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An asymmetric VR system to configure and practice low-vision aids for social interactions in clinical settings

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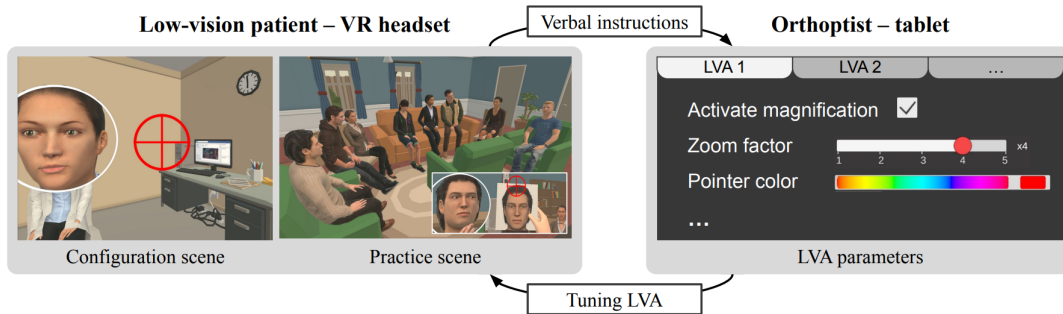


Figure 1: Overview of the asymmetric system involving (1) a patient in virtual reality (VR), equipped with low-vision aids (LVAs), immersed in scenes with various characters; and (2) an orthoptist using a tablet to select and configure different LVAs. This system was tested in a social interaction context in VR.

ABSTRACT

Patients with visual impairment often rely on low-vision aids (LVAs), such as magnifiers, to perform near-vision tasks, with rehabilitation programs traditionally focusing on these activities. Extended reality (XR) technologies offer opportunities to address broader needs, including social interactions, which require also guidance and training. We present a system leveraging virtual reality (VR) to enable realistic testing and training of LVAs within immersive scenarios. Through an observational study involving patients and orthoptists, we illustrate how this approach expands traditional care practices, integrating emerging technologies, facilitating personalization, and enabling efficient training of LVAs under conditions otherwise challenging to replicate in clinical settings.

Index Terms: Asymmetric system, virtual reality, low-vision aids, real-world scenarios.

1 INTRODUCTION

Low vision is a permanent visual impairment that cannot be improved with regular eyeglasses. Age-Related Macular Degeneration (AMD), the first visual impairment in industrialized countries, leads to central vision loss, while peripheral vision remains unaffected. This pathology significantly impairs a patient’s ability to perform everyday activities, such as reading, navigating, and interacting with others. Among these, social interactions are particularly affected, as difficulties in recognizing faces, expressions and gestures create barriers to effective communication, leading to feelings of isolation and a reduced sense of independence, which profoundly impact patients’ quality of life [2].

To cope with visual impairment, patients generally use low-vision aids (LVAs), primarily magnifiers and optical devices de-

signed for near-vision tasks like reading, with rehabilitation programs focusing almost exclusively on these limited activities. In this context, extended reality (XR) technologies are emerging as a viable solution [3], offering innovative tools that can address a much wider range of demands—such as navigation or social interactions—with unprecedented possibilities. However this shift raises the critical question of how to provide patients with the same level of guidance and training they currently receive for near-vision tasks, but adapted to these advanced tools and their wider applications. To address this challenge, we propose a system that enables realistic LVAs testing and training in immersive scenarios mirroring everyday life that can be used in clinical settings. Our system combines (1) a virtual reality (VR) application that enable the configuration and testing of LVAs in immersive scenarios, and (2) a tablet application for configuring these LVAs.

2 METHODOLOGY

The goal of our work was to explore how XR-based LVAs can be configured and tested in the context of social interactions. Social interactions, such as face recognition, require fine visual analysis of facial details—an essential but challenging task for individuals with low vision. To address this need, we designed and implemented a system that allows orthoptists and patients to collaboratively test and configure LVAs in realistic, immersive scenarios.

To simulate a social interaction scenario requiring facial detail analysis, we implemented a face recognition task. The task involves identifying an avatar in a virtual environment that matches a reference picture held by the patient. This task was chosen in collaboration with orthoptists to align with real-world challenges faced by patients in social contexts.

Two specific LVAs were selected to assist with the face recognition: (1) Head-centered magnifier: a simple head-contingent magnification tool that dynamically magnifies the region of interest (ROI) based on where the user is pointing (similar to [4]); (2) World-centered magnifier: a magnification method that allows the user to select and enlarge faces only, while preserving the global view of the environment (adapted from [1] to faces).

Our system consists of two interoperable applications: (1) VR application: used by the patient to experience the virtual environ-

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ment and interact with the LVAs; (2) Tablet application: operated by the orthoptist to configure the LVAs based on the patient's feedback and voice commands. The patient wears the VR headset while the orthoptist uses the tablet to adjust parameters of the LVAs in real time. This allows for seamless interaction between the patient's needs and the orthoptist's expertise.

