvement from questions (1), (2), and (3); Adaptation/Immersion from questions (4), (5), and (6); and Interface Quality from question (7).

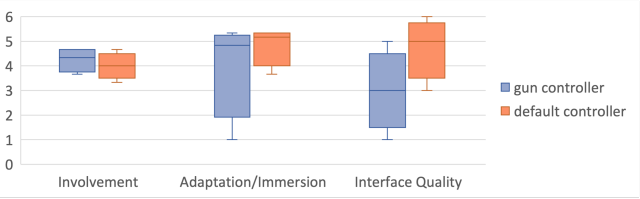

Figure 2: Presence Questionnaire results for each controller

While no significant difference was observed in Involvement, the gun controller was rated lower in Adaptation/Immersion and Interface Quality, with a particularly large difference in Interface Quality (figure2). Some respondents indicated problems in pressing the trigger and erroneous input. Moreover, the results for the third question were better for the gun controller, which we attribute to the ease of identifying objects from the shape of the device.

4 CONCLUSION

A common experience sample was proposed and prototyped for the purpose of comparative evaluation of haptic displays. This study made available an experimental platform that allows sharing of visual stimuli among researchers. Case studies were conducted to simulate usage scenarios and to verify that comparisons between different types of haptic displays are possible.

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