Virtual Gaze : Exploring use of Gaze as Rich Interaction Method with Virtual Agent in Interactive Virtual Reality Content

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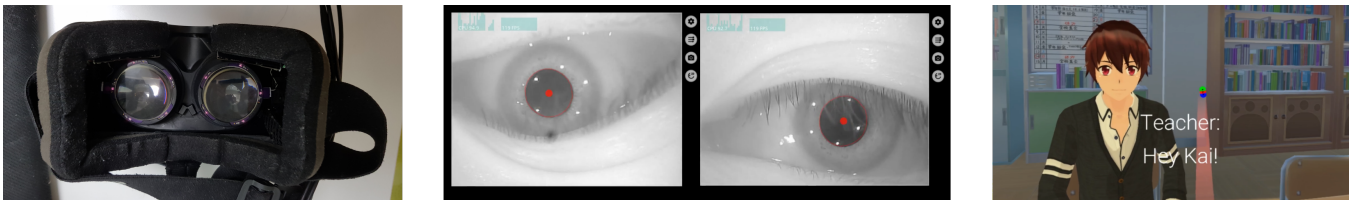

Figure 1: (a) Hardware setup (Pupil Labs eye tracker installed on Oculus Rift DK2), (b) real-time eye-tracking by Pupil Labs eye-tracker, and (c) interaction with virtual agent on interactive 3D virtual Reality environment

ABSTRACT

Nonverbal cues, especially eye gaze, plays an important role in our daily communication, not just as an indicator of interest, but also as a method to convey information to another party. In this work, we propose a simulation of human eye gaze in Virtual Reality content to improve immersion of interaction between user and virtual agent. We developed an eye-tracking integrated interactive narrative content with a focus on player's interaction with gaze aware virtual agent, which is capable of reacting towards the player's gaze to simulate real human-to-human communication in VR environment and conducted an initial study to measure user's reaction.

CCS CONCEPTS

• **Human-centered computing** → *Virtual reality*; **Interaction techniques**;

KEYWORDS

Human Computer Interaction, Eye Tracking, Virtual Reality, Virtual Agent, Game.

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1 INTRODUCTION

Virtual Reality (VR) technology today provides users with entertainment contents which are more immersive than ever before. While there are a lot of effort done to improve immersion through the visual aspect by both hardware and software developers, interaction element between user and in-content virtual agent have not changed so much from conventional non-VR contents. In the case of VR games, one of most common problem is a lack of player's sense of presence in front of virtual agents. For example, a major Playstation VR video game title, "Summer Lesson" by Bandai Namco Entertainment [2], focuses on one-on-one interaction between player and an in-game virtual character. When the player focusing his or her gaze towards the character's eyes for a long time, the character does not show any kind of response such as discomfort or confusion. Conversely, it also does not show any annoyance nor disappointment when the player does not look at it's direction at all when it talks to the player, which is expected from real human-to-human social interaction. This kind of interaction contributes to reduced immersion in VR environment.

In order to simulate a realistic, immersive interaction with virtual agents, Vidal et al. 2015 [4] and Bee et al. 2009 [1], despite being in different platform of conventional screen-based display, both concluded that implementation of eye-tracking to simulate social gaze in a interactive content resulted in increased immersion. With recent rapid advancement in integration of eye-tracking on VR Head Mounted Display (HMD) technologies, this approach shows promise in effort of improving immersion of interaction between user and virtual agent in VR content.

Through this paper, we present the following contributions:

(1) We propose user's gaze as a feasible immersive method of interaction between user and digital content on VR platform.
(2) Through our demo content, we present an example on how the concept of social gaze could be implemented in VR content and how it positively impacts user's experience.

Table 1: List of implemented gaze based interaction concept on demo content

Concept	Condition	Gaze Pattern	Teacher's Reaction	Potential use-case in video game
Seeking for interaction	Gaze at Teacher's face	Momentary	Acknowledges player's attention, greets	Automatically engage interaction with Non-Playable Character (NPC)
Cultural disrespect	Gaze at Teacher's face when it does not talking	Continuous	Distressed, confused	Implicit assesment of player's attitude and tendecy to customize storyline and gameplay
Signs of intention	Gaze at wall clock	Continuous	Ask question to player	Automatically triggers object related event, draw attention of NPC
Joint attention	Gaze at book on table when Teacher tells to	Momentary	Acknowledges player's attention, continue dialogue	Implicit acknowledgement of player's knowledge of certain game object
Avoidance of interaction	Do not gaze at Teacher's face at all when it talking	Continuous	Angry	Automatically disengage from interaction with NPC

2 SYSTEM DESCRIPTION

For the implementation, currently we are using the Oculus Rift Developer Kit 2 as our main VR HMD. To enable robust and reliable eye-tracking function, we also use Pupil Labs Oculus Rift DK2 Binocular add-on [3], which runs at a sampling rate of 120 Hz and latency of 4.5 ms. By tracking the user's pupil positions, Pupil Labs provides an estimation of the user's gaze direction.