The system operates in the following steps: (1) Pairing and calibration: pair the VR headset with the tablet and calibrate the headset. (2) Configuration scene: the patient is seated in a virtual hospital-like room with an avatar orthoptist for LVA configuration. (3) Practice scenes: the patient performs the face recognition task across two trials, with the orthoptist using the tablet to adjust the LVA settings based on patient feedback. Eight avatars are positioned in an arc one meter away from the patient. The patient must identify the avatar in the scene matching the reference face picture attached to the hand controller. The orthoptist guides the task, adjusting the LVA as needed. After completing the trials, the orthoptist can return to the configuration scene to setup a second LVA.

3 RESULTS

For the study, five patients (three women, two men; ages 75–94, average 82.6) with moderate to severe AMD were recruited. The studies were done during the consultations and participants were not paid. Our experiment was ethically approved by the Comité de protection des personnes of France ID RCB: 2019-A00342-55.

We used the System Usability Scale Questionnaire to measure the usability of interactive systems. This questionnaire was given to the patients and to the orthoptists after the study with their first patient. All patients described the application at least as “Excellent” (N=1) and the majority considered it as the “Best imaginable” (N=4). For the orthoptists, one considered the system as “Good”, and the other one as the “Best imaginable”. These results are encouraging and show that all our participants found our system highly relevant to configure and test LVAs.

Regarding patient experience, none of our patients experienced any symptoms of cybersickness, such as nausea, instability, or physical fatigue. Patients adopted the system quickly and naturally collaborated with the orthoptists to adjust the LVAs starting from the first configuration scene, emphasizing that orthoptists' presence was important, providing essential guidance and making them feel comfortable. Patients generally did not use the vocal commands provided by the orthoptists and instead preferred to express themselves in natural language. This technique was suitable for the majority of patients (N=4), although they were open to the idea of interacting with hand-controllers in the future. During the practice scenes, we observed that patients moved freely on their chair to see the avatars surrounding them. They naturally brought the hand-controller closer to the headset to better see the picture.

Patients highlighted that VR helped them see the details better. One patient for instance said “*I was able to see people, whereas in real life, I cannot make anyone out*”. They also found the headset comfortable, noting that while it can take some time to adjust it, once done, they forgot they were wearing it. They also mentioned that they enjoyed testing the two magnifiers in a close to real life scenario, with people around them: “*it's a comfort to be able to recognize the face*”, “*it's fun, it's like a game. I felt like I was in an interrogation room being questioned by the police!*”.

Regarding orthoptists' interactions, we observed that during the configuration scene, they first demonstrated how the magnifier worked by activating it, and then explained which settings could be adjusted. In the practice scenes, they guided the patients, encouraging them to describe the face in the picture before moving on to describe the avatars around them. They relied heavily on the streaming view of the patient's perspective to provide guidance. Orthoptists found that the system was easy to use and engaging: “*You master it in no time. It's an app you can use easily, and with which*

you can quickly set something up with the patient”. They also found that testing LVAs in VR with immersive scenarios offers a remarkably accurate simulation of what would occur in real-world scenarios: “*It's really a simulation of what should actually happen*”. Orthoptists highlighted the value of simulating a social interaction scene, noting that “*it's motivating for the patient because it addresses their need to see faces, which is also an emotional need, so it resonates with them and motivates them. The patient's motivation in the exercise is very important*”. They found the configuration system easy for the patients to use and observed that patients adapted well to both the task and the virtual environment.

However, orthoptists pointed out that the VR experience “*lacks detail and realism in the faces*”, and would have liked to push the scenarios more to include everyday life scenarios: “*It would be good to include everyday life scenarios for testing visual aids, focusing on things people want to do, rather than just faces.*”

While the purpose of this study is not to compare the two LVAs in terms of efficiency, we observed that our system could benefit the orthoptists to provide some insights about the usage of a LVA in a given context. The head-centered magnifier was appreciated for its general usage, while the world-centered magnifier helped some patients see faces better and was appropriate to the given task because one could see the picture next to the magnified region. We observe that even with a very poor visual acuity, all participants managed to complete the tasks in a relatively short amount of time.

4 CONCLUSION

In this work, we investigated how traditional care practices for standard LVAs used in simple tasks could be adapted to emerging XR-based LVAs in more complex scenarios. Leveraging a shared technological environment, we demonstrated how patients and orthoptists can collaborate effectively, enabling patients to configure and practice using potentially sophisticated LVAs under realistic conditions that are otherwise difficult to replicate in clinical settings. Our results suggest that XR-based LVAs have significant potential to become both practical and beneficial for patients, as technological barriers can be effectively addressed with the support of medical experts. However, to bridge the gap between simplified, controlled VR scenarios and real-world applications, future efforts could focus on enabling patients to train with LVAs in more realistic environments. One promising direction is the use of immersive 360-degree real-world videos, which would allow patients to engage with dynamic, life-like scenