THE VIRTUAL REALITY SOCIETY OF JAPAN

第 23 回日本バーチャルリアリティ学会大会論文集（2018 年 9 月）

A Virtual Agent to Attract the Attention of Passersby Through Eye Gaze and Motions

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Abstract - Nowadays, some digital signs are used as entertainment media to boost customers' awareness. In this research, we would like to utilize an interactive virtual agent for the digital content and try to explore how motions and eye gaze can affect people's attention. However, there is a gaze illusion, Mona Lisa effect, which may happen in a picture that the eye of a portrait often follows observers even though they stand in different positions. This study will try to solve such inaccurate perception while people is interacting with the virtual agent on 2D signage display.

Keywords: Virtual agents, Human-computer interaction, Computer animation, Gaze perception

1. Introduction

Due to the demand for development of digital signage by companies, the global digital signage market keeps growing recently[1]. Although there are various purposes of digital signage, engaging customers' attention at sales is what many companies are concerned. Nevertheless, there is no definitive way to catch people's attention. Among various solutions, we find that humans and some social animals pay attention to other members of their groups to acquire social information about them.(This is called social attention.) [2] For example, in many business exhibitions, companies would hire receptionist to draw people's attention. In that case, if we introduce a virtual agent which behaves like a receptionist into the digital signage, it may successfully draw people's attention. Therefore, this study will try to utilize an interactive agent and explore how social behavior such as gaze and gestures that can catch passersby's attention in the digital signage.

The digital signage we see nowadays, however, is usually 2D flat display. It may cause some visual illusions because humans have limitation in perceiving the correct orientation of the object in the 2D image. The apparent one is Mona Lisa effect[3], no matter what viewing angle is, the gaze of the projected head in the portrait tends to follow an observer. Therefore, such inaccurate perception of gaze may severely influence the social interactions with the virtual character. Therefore, for the first step of this study we would like to address this problem and make people feel virtual agent's gaze faithfully. After that we can discuss how social behavior to appeal people's attention.

2. Experiment

There can be some psychological stimuli that may influence our perception on the character's gaze. We conducted an experiment to investigate whether such stimuli can decrease the visual illusions in the 2D display or not.

2.1. Method

According to Wollaston effect[4], the gaze direction is not only influenced by eyes but also head turn. In addition, different from static portrait, our system uses active character. While the eye gaze is in the moving status, observers may have different perception from the static status. Therefore, we firstly made the assumption that altering the moving pattern of pupils may decrease Mona Lisa effect. In the next experiment, we want to investigate whether the observer can feel natural eye-contact with the character by this method.

2.2. Apparatus

We used flat mirror display (80.5cm x 148cm) which can show 2D virtual character model in nearly human size. To allow the character's head and pupil to move with an observer, a Kinect device (Microsoft Kinect Sensor V2) is positioned behind the mirror display to track one's movement. The participants will stand 100 cm ahead the screen to observe the character model. For the moving test trial, the participants would stand on the left side of the display and walk toward the right side of the display in -30° direction (See Fig.1), and the path is also marked on the floor. In addition, we conducted the experiment in the bright room instead of the dark room to allow the mirror display to reflect the objects of the real world, which makes screen look like 3D space.

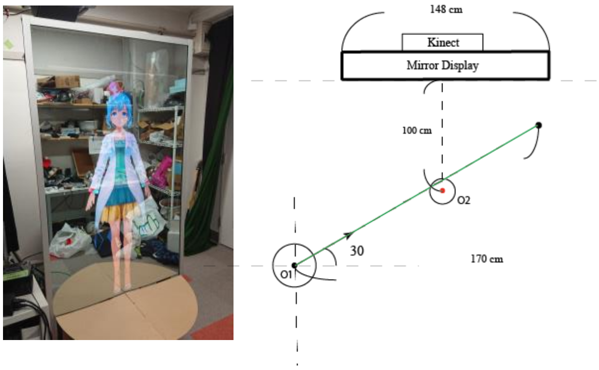

Fig. 1. (Left) The mirror display used for the experiment. (Right) The top view of the room arrangement. In the moving test trial, participants start from the O_1 point and walk through the green line to observe the character model. For the standing test trial, participants stand on the O_2 point to observe the target.

2.3. Stimuli

The stimuli were different moving patterns of non-photorealistic 3D character model presented by Unity engine. Since Mona Lisa effect originally happens in a realistic portrait,

we would like to see whether toon-shading model can cause different perception to the observers or not. For the moving patterns, deviation of the head turn is fixed in the horizontal plane and controlled by the relative angle from the center of the character model toward the observer. The pupils, on the other hand, have two ways of moving pattern. For the first, pupils move with the same angle as the head turn. Second, pupils keep in the direct gaze while the head orient rightward or leftward. (See Fig.2) Both pupils moving patterns are also fixed in the horizontal plane as well.

Fig. 2. Two stimuli in the experiment. The character's head would turn in response to an observer's position. The left image shows that the pupils rotates at the same angular position with the head turn. In the right image, the pupils almost stay in the direct gaze but the head can rotate rightward or leftward.

