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A Breeze Enhances Presence in a Virtual Environment

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Abstract: *Usually, virtual situations are created with visual and sound jolts, but less often do they include haptic incitement. We made a breeze cannon using components that could be used in a virtual environment and compared it to four conditions: no wind, self-generated wind, object-generated wind, and nature-generated wind. People said they felt more immersed in the environment when the wind was caused by their claims. Recounted suggests that moving discuss may help reduce test system ailments. As virtual situations become more prevalent in different places, the idea of being "drowned" in a virtual space becomes more important for customer engagement and satisfaction. This study looks at how adding a mimicked breeze to virtual situations can improve the user's feeling of closeness. It uses a multi-disciplinary approach that includes human-computer interaction and brain research, as well as natural design. This not as it was question adds to the idea of closeness in VR, but it also has some useful ideas for developers and engineers who want to make their client experiences better. Adding a recreated windup suggests a new way to improve VR apps, which could affect the design of gaming scenarios, virtual getting ready recreations and useful apps..*

Keywords: VR apps

I. INTRODUCTION

Typically, virtual environments (VEs) are created with visual and auditory stimuli. Less often haptic stimulation is included as well, in the form of force feedback and tactile manipulators such as gloves or joysticks. Some VEs include moving air to simulate a breeze, but little research has been done to study the impact this type of haptic feedback could have on users. In this paper, we examine what sources for moving air could be used to increase users' feeling of presence within a virtual world.

1.1 Presence

The psychological perception of being inside a virtual world is known as *presence* [20]. A user's feeling of presence can be affected by several factors, one of which is the content of the virtual environment [10].

Research suggests that realistic information can increase users' sense of presence. For example, Hoffman et al. [8] had participants look at virtual displays of chess pieces that were either placed in a realistic pattern (taken from an actual chess game) or placed in a random pattern on the chessboard. The task consisted of remembering the position of the pieces. The participants were classified into four levels of chess expertise, ranging from naïve (does not know the rules of chess) to expert (tournament-level players). Apart from the naïve group, all participants reported a higher feeling of presence when the pattern was realistic than when it was random.

1.2 Haptic feedback

Haptic input is ordinarily characterized as joining both kinesthetic (coming from muscles, joints and ligaments) and material (coming from nerve receptors within the skin) data [3,5,8].Haptic criticism can progress assignment execution. Teleoperators advantage from haptic input when controlling inaccessible objects [4,14]. Individuals working together on a errand inside a VE can too advantage from haptic criticism. Sallnäs and her colleagues [17,18] found that when one individual was inquired to hand an protest to another individual inside a collaborative virtual environment (CVE),

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the members completed the errand quicker and thought that their execution was predominant when haptic criticism was used. In another consider employing a CVE [1,2,7], two individuals had to collaborate to move a virtual ring along a virtual wire without touching the wire. Once more, participants performed altogether way better within the haptic than within the non-haptic condition.

Haptic input can too increment people's sense of nearness inside a VE. Within the CVE-based studies mentioned already (where members either passed an protest or moved a ring over a wire) [1,2,7,17,18], members detailed having the next sense of nearness within the haptic condition than within the non-haptic condition. In another consider inside a CVE [11], members who got haptic input whereas lifting a virtual box together felt a more prominent sense of co-presence (being with somebody else within the VE) than when they gotten no haptic criticism amid the assignment. Hoffman et al. [9] too found that haptic input expanded the sense of nearness inside VEs. Their participants' assignment was to handle a virtual ball either with or without haptic input (working at a time when advanced gloves were still primitive, they utilized genuine balls for the haptic input).

1.3 Air as haptic feedback

A few simulators already incorporate air as a source of haptic feedback. For example, the flying simulator "Soarin' over California" in Disney's "California Adventure" theme park includes moving air to simulate the sensation of wind. Other examples of commercial applications that incorporate air in their feedback include the virtual reality games *Dream Glider*, a hang glider replicator, and *Sky Explorer*, an ultralight plane replicator.

Very little research appears to have been done on the subject of incorporating moving air into a virtual world. We could find only one report (in Korean) that studied the impact of moving air, and which reported that the feeling of presence can be increased by adding moving air to a VE.

In the real world, there are three main sources for air movement: when a person moves through space (selfgenerated), when an object passes close to a person (object-generated) and when the wind blows (naturegenerated)[1]. This study compared people's sense of presence using each of these three sources to investigate whether people find one more realistic within the context of a virtual world. We also expected people to report a greater sense of presence no matter what the source of the breeze when compared to a neutral condition in which there is no moving air.

II. DESCRIPTION OF THE EXPERIMENT

2.1 Participants

Eight participants (five women and three men) were recruited during a one-week period from within the Communications Research Centre. Average participant age was 35 (standard deviation of 7.4) and ranged from a minimum of 26 to a maximum of 48. The majority of participants answered the English version of the questionnaires, although two answered the French version.

