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The Research On Virtual Reality Sickness With Advancing Color And Receding Color

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ABSTRACT

In recent years, the market sales of VR equipment have been incre asing, and more users have access to VR equipment more conveni ently. However, if you use a VR device to use image content or ga mes, it can cause sickness or discomfort to the users. So I think re ducing VR sickness is an important subject.

Therefore, I investigated the reasons that affect VR sickness. Acco rding to "Evaluation of 3D Motion Sickness Induced by Videogam es"[1] and by keeping the visual distance, it can slow down the vie wing discomfort to some extent. From the " Shikisainoshinrikyou ka[2]", the definition of the forward color and the backward color o f "the psychological effect of color" can be seen. Based on the resu lts of these two papers, the paper aims to clarify and verify the imp act of color on VR.

CCS CONCEPTS

• Bstraction • Procedural animation • Scenario-based design

KEYWORDS

Virtual reality, Sickness, Color, Balance

1 The Experimental Objective

Combine with leading research, using the color (advancing color and receding color) to clear the relationship between color and VR sickness. In order to get the influence of advancing color and receding color to VR vertigo, I have made the VR content that experiment uses.

2 Previous Studies

From the research" The Effects of the Environmental Color Change on the Ability of the Human Movement [3]", I know **the advancing color in the work environment has better movement accuracy and the whole body reaction time than ordinary light.**

From the research" Effects of color stereoscopic phenomenon on performance in long jump [4]"I know These findings suggest that colors have some influence on distance (depth) perception in a long jump situation under limited conditions.

From the research" A Survey of Countermeasure Design for Virtual Reality Sickness[5]" I know the cause of VR sickness, and how to defense it.

According to previous studies, the relation of the color and the movement has been cleared, but it has not applied in the VR aspect, and the relation of the color and the VR sickness has not been learned.

3 System And Practice

(1) Manufactures the VR animation (three). The line of sight is controlled with OCULAS.
(2) Experience the experimenter, and carry on the appraisal.
(3) Analyze the empirical data.

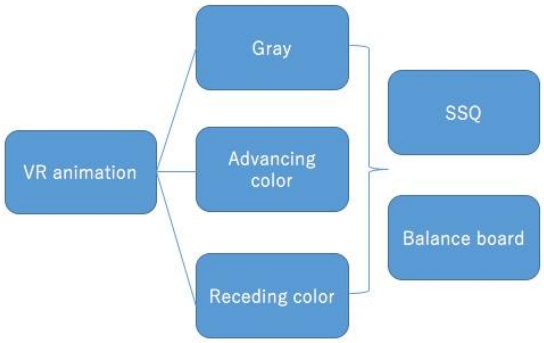

Figure 1: System Process

3.1 System And Practice

Three VR tunnels had been prepared, ordinary tunnel (gray) and the advancing color and receding color adopt the most representative red and blue.

3.2 Experimental Evaluation

3.2.1 Simulator Sickness Questionnaire[5]. The Simulator Sickness Questionnaire (SSQ) has 16 project problems with each question having 0 (no) to 3 (yes) or 4 indicators.

01	General Discomfort
02	Fatigue
03	Headache
04	Eyestrain
05	Difficulty Focusing
06	Increased Salivation
07	Seating
08	Nausea
09	Difficulty Concentrating
10	Fullness of Head
11	Blurred Vision
12	Dizzy (Eyes Open)
13	Dizzy (Eyes Closed)
14	Vertigo
15	Stomach Awareness
16	Burping

Figure 2: SSQ questions

3.2.2 objective evaluation method. With regard to the measuri ng method of the Wii balanced board, according to the " Baransu Wiiboudonojyushindouyoukeitoshitenoriyou [6]" and "Effects of co lor stereoscopic phenomenon on performance in long jump ", acco rding to the credit and experimental procedures of the balance plat e, it shows that the correlation between visual inducement and cen ter of gravity shaking is very high, and people will keep the body balance .And the Wii Balance board center of gravity shaking mea surement is also used in the field of basic research and rehabilitati on training.

4 Preliminary Experiments

Preliminary experiment is intended to demonstrate the reliability o f the Wii balance board program without using subjective evaluati on technique.

4.1 Experiment Sequence

(1) Normal gravity measurement (15 seconds) ・ 1 minutes to rest
(2) Center of gravity test (gray)
- while watching
- after watching