2.4. Procedure

In each experiment, the participants would see two stimuli: eyes keep in the same direction as the frontal face, and the stimulus that eyes almost keep in the direct gaze but the head may orient rightward or leftward. In addition, participants had to see these two stimuli in moving status and fixed status separately. At first, one of the stimuli and observing condition would be randomly decided for the participants. Assuming that the experiment starts in moving status to observe the stimulus which eye direction follows the movement of frontal face, and then the next steps are as follows:

1. Show different head turn amplitude by 5 different multipliers from the biggest one to the smallest one for the participants (1.5x, 1.0x, 0.5x, 0.1x, 0.0x), and using number 1 to 5 to represent each multiplier. 1.0x makes the head turn angle the same as the coordinate of the real world. The participants pass by the screen once for each multiplier and answers the number that mostly fits eye-contact after checking 5 different head turn amplitude.
2. Give the mouse to the participants and let themselves adjust the head turn amplitude while walking forth and back in front of the display. (Rolling the mouse wheeler once to increase or decrease 0.1 x) The participants start to adjust the parameter from the multiplier he/she choose in the last step and keeps adjusting it until he/she feels that the eye-contact always matches while he/she is walking.

When checking another stimulus, the participants repeat the above steps again.

In the next condition, observing in the fixed position, the participants can only see the character by moving upper half of the body. The steps of the experiment are also the same. However, in the step2, there is a difference that the participants are required to find the upper threshold and the lower threshold that eye-contact occurs instead of finding the pinpoint. In addition, if the participants observe the character in a long time, the visual fatigue might appear and influence the result. We would pay attention to this case and allow the participants take a rest if this case happens.

Finally, when the participants checked the two conditions, they would be asked to answer which stimulus appears to match the eye-contact.

3. Results and Discussion

We had 10 students conduct the experiment. The figure 3 shows the results of observing in walking status. The smaller the multiplier is, the narrower the head turn amplitude is. As the histogram shows, values of multiplier in the stimulus 1

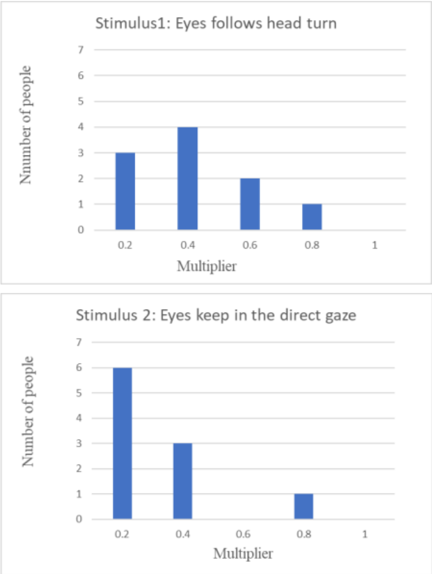

Fig. 3. The results of two stimuli in the condition of walking through the display.

(character's eyes follow head turn) tend to be scattered, and the values of multiplier in the stimulus 2 (Character's eyes stay in the direct gaze) mostly gather in the range of 0.1~0.2. We originally estimated that the result of the general situation (stimulus 1) would tend to be smaller values because of Mona Lisa effect, and then the values of stimulus 2 are expected to be bigger ones. However, the result is contrary to the expectation despite the data of stimulus 2 are more centralized. According to participants' comment, some people felt that the small head turn of the stimulus was more natural because eye-contact would mismatch in the larger moving amplitude. Besides, some people also feel that it is not natural to watch people in this way.

For another condition, observing the participant in the fixed position, we expected that the perception of the gaze range in the stimulus 1 would be narrower and near the zero value because Mona Lisa effect makes the frontal face eye-contact most intensive. On the other hand, we anticipate our method different from the stimulus 1 and observers should perceive the gaze under a higher value, which means that head turn will become larger when observers shake upper bodies to watch the character's gaze. For the results shown in the figure 4, however, the stimulus 2 that eyes keep in the direct gaze didn't really match our expectation. There are still some participants feeling that less head turn does match eye-contact. In addition, the range of gaze perception is not very stable. This is because every individual may have different perception, or perhaps the method of the experiment itself is not very objective. We should figure out if there is some noise that influence the experiment result.

Fig. 4. The results of two stimuli in the condition of standing in a fixed position ahead the display.

4. Conclusion

The overall results of the experiment didn't match our expectation very well. As we discussed before, there could be some interference or other reasons that made the results. For example, the participants sometimes went over the range and made Kinect device unable to detect them. The method of adjustment may also not be good in our case, which adjusting the parameter back and forth could influence people's perception gradually. Besides, the walking distance and speed of foot pace should also be changed like the situation that passersby go through the digital signage. Therefore, in the next step we aim to conduct a more accurate experiment to confirm the results again.

5. Acknowledgements

This paper is based on author's mater thesis which is supported by Hasegawa Laboratory. We also thank our laboratory members and those who came to participate our experiment.

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