IEEE VR Paper Summaries

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Detection of Scaled Hand Interactions in Virtual Reality: The Effects of Motion Direction and Task Complexity

Objectives
In Virtual Reality(VR), by tracking the head, hands or even the entire body, it is generally considered that the user can use familiar movements and gestures to interact with the virtual environment as the most basic element. In order to allow users to experience the most real feelings, the physical movement of the real world is usually mapped to the virtual world one-to-one to determine the virtual movement. However, there are different situations in different virtual scenes, and sometimes we don't need to map our real body motion to the virtual system one-to-one. Due to the limitation of the actual physical space or the distance to the interactive objects, improved interactive techniques are often used. For example, the improved gait technology allows users to use real gait, but allows them to pass through a virtual space larger than the real space. Adjusting the size of the hand can also be used to reach distant objects through physical props in the real world, or to physically interact with virtual objects.

Methods
The primary goal of this paper is to answer 2 research questions:

- How do detection threshold estimations differ within each single degree of freedom for scaled hand motion?
- How do detection threshold estimations change with respect to task complexity: controlled hand movements compared to complex reaching motions in a cognitively demanding game scenario?

In order to solve these research problems, this paper conducted two psychological experiments. They designed a two-alternative forced-choice (2AFC) experiment to use psychological measurements to estimate the user's detection threshold for enlarged hand movement perception. In the first experiment, they tested the user's perception of the scale of simple hand movements in three directions: horizontal, vertical, and depth. In the second experiment, they tested complex hand-stretching movements in game scenarios with high cognitive

requirements.

Conclusion
This paper estimates the threshold in each direction and the compound hand movement in complex situations:

- horizontal plane: (0.809, 1.310), scales in the range of 0.809 (slow) to 1.310 (fast)
- vertical plane: (0.869, 1.520), scales in the range of 0.869 (slow) to 1.520 (fast)
- depth plane: (0.779, 1.380), scales in the range of 0.779 (slow) to 1.380 (fast)
- compound(3-dimensional):(0.758,1.430),scales in the range of 0.758 (slow) to 1.430 (fast)

These results show that we can change scales of virtual hand movements in the range (0.758, 1.430) with users cannot detect any differences. And they also found that the range of scaled thresholds in different directions also differed greatly.

Connection
In the locomotion chapter, we can also realize the perception of a larger virtual space within the limited real space by changing the scale of the steps within the effective threshold range. Through the study of this article, I have a deeper understanding of virtual perception. Regarding the interaction technology, we can also change the limited scale to realize the interaction with distant objects without making users feel strange.

The Impact of Multi-sensory Stimuli on Confidence Levels for Perceptual-cognitive Tasks in VR

Objectives
In daily life, we use visual, auditory, tactile, olfactory, and taste sensations to support our perceptual and cognitive activities, and enhance our credibility in cognitive activities. In the VR system, multi-sensory perception of the surrounding environment is also required to fulfill the needs of various cognitive tasks. In this paper, the authors mainly studied the effects of visual, auditory, two types of tactile sensations (floor vibration and wind) and odor on the confidence of position matching tasks. At the same time, they also measured the level of presence when users use different combinations of sensory feedback to complete the perceptual-cognitive tasks.

Methods
So their question is does Multi-sensory feedback enhance subjective confidence on the decision-making related tasks in VR? Unlike traditional perceptual VR systems that only have visual and audio feedback, the authors implemented a multi-sensory VR (MVR) system that adds perceptual feedback on floor vibration, wind, and smell. By comparing the MVR system with the typical-sensory VR (TVR) system, they measured the MVR's measures of confidence and correct answer ratio, and studied the effects of subjective measures such as

presence, user preference, and network disease. In this experiment, participants experienced the virtual location using MVR or TVR and reported their binary answers and confidence. They proposed the following three hypotheses:
H1. MVR will result in higher confidence levels and faster response times than a TVR.
H2. MVR and TVR will result in similar correct-answer ratios.
H3. MVR will result in more positive subjective feelings (higher presence, less cybersickness) than TVR.

Conclusion
In this experiment, they found that because the multi-sensory VR system has a higher sense of presence and better effect display, all participants said they prefer MVR to TVR. However, their experimental results did not reveal any difference between the two systems regarding cybersickness, so their findings partially support hypothesis H3. Although all participants preferred MVR, they showed higher confidence in their answers in the TVR system. And The authors also found that MVR lasted significantly longer than TVR. Therefore, hypothesis H1 cannot be supported. Since most participants' judgment of location mainly comes from visual feedback, they do not care much about other feedback, hypothesis H2 is not reliable.

Connection
Through the study of this article, I have a deeper understanding of VR perception. In a VR system, adding multiple sensory feedbacks does not necessarily reduce sickness, but users prefer this kind of system that gives them multiple feedbacks like the real world. Although people have a variety of perceptions, most people rely more on their visual and auditory feedback to enhance their confidence in cognitive activities.

Examining Whether Secondary Effects of Temperature-Associated Virtual Stimuli Influence Subjective Perception of Duration

Objectives
A large number of studies have shown that changes in body temperature can cause people to have higher or lower deviations in the duration of things they experience. This means that people can change their sense of continuity through psychological or physiological changes in body temperature. Therefore, the authors raise the following research questions:

- RQ1: Does the virtual temperature-related stimulus have a secondary effect on the observer 's subjective duration?
- RQ2: How do virtual stimuli at different locations affect the user 's subjective duration perception?
- RQ3: Do multiple stimuli presented simultaneously in the user 's environment and on their bodies have a stronger effect on subjective duration and / or temperature than any other location?

Methods
In the paper, the authors provided a user study within a 2 x 3 factorial that evaluated the relationship between temperature-related visual stimuli and participants' perception of temperature and duration. In the experiment, participants were able to put on and take off HMD comfortably through HoloLens. Then he or she can see the virtual objects placed on the table next to them and hear the repeated tones played through the device speakers. After that, stop these visual and auditory stimuli. Participants were asked to place the right palm rest on a fixed position on the table and make three time estimates and two temperature estimates. The first estimation task will serve as a baseline for comparison in subsequent experiments. Authors applied two different types of temperature stimuli (cold or hot) to the participants' hands, and then they estimated the time and temperature after the relevant conditional visual stimuli.

Conclusion
The authors found that the simulated temperature has a significant main influence on the user's body temperature and the estimated value of the ambient temperature. The experimental results show that the temperature estimation value is higher under thermal stimulation and lower under cold stimulation. The time estimate is generally overestimated. During the training phase of the experiment, the average time for all participants to receive no stimulation was estimated to be 33.809 seconds, and the average time during the study conditions was estimated to be 35.183 seconds to 37.539 seconds. When comparing the time estimate of the condition with the estimate of the training phase, this indicates that the overestimate range is between 4.06% and 11.03%.

Connection
In the classroom, the teacher only briefly introduced the main effects of virtual visual stimuli on the user's senses, and did not explain in depth the effects of time and temperature. By studying this paper and listening to the author's report, I have a deeper understanding of virtual visual stimulation. In the virtual world, all kinds of perceptual feedback we perceive will cause errors in our cognition, both physically and psychologically. Once these virtual perception stimuli are abused, it will cause great VR Sickness. Therefore, in the process of designing experiments, we must pay attention to the impact of these sensory stimuli on users.