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Poster

Study of alleviating the symptoms of VR sickness by cooling skin surface

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Abstract

VR sickness with symptoms like motion sickness such as carsick may occur when using VR. The occurrence of VR sickness varies from person to person, and the intensity and symptoms of sickness vary. However, in case of the VR sickness once occurs, it interferes with VR activities. Therefore, the elimination or alleviation of VR sickness is necessary for comfortable VR activities. In this study, we propose a method of cooling the neck and temples of the skin surface to alleviate the symptoms of VR sickness when VR sickness occurs. The experimental results show that skin surface cooling is effective in suppressing the symptoms of VR sickness when it occurs.

CCS Concepts

• ***Human-centered computing*** → ***Virtual reality;*** *Ubiquitous and mobile computing systems and tools;*

1. Introduction

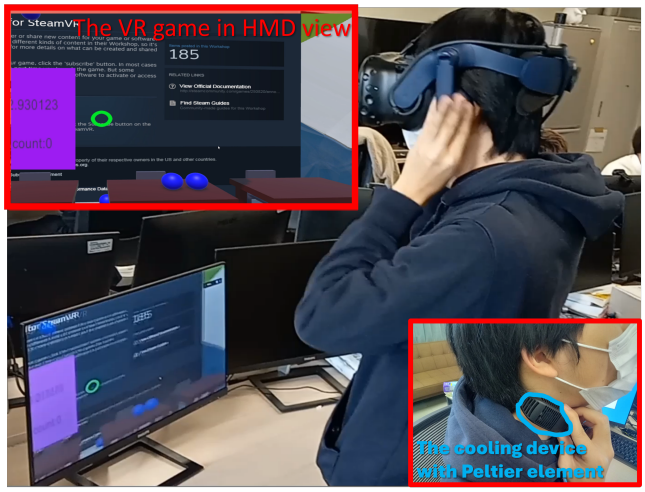

Figure 1: *Experimental apparatus, VR game in HMD view, cooling apparatus and the cooling device*

Various studies have been conducted to alleviate VR sickness. The main factors that cause VR sickness are sensory mismatch, insufficient display resolution, latency, improper interpupillary distance setting, and visual field. Many studies that attempt to treat VR sickness address these factors by removing or reducing them. In addition, as methods that do not directly address the aforementioned factors, research is being conducted on displaying a virtual nose in VR images [DMW15], restricting the peripheral vision when walking [ZC18], which tends to cause VR sickness, and alleviating sickness by stimulating senses other than vision [BK15].

Instead of using methods such as eliminating delays or improving the sense of realism, we decided to develop a solution from other perspectives. Broadly categorizing the methods of improving VR sickness, the following methods were considered: minimizing the occurrence of VR sickness, recovering quickly from VR sickness, and eliminating VR sickness. On the other hand, we consider ways to quickly suppress the symptoms of VR sickness when it occurs. Specifically, we propose a method of cooling the skin surface of the neck and temples when VR sickness occurs. This proposed method was devised based on empirical rules, referring to solutions especially for "carsickness" and our own VR experience. Note that the proposed method is not based on medical or physiological evidence.

2. Preliminary Investigation of alleviation of VR Sickness by skin surface cooling

In this study, we aimed to observe that cooling the subject's skin surface alleviates the symptoms when the subject feels VR sickness. To investigate the alleviation of the symptoms of VR sickness by cooling the skin surface, we had subjects experience a VR game that induces VR sickness and operated only by neck movements. The time to complete the VR game was used as a quantitative evaluation to evaluate VR sickness, and the SSQ (Simulator Sickness Questionnaire) was used as a qualitative evaluation. Therefore, in the VR game operated by only neck movements, we set the task of acquiring spheres that appeared at a certain period in the VR

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space. Also, in order to induce strong VR sickness in the subject, the VR environment is designed to follow the head movement with a 1-second delay.

