Review on Eye Visual Perception and tracking system

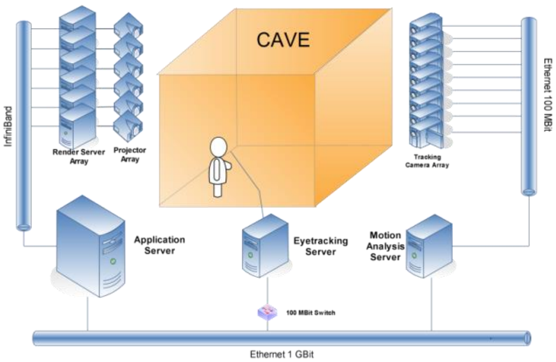
Pallavi Pidurkar[1], Rahul Nawkhare[2]
[1]*Student, Wainganga college of engineering and Management*
[2]*Faculty, Wainganga college of engineering and Management*

Abstract- **Eye visual perception that is predominantly deluded in Virtual Realities. Yet, the eyes of the observer, despite the fact that they are the fastest perceivable moving body part, have got relatively little attention as an interaction modality. Eye tracking technology in a head-mounted display has undergone rapid advancement in recent years, making it possible for researchers to explore new interaction techniques using natural eye movements. In this we explores three novel eye-gaze-based interaction techniques: (1) Duo-Reticles, eye-gaze selection based on eye-gaze and inertial reticles, (2) Radial Pursuit, cluttered object selection that takes advantage of smooth pursuit, and (3) Nod and Roll, head-gesture-based interaction based on the vestibulo-ocular reflex. In an initial user study, we compare each technique against a baseline condition in a scenario that demonstrates its strengths and weaknesses.**

Index Terms- **human-computer interaction, virtual reality, eye tracking, monocular**

I. INTRODUCTION

Eye tracking technology has been studied in the field of Human Computer Interaction to understand the user's point of regard in analyzing user interface designs, and also as an interaction device in its own right . While most prior research used eye tracking sensors for interacting with desktop monitors, recent advances in head-mounted displays (HMDs) for Virtual Reality (VR) have also driven development of head-worn eye trackers. VR HMDs with eye tracking technology are becoming more accessible, such as the FOVE HMD [2]. Using an HMD with such capability, a computer can observe and learn user attention. Well-designed eye gaze-based interaction could potentially offer more natural and implicit interaction that impacts the VR experience in a significant way. Early investigation with eye tracking for interaction in an HMD-based VR environment has shown performance benefits compared to pointing with fingers [3]. The interaction method used was selection based on eye-fixation time which has been widely adopted for 2D interfaces to solve the Midas touch problem. Fixation or dwell time is a standard delimiter for indicating a user's intention to select an object through eye gaze alone. Dwell time typically ranges from 450 ms to 1 second for novices, but can be improved over time to around 300 ms in the case of gaze typing. However, this time constraint can negatively impact the user experience. For example, when the required dwell time is too short, it puts pressure on the user to look away, avoiding accidental selection, but if it is too long, it results in longer wait times. While there are various approaches for developing novel eye gaze-based interaction, forcing unnatural eye movements could quickly cause fatigue or eye strain. If the method is too complex, it could end up overwhelming the user and require long training times. To prevent such problems, we need to understand natural eye movements and design interactions based on them. Prior research showed four primary types of natural eye movements: (1) saccade, a quick eye movement with a fixed end target, (2) smooth pursuit, a smooth eye movement towards a moving target (3) vestibul-ocular reflex (VOR), an automatic eye movement that counters head movement when fixating on a target, and (4) vengeance, converging/diverging our eyes to look at targets at different distances. Previous research explored various interaction methods based on natural eye movements, such as detecting head gestures based on VOR leveraging smooth pursuit for autocalibration spontaneous interaction on public displays and interacting with 2D GUI controls. However, these were mainly designed for 2D interfaces on desktop monitors or large-screen displays. In this paper, we report on our explorations into designing novel eye-gaze-based interaction techniques leveraging natural eye movements for immersive VR experienced in an HMD. We introduce three novel interaction techniques, based on saccade, smooth pursuit, and VOR. We also report on our initial user study and discuss the relative strengths and weaknesses of the techniques.



II. LITERATURE SURVEY

1) Thammathip Piumsomboon1 Gun Lee "Exploring Natural Eye-Gaze-Based Interaction for Immersive Virtual Reality" (IRJET)e-ISSN: 2395 -0056 Volume: 04 Issue: 0 5| May-2017

In this given novel eye-gaze-based interaction techniques inspired by natural eye movements. An initial study found positive results supporting our approaches. Our techniques had similar performance with Gaze-Dwell, but superior user experience. We plan to conduct a follow-up study with a larger sample size and more dependent variables. We will continue to apply the same principles in design to improve user experience using eye gaze for immersive VR

2) Adrian Haffegee, Russell Barrow "Eye Tracking and Gaze Based Interaction within Immersive Virtual Environments International Conference on Computational Science ICCS 2009: Computational Science – ICCS 2009 pp 729-736"

In this paper, we discuss a method of tracking a user's eye movements, and use these to calculate their gaze within an immersive virtual environment. We investigate how these gaze patterns can be captured and used to identify viewed virtual objects, and discuss how this can be used as a natural method of interacting with the Virtual Environment. We describe a flexible tool that has been developed to achieve this, and detail initial validating applications that prove the concept.

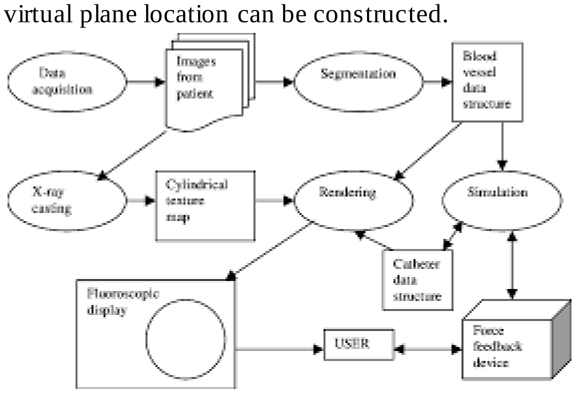
III. RESEARCH METHODOLOGY

Radial Pursuit (RP) is a novel eye-gaze-based selection method for VR using smooth pursuit, a natural eye movement when our eyes lock onto a moving object. RP can be useful in circumstances where a small target needs to be selected or the target is located among cluttered objects in a small volume where disambiguation is important. Since long dwelling is unnatural for our eyes because they normally saccade several times a second , it can be very difficult using only the gaze-dwell technique for selection. To overcome this problem, we leverage smooth pursuit. Previous research has shown that interaction techniques based on smooth pursuit can be versatile and robust Nevertheless, we could not find any work applying this technique in immersive VR. RP expands cluttered objects away from each other, reducing the ambiguity and enabling the user to clearly gaze at an object of Interest. The model will create a forum for these researchers to gather, present their ideas, and to discuss techniques and applications that go beyond classical eye tracking and stationary eye-based interaction. Specifically, we want to encourage these communities to think about the implications of pervasive eye tracking for context-aware computing, i.e. the ability to track eye movements not only for a couple of hours inside the laboratory but continuously for days, weeks, or even months in people's everyday lifes. The workshop aims to identify the key research challenges in pervasive eye tracking and mobile eye-based interaction and to discuss the technological and algorithmic methods required to address them.

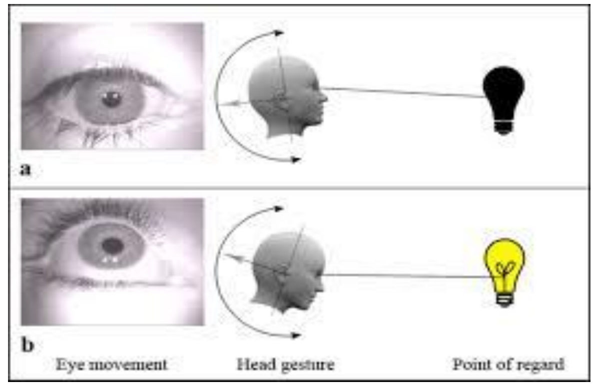
This project converts the PoG output from the Mobile Eye into a virtual world gaze vector. This is a vector starting at the user's eye position and heading off in the direction of their line of sight. Within the VE, this vector can be used to indicate potential areas of visual interest, or as advanced methods of controlling the environment. Being glasses mounted, the Mobile Eye's frame of reference is that of the head tracker offset by the distance from the tracker to the eye.

This relationship provides a method of converting from the (x,y) PoG coordinate output into the 3D virtual world gaze vector.

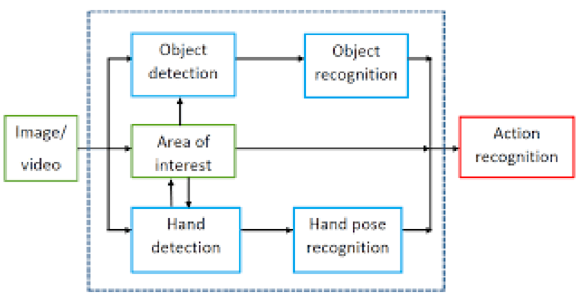
Eye Tracking Control Module Serial Capture, Alignment and Decoding. The Mobile Eye streams the encoded tracking information as consecutive 10 byte blocks of serial data. This component locks onto the stream to locate the start of each block, and then decodes the data into a structure which contains the PoG coordinates in the video stream. If the tracker fails to calculate the eye position, (e.g. due to the user blinking or removing the glasses), a status byte within this structure is used to indicate an error condition. Mapping PoG Coordinates on to a Virtual World Plane. The PoG coordinates can be considered as the (x,y) coordinates on a plane that is a constant distance and perpendicular to the user's head position. A similar plane can be created in virtual space maintaining a fixed position relative to the user's head tracked location. A relationship between the real and virtual gaze positions can be obtained by having the user fixate on a known point on the virtual plane, while reading the PoG coordinates streamed from the Mobile Eye. The software takes several readings for each of these fixation points, and averages the valid ones to minimise errors or inaccuracies. By sampling a number of these relationships across different positions on the gaze plane, a calibration mapping of PoG (x,y) position to virtual plane location can be constructed.



We conducted an initial user study with three parts to test our interaction techniques, where our primary interests were qualitative feedback and usability ratings. The first and second parts tested Duo-Reticles (DR) and Radial Pursuit (RP), respectively, for their performance and usability against a baseline method, Gaze-Dwell (GD). In the third part, participants tried Nod and Roll and gave their impressions. Conditions were carefully balanced in terms of performance and so we predicted comparable performance between our proposed techniques and the baseline. However, we were expecting some differences in usability in favor of our techniques due to our design approach based on natural eye movements.



Although our initial study had a small sample size, which reduced the statistical power, we could find significant differences in terms of subjective ratings in favor of our methods. We could also confirm that there was no significant performance difference between our methods and the baseline as we carefully balanced each condition to create a fair test. This early finding is a positive indication that designing eye-gaze-based interaction around natural eye movements could improve the user experience while maintaining comparable performance to standard interaction techniques. We also obtained interesting feedback for each technique from the semi-structured interviews: DR: Participants felt the interaction was almost implicit as the alignment time was short compared to GD1. Although there was no difference in performance, they did not notice the travelling time required by the IR as they were busy looking for the right match. They also felt they had more control with DR. P05 stated: "I felt time pressure with GD1. With DR, I felt I had time to look and I knew where the other reticle was." However, some participants were briefly distracted by the IR as it moved toward their gaze location and accidentally gazed at it. Eventually, they became accustomed to the second reticle and could understand its behavior. As P01 pointed out, "I accidentally looked at the green reticle when it came close, but I got used to it." We believe that the issue could be addressed by having an adaptive reticle that changes color depending on the background, so that it could still be seen, but does not distract the user. RP: Again, participants did not perceive the waiting time during their pursuit of the moving object as opposed to dwelling on the object. P02 stated that, "RP was easy, just follow the object and it was selected." However, some participants preferred to take their time to look for the right object. As P01 pointed out, "With RP, I need to know in advance the object to follow, but with GD2, I could wait until it expanded and look for the object I wanted to select." Another problem was that if the participant pursued too late, the selection would be cancelled, as the confidence level was too low. We believe both issues could be addressed by using a fallback method when the confidence level is too low after the RP period by using GD with a shorter dwell time of 200-300 ms. NR: Participants found it amusing to use their head for interaction. Most participants found it fun and engaging. Some felt that it was alright if they did not need to gesture all the time. We found that strong head movement could lead to shifts in the HMD's position on the face, and this could invalidate the eye calibration. P07 expressed this, "The HMD was not very light, so it was awkward to gesture, especially nodding". We expect head gestures to be good for input as HMDs become lighter, and better methods for securing the HMD on the user's face are found.



IV. CONCLUSION

The proposed new a growing number of researchers study eye-based interaction in mobile daily life settings, thereby opening up new application areas and promising eye-based interaction to become mainstream. Driven by limitations in eye tracking accuracy we introduced eye gestures for mobile eye-based interaction . we used gaze as an indicator of attention to extract information from objects in the environment . The system exploits the users' gaze as an indicator of attention to identify objects of interest and offer real-time auditory feedback. We believe eye movements provide a promising modality for inferring aspects of the "cognitive context" of a person in context-aware computing

In future work this project can be modeled for Mobile eye-based interaction with public displays, tabletops, and smart environments, Eye-based activity and context recognition Pervasive healthcare, e.g. mental health monitoring or rehabilitation. Autism research. Daily life usability studies and market research. Mobile attentive user interfaces

REFERENCES

[1] R. Atienza and A. Zelinsky. Active gaze tracking for human-robot interaction. In Proc. of the 4th IEEE International Conference on Multimodal Interfaces, 2002.

[2] M. Baldauf, P. Frohlich, and S. Hutter. Kibitzer: a ¨ wearable system for eye-gaze-based mobile urban exploration. In Proc. of the 1st Augmented Human International Conference, pages 1–5, 2010.

[3] A. Bulling, A. T. Duchowski, and P. Majaranta. PETMEI 2011: the 1st International Workshop on Pervasive Eye Tracking and Mobile Eye-Based Interaction. In Proc. of the 13th International Conference on Ubiquitous Computing, pages 627–628, 2011.

[4] A. Bulling and D. Roggen. Recognition of visual memory recall processes using eye movement analysis

[5] 5.A. Bulling, J. A. Ward, H. Gellersen, and G. Troster. ¨ Eye Movement Analysis for Activity Recognition Using Electrooculography. IEEE Transactions on Pattern Analysis and Machine Intelligence, 33(4):741– 753, 2011.

[6] A. Clark and D. Gergle. Mobile dual eye-tracking methods: Challenges and opportunities. In Proc. of International Workshop on Dual Eye Tracking, 2011.

[7] A. De Luca, M. Denzel, and H. Hussmann. Look into my eyes!: can you guess my password? In Proc. of the 5th Symposium on Usable Privacy and Security (SOUPS 2009), pages 7:1–7:12, 2009.

[8] D. Decker and J. Piepmeier. Gaze tracking interface for robotic control. In Proc. of the 40th

South-eastern Symposium on System Theory, pages 274 –278, 2008.

[9] H. Drewes, A. De Luca, and A. Schmidt. Eye-gaze interaction for mobile phones. In Proc. of the 4th International Conference on Mobile Technology, Applications, and Systems and the 1st International Symposium on Computer-Human Interaction in Mobile Technology, pages 364–371, 2007.

[10] A. T. Duchowski. Eye Tracking Methodology: Theory and Practice. 2007.

[11] A. T. Duchowski, V. Shivashankaraiah, T. Rawls, A. K. Gramopadhye, B. J. Melloy, and B. Kanki. Binocular eye tracking in virtual reality for inspection training. In Proc. of the 2000 Symposium on Eye Tracking Research and Applications (ETRA 2000), pages 89–96, 2000.

[12] D. Gergle and A. Clark. See what i'm saying?: using dyadic mobile eye tracking to study collaborative reference. In Proc. of the ACM 2011 conference on Computer supported cooperative work, pages 435–444. ACM, 2011.

[13] K. Hadelich and M. W. Crocker. Gaze alignment of interlocutors in conversational dialogues. In ETRA'06, pages –1–1, 2006.

[14] D. W. Hansen and Q. Ji. In the eye of the beholder: A survey of models for eyes and gaze. IEEE Transactions on Pattern Analysis and Machine Intelligence, 32(3):478–500, 2010.

[15] Y. Ishiguro, A. Mujibiya, T. Miyaki, and J. Rekimoto. Aided eyes: Eye activity sensing for daily life. In Proc. of the 1st Augmented Human International Conference (AH2010), 2010.