(3) Center of gravity test (advancing color)
- while watching
- after watching

(4) Center of gravity test (receding color)
- while watching
- after watching

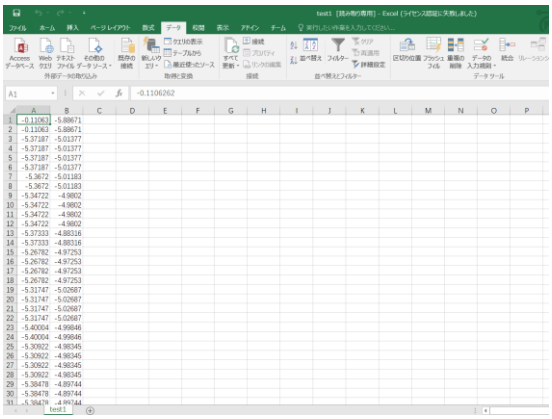

Figure 3: Example of balance board data

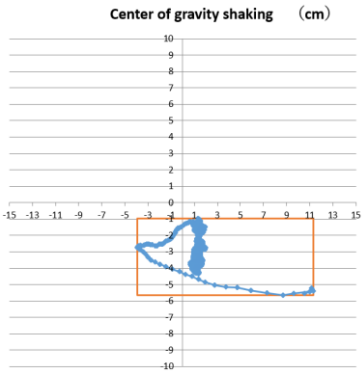

Figure 4: Example of balance board barycenter displacement measurement

4.2 Evaluation System

I add the evaluation system in program, it can computational the acreage of square and migration length.

5 Result And Analysis

I deleted the outlier from the data [11], and calculated the mean area.

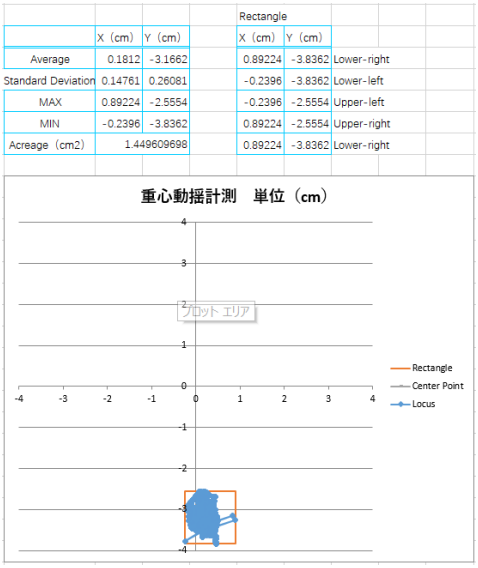

Figure 5: Example of balance board result

			Rectangle		
	X (cm)	Y (cm)	X (cm)	Y (cm)	
Average	0.1812	-3.1662	0.89224	-3.8362	Lower-right
Standard Deviation	0.14761	0.26081	-0.2396	-3.8362	Lower-left
MAX	0.89224	-2.5554	-0.2396	-2.5554	Upper-left
MIN	-0.2396	-3.8362	0.89224	-2.5554	Upper-right
Acreage (cm2)	1.449609698		0.89224	-3.8362	Lower-right

Figure 6: Area Calculation System

The program of Excel which can ask for average :

ask for average、standard deviation

```
Range("G12:G16").HorizontalAlignment = xlCenter
Range("H11").Value = "X（cm）"
Range("I11").Value = "Y（cm）"
Range("G12").Value = "average"
Range("H12").Formula = "=AVERAGE(D2:D1746)"
Range("I12").Formula = "=AVERAGE(E2:E1746)"
Range("G13").Value = "standard deviation"
Range("H13").Formula = "=STDEVP(D2:D1746)"
Range("I13").Formula = "=STDEVP(E2:E1746)"
```

ask for MAX,MIN

```
Range("G14").Value = "MAX"
Range("H14").Formula = "=max(D2:D1746)"
Range("I14").Formula = "=max(E2:E1746)"
Range("G15").Value = "MIN"
Range("H15").Formula = "=min(D2:D1746)"
Range("I15").Formula = "=min(E2:E1746)"
```

ask for acreage

```
Range("G16").Value = "acreage（cm²）
Range("H16:I16").Merge across:=True
Range("H16").Formula = "=(H14-H15)*(I14-I15)"
```

5.1 Result

Normal gravity measurement: 2.91 cm^2

while watching:

Center of gravity test (gray): 3.19 cm^2
Center of gravity test (advancing color): 9.41 cm^2
Center of gravity test (receding color): 4.67 cm^2
Advancing color > Receding color > Gray > Normal

after watching

Center of gravity test (gray): 2.49 cm^2
Center of gravity test (advancing color): 2.98 cm^2
Center of gravity test (receding color): 3.02 cm^2
Receding color > Advancing color > Normal > Gray

5.2 Analysis

From the result of while watching, advancing color make the strong sense of instability research subjects, and the normal environment less impact center of gravity shaking. From the result of after watching, receding color make the strong sense of instability research subjects, and the gray environment less impact center of gravity shaking.

Target result is **Advancing color > Gray > Receding color > Normal.**The advancing color will make the strong sense of instability research subjects, and the receding color will make research subjects fell calm down. This is the preliminary experiments, we found the problem of experiments, first is rest time is not enough, if 1 min to rest, the research subjects maybe feel tired; second not used SSQ in this time.

6 Prospect

We have conducted the preliminary experiment in this paper, cleared the reliability of the Wii balance board, and modified the experiment steps through the result. We will add the rest time to 3 minutes, it will make research subjects fell calm. We will next conduct the formal experiment, and add the Simulator Sickness Questionnaire (SSQ) , and add new evaluation system in program, which can calculate migration length in graph, and further verify the effect of advancing color and receding color on VR sickness.

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