Previous exposure to VEs ranged from none to several hours, with six participants having had at least some previous exposure (minimum of five minutes).

2.2 Material

The virtual world was created using VRML97 markup (ISO/IEC 14772-1:1997) and rendered using the FreeWRL VRML browser (www.crc.ca/FreeWRL). The computer used to render the world was a Pentium III with dual 1Ghz processors and an NVIDIA GeForce III video card. The framerate achieved during the experiment was approximately 25 frames per second. The environment was displayed using a Virtual Research V8 head mounted display (HMD) and head movements were tracked using a Polhemus 6DOF motion tracker mounted on a chair [16]. A generic computer joystick was used to move the person's avatar around the world. Pulling the joystick trigger moved the avatar forward, while tilting the joystick left or right changed its orientation. When the participant pulled the trigger, the avatar would begin to move forward at a slow pace that would accelerate to a set maximum speed (three units per second) in seven to eight seconds. The speed at which the participant was moving was sent via a socket connection to a separate computer

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where it was displayed in a GUI interface. An audio clip of 'forest sounds' (including bird songs) was played in a continual loop at a low level so as to block background noise.

In order to generate a breeze, we constructed a *breeze cannon* from readily-available components (see figure 1). A bathroom ventilation fan blew 110 cubic feet of air per minute through a 3 inch (7.6 cm) diameter nozzle via flexible ductwork. The fan ran continuously and air flow was controlled by a manually operated valve to ensure that there was no change in fan noise to cue the person experiencing the breeze. This valve could be set at three levels (no breeze, weak breeze, strong breeze). The nozzle was placed 60 cm from the person's face. As people were wearing a headmounted display, they only felt the breeze on the lower half of their face and neck. The subjective impression was that of a noticeable cool breeze.

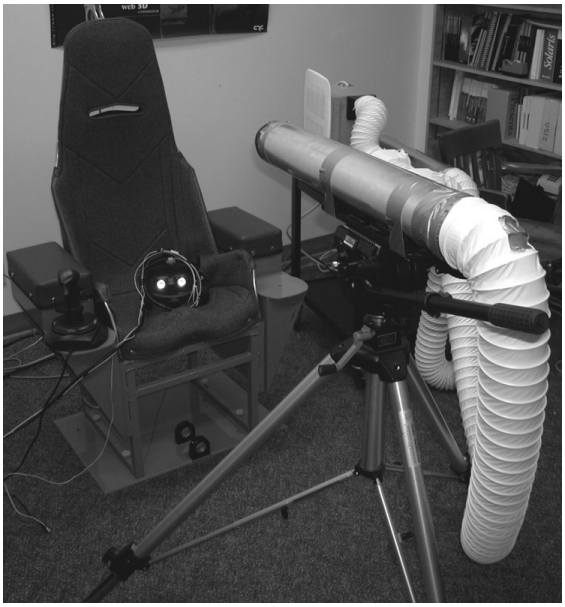

Figure 1. Breeze cannon directed toward the VR chair.

Three surveys were filled out by members, one on nearness, one on test system affliction, and one concerning the haptic feedback. There have been a few surveys created to degree nearness [13]. Be that as it may, we required a brief survey that can be managed rapidly between conditions.

We adjusted the five-item survey utilized by Prothero [15], which was based on the one created by Usoh and colleagues [19]. Our adaptation has four things, each with a seven-point scale with semantic stays at both closes. Each address tests for a different aspect of nearness inside the virtual world. The primary question (lab vs. VE) asks whether individuals felt like they were within the lab or within the stop (1=lab, 7=park). The moment address (authenticity) inquires how reasonable the world felt like (1=as genuine as an envisioned world, 7=indistinguishable from the genuine world).

The third address (restrictiveness) inquires to what degree the virtual world got to be the person's reality (1=never, 7=all the time). The fourth address (inclusion) inquires in the event that the VE felt more like something individuals were looking at or an genuine put they gone by (1=something they saw, 7=a put they visited).

We utilized the Test system Affliction Survey (SSQ) [12] to confirm the physical affect that the explore had on our members. At long last, we made a brief survey to check whether individuals were mindful of the breeze and to degree their sentiments almost this sort of haptic input. All three surveys were interpreted by the first creator into French.

2.3 Stimuli

The virtual environment utilized was that of an 'urban park' comprising of roughly 300 broadly divided basic pine trees made up of truncated cones and of five in an unexpected way-coloured houses. The measure of the environment was set to 1,000 units long by 1,000 units wide. By comparison, the user's avatar was around two units in tallness, whereas the houses were 6 units wide by 6 units profound by 10 units tall. To assist members arrange themselves inside the

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environment, the four quadrants had distinctive backdrops: an urban horizon, a mountain chain, a wheat field and a moor.

Six objects speaking to radio-controlled airplanes were consolidated into the environment. Five of the planes taken after circular directions around each house, whereas the 6th taken after a circular direction around the user's position.

The houses were randomly placed in the environment such that one house was in each quadrant and the fifth house was in the approximate center of the world. Five different random placements were created for each of the four conditions as well as for a practice condition. This practice condition was the same as the experimental conditions with the exception that, in the experimental conditions, each house was highlighted one at a time by a colored pole that started from the house's roof and went towards the sky. This pole or beacon was wide enough and tall enough to be visible from anywhere within the environment, provided the person was facing the right direction.

2.4 Experimental procedure

The participant was seated in the virtual reality chair and was given a brief explanation of the task by one of the experimenters. The task consisted of visiting each of the five houses in a pre-determined order. The house to visit was indicated by a colored beacon coming out of its roof. When the person got close enough to the house (within 15 units of the house), the house would change color (becoming white) and the next house to be visited would be indicated with a new beacon until the last house had been visited. Participants were encouraged to accomplish this task as quickly as possible.

Once the participant understood the task and was shown how to manipulate the joystick, the HMD was placed on their head and the practice environment was initiated. The participant was encouraged to move around this environment for approximately one minute. After the participant had familiarized themselves with the controls the practice environment was shut down and the first of the four test environments was initiated.

Each participant was exposed to all four conditions (within subject) but in a different order (between subjects), with two people assigned to each order. The order of the conditions was varied in a Latin square as seen in table 1.

Table 1. Latin square order

Session 1	Session 2	Session 3	Session 4
Neutral	Self	Object	Nature
Self	Nature	Neutral	Object
Object	Neutral	Nature	Self
Nature	Object	Self	Neutral

The neutral condition contained no breeze. In the self-generated condition the air cannon was activated whenever the person moved within the environment. If the person was moving slowly (up to half of the maximum speed), the cannon was set to produce a weak breeze. If the person was moving quickly (above half the maximum speed), the cannon was set to produce a strong breeze. In the object-generated breeze condition one of the experimenters handled the breeze cannon to synchronize the movement of air with the motion of the planes in front of the person's avatar. For example, if the planed moved from left to right in front of the avatar the breeze cannon was swept from left to right across the person's face. In the nature-generated breeze condition the breeze cannon was turned towards the participant for approximately ten seconds once every minute that the user was in the environment. For both the object generated breeze and nature generated breeze conditions, the cannon was set to produce a strong breeze.

The time to complete the task was measured from the moment the environment became live (the participant was informed of this by one of the experimenters, and through a visual cue in the environment) to the moment the participant reached the last house.

After the person reached the last house, the environment was shut down and the participant was invited to either shut their eyes or remove the HMD (most people chose to shut their eyes). At this point, the presence questionnaire was read out to them and their answers were recorded on paper. Once the questionnaire was finished, the participant was invited to open their eyes or put the HMD back on and the next environment was initiated. This procedure was completed four times, once for each condition.

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After the fourth trial was wrapped up and the final nearness survey completed, the experimenter studied the SSQ to the member and recorded the answers on paper. At that point the haptic survey was filled out in this same way. A short time later, the experimenters questioned the member and any questions from the member were answered.The entirety strategy kept going between 20 and 40 minutes.

III. RESULTS

In arrange to analyze the feeling of nearness, Usoh et al. [19] checked the entire number of times individuals replied 6 or 7 on their survey. In any case, we accept that this approach leads to a misfortune of data. Instep, we have chosen to analyze each address independently. Since of the little number of members, we collapsed the distinctive orders together and utilized the non-parametric Friedman two-way examination of change by positions on each of the four nearness questions. Table 2 presents the normal evaluations given by members for each address agreeing to the four conditions, whereas Table 3 presents the comes about from the Friedman investigation of fluctuation. Appraisals can shift from 1 to 7, with higher appraisals demonstrating more noteworthy sentiments of nearness.

Table 2. Average rating on presence questions according to the condition

	Conditions			
Question	**Neutral**	**Self**	**Object**	**Nature**
1. Lab or VE	3.0	4.3	2.5	3.3
2. Realism	2.5	3.1	2.3	2.6
3. Exclusivity	3.3	4.0	2.9	3.6
4. Insertion	3.1	3.8	3.4	3.3

Only the first question reached significance, which means that the participants judged the feeling of presence differently for the four conditions when asked whether they felt as though they were seated in the lab or walking through a park. Although questions 2 and 3 follow a similar pattern of response as that given on question 1 (self condition highest and object condition lowest), neither reaches significance. Question 4 shows a slightly different pattern (neutral condition getting the lowest rating), but again, it does not reach significance. This lack of significance may simply be due to the small number of participants in this experiment.

Table 3. Results of Friedman analysis

Question	**$\chi 2$**	**dl**	**p**
1. Lab vs. VE	11.87	3	.008
2. Realism	5.75	3	.125
3. Exclusivity	4.62	3	.202
4. Insertion	3.71	3	.295

Pairwise comparisons were done on the answers for question 1 and significant differences were found between self and neutral ($p<0.01$), self and object ($p<0.001$) and self and nature ($p<0.05$). In other words, our participants felt more as though they were inside the park than in the lab when the breeze was associated with their own movement than when it was associated with any other condition or when there was no breeze.

In order to see whether adding air would have an impact on task, we measured the time spent to complete the task. A measurement error occurred in one case (participant #3, condition B), when the experimenter did not notice that the last house had been reached, thus causing this time to be inflated (over six minutes). It doesn't appear that this inaccuracy has had much of an impact, though. The average time required to do the work under each of the four situations is shown in Table 4. The time taken did not show significant results from a Friedman two-way analysis of variance by rankings ($\chi 2$ (3) = 0.75).

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Table 4. Average time to complete task according to the condition

Condition	Neutral	Self	Object	Nature
Time	3m16s	3m55s	3m3s	3m42s

Total SSQ ratings ranged from 0 to 60, with a mean of 35. Compared to Kennedy et al. [12], these results are relatively high. This may be due to the task, which often required participants to orient themselves in the VE. A common strategy used by participants to find the next house was to turn around until they made visual contact with the beacon. In some cases, participants had difficulty finding the beacon (either they did not recognize it or the house blocked their view), so they turned around frequently, which may have increased morbidity. All participants reported being aware of the wind. They were asked to rate its pleasantness on a seven-point scale, where 1 represented very unpleasant and 7 very pleasant. On average, people reported that the wind was pleasant, giving it an average score of 5.5 (minimum score 3, maximum 7). When asked if they associate the wind with anything in the virtual world, the answers varied. Two people thought it was correlated with anything, while one person said they hadn't noticed the wind for a while. Of those who attributed it to something, four people mentioned that it affected their movement, while two people attributed it to the wind. When examined, one person thought the other conditions were random, one person noted that the planes created a wind, and two people thought the air was there to help them (either to reduce nausea or to help them breathe). During the briefing, several attendees reported that the wind helped improve their attendance.

V. CONCLUSION

Members detailed an expanded sense of nearness amid trials with a self-generated breeze as compared to all other conditions, but as it were in reaction to the address inquiring whether they felt as in spite of the fact that they were in a lab or within the virtual world. We had anticipated that all the exploratory conditions would create higher evaluations than the impartial condition, but this was not the case. There are a few conceivable clarifications for this. For one thing, the object-generated breeze condition did not create as numerous experiences with planes as we had expected. The plane circling the avatar seem not keep up with the fast pace of development through the environment and, as a result, once in a while circled the individual unless their avatar was standing still (which individuals did rarely since the instructions inquired them to achieve the errand as rapidly as conceivable). Moreover, individuals went through exceptionally small time another to any one house (fair sufficient time to reorient themselves), so there were moreover exceptionally few experiences with the planes tied down to the house areas. This come about in exceptionally few breezes created in this condition (less than three in most cases, and more frequently than not as it were one).

In spite of the fact that the nature-generated condition created somewhat more breezes than the object-generated condition, these breezes were still not visit when compared to the self-generated condition. A individual within the nature condition would have ordinarily been uncovered to three or four breezes (30 or 40 seconds of discuss), while within the self condition, the individual would have been nearly continually uncovered to discuss (a few minutes worth). It may be at that point that it isn't the clear source of the breeze that increments the feeling of nearness so much as the sum of breeze that the individual felt amid their visit to the virtual world. Advance experimentation would offer assistance clarify this issue.There is another distinction between the three exploratory conditions that may possibly have an affect on people’s feeling of presence. Depending on the condition, the breeze was either in development or steady. That's , the breeze was either cleared over the person’s confront (object-generated condition) or it was pointed straight at the individual over a shorter or longer period of time (nature- and self-generated conditions). In spite of the fact that the question condition was not essentially diverse from the nature condition in this ponder, a bigger test estimate might uncover a distinction between these two ways of blowing discuss towards individuals in a VE.

Surprisingly, a few individuals detailed a little diminish within the feeling of ailment when uncovered to a breeze. Shockingly this try was not set up to investigate the affect of moving discuss on people’s simulator sickness indications. However if moving air can be demonstrated to assist reduce people’s side effects, it would warrant joining this source of haptic feedback more regularly into VEs.

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