Unity (2019.4.31f) was used to create the VR game that induced VR sickness, and a VIVE Pro2 was used as the HMD. A commercially available neck cooler (Neo TKNECK2-BK, 150 g in weight), modified (hereafter referred to as "cooling device"), was used as the cooling device. The cooling device has a built-in Peltier element, and the temperature can be adjusted according to the applied voltage. Originally, only a voltage of 3 V or 5 V could be applied to the cooling device, but the voltage could be manipulated by modifying the cooling device so that a voltage of 8 V could be applied. The Kungber variable DC stabilized power supply SPS3010 (output range 0-30V 0-60V, output current range 0-10A 0-5A) was used as the power supply for this applied voltage. A K-type thermocouple thermometer AD-5601A was attached to the subject's skin to measure the skin surface temperature during this investigation.

Our small user study was conducted in the following order: playing the VR game → answering the SSQ → playing the VR game → performing the cooling → answering the SSQ. To confirm whether the VR game made them feel VR sickness, 7-point Likert Scale questionnaire was asked after the experiment. The questionnaire asked the following questions: "Have you ever used VR before?", "How often do you experience VR?", "Are you prone to VR sickness?", "Do you often experience 3D games or 3D video works?", "Did you feel VR sickness in the experiment?", "Degree of VR sickness before cooling starts", "Degree of VR sickness during cooling", and "Degree of VR sickness after cooling", "Did you feel the effect of the experiment?".

Sixteen participants (11 males and 5 females) aged 19-24 years participated in the experiment. Each subject was informed in advance of the possibility of VR sickness in this experiment and that they could stop the experiment at any time in case of they felt sick, and the experiment was conducted with the consent of each subject. In addition, permission was obtained from the ethics committee of the institution to which the subject belonged.

First, after having the subjects practice the task of the VR Game, the subjects were asked to choose whether to cool the area near the temples or around the neck. The chosen area was used as the cooling spot in this experiment. Note that the limitation of candidate of the cooling area to the temple area and neck area was due to the preliminary survey. In this time, 9 subjects chose cooling near the temples and 7 subjects chose cooling around the neck. When conducting the experiment, thermocouple thermometers were attached to the spots to be cooled to measure the respective skin temperatures before and after playing the VR game. The experiment and cooling apparatus are shown in Figure 1.

3. Results and Discussion

Since this experiment evaluates the alleviation the symptoms of sickness, we focused on the seven participants gave a rating of 4 or higher in the "Did you feel VR sickness in the experiment?" section of the above questionnaire.

As shown in Figure 2, a difference in SSQ score was observed depending on whether the skin surface was cooled, suggesting that the symptoms VR sickness was alleviated by cooling the skin surface. However, these results are not statistical due to number of participants.

Regarding the skin surface temperature during the experiment, the skin surface temperature was higher than normal at the end of the task. Figure 3 also shows that the body temperature tended to increase at the completion of the task compared to before the HMD was worn. The fact that the significant difference in skin surface temperature was observed suggests that the skin surface temperature may have increased during the VR game.

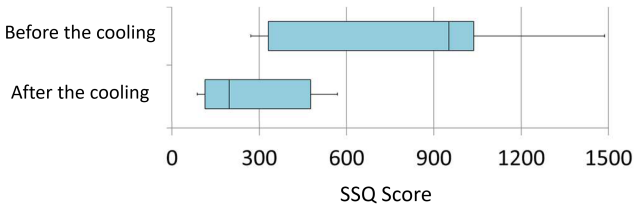

Figure 2: *Comparison of SSQ total evaluation value*

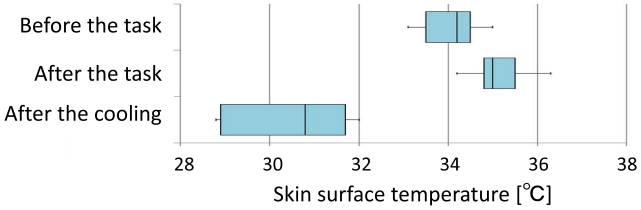

Figure 3: *Skin surface temperature during the experiment*

4. Conclusion

In this study, we proposed a method of using skin surface cooling to alleviate the symptoms of VR sickness induced during VR use and conducted evaluation experiments. For the experiment, we used a modified commercial neck cooler and the VR game that induces sickness. The results show that a difference occurred before and after cooling when the SSQ scores were evaluated. This result suggests the possibility that the symptoms of VR sickness alleviated by skin surface cooling.

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