In the demo, the player takes the role of a male high school student who is having a consultation session with his teacher. The teacher acts as a gaze-aware virtual agent and is reactive towards the user's gaze, simulating various concepts of how a real human is expected to act in a real life scenario, as shown on table 1.

3 EVALUATION

3.1 User Test

In order to evaluate how user reacts toward our model, we conducted an initial user study. In total, there were four participants (two male and two female) with average age of 25 years old. User test was done by asking each participant to try out the demo content with two different kinds of interaction model; gaze based model and HMD direction based mode. In gaze based model, application assumes participant's gaze as point of focus, while in HMD direction model application assumes center of HMD direction as the participant's point of focus, which is interaction model of some currently available VR video games, such as Summer Lesson [2]. After each session, participants are asked to answer 9-point Likert scale (from disagree to strongly agree) questionnaire regarding the demo experience aspects as designed by Bee et. al [1], which are Social Presence, Rapport, Engagement, Social Attraction, and Perception of Story.

3.2 Result and Discussion

The results from the initial user test as shown on figure 2 shows that Gaze based model outperforms HMD direction based model in all aspect of evaluation. Furthermore, to measure the significance between the two models, we ran a two-tailed t test for each aspects. Significant difference was found on aspect of rapport (t:3.31, p:0.02) and perception of story (t:2.9, p:0.03).

One interesting insight we gain from the user test is how two of test participants actually performing body gestures during demo, particularly nodding head and waving hand, in respond to feedback from The Teacher, indicating how powerful interaction between player and agent in VR environment. While head gestures such as nodding could be considered normal and even used in some available VR games, hand gestures such as waving could be done more freely with our model due to a fully hands-free interaction, though it's relevancy might needs to be further proved.

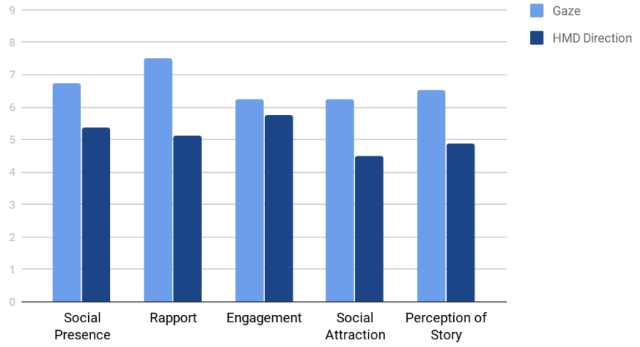

Figure 2: Result of initial user test regarding comparison between gaze based model and HMD directon based model

4 CONCLUSION AND FUTURE WORKS

Through this work, we presented a novel interaction mechanic with gaze aware virtual agents through the use of eye tracking in VR contents. Furthermore, through the initial user test, gaze based interaction resulted in overall better user experience compared to currently available HMD direction based interaction, as indicated by the higher scores in every aspect of the evaluation.

For the future work, we will explore other potential modules (e.g. affective speech recognition, tactile feedback) as well as more in-depth study of human gaze pattern and it's implication to further improve the interaction between the user and a virtual agent.

REFERENCES

[1] Nikolaus Bee, Johannes Wagner, Elisabeth André, Thurid Vogt, Fred Charles, David Pizzi, and MO Cavazza. 2010. Gaze behavior during interaction with a virtual character in interactive storytelling. IFAAMAS.
[2] Bandai Namco Entertainment. 2016. Summer Lesson. http://summer-lesson.bn-ent.net/
[3] Pupil Labs. 2015. Pupil Labs. https://pupil-labs.com/
[4] Melodie Vidal, Remi Bismuth, Andreas Bulling, and Hans Gellersen. 2015. The royal corgi: Exploring social gaze interaction for immersive gameplay. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, 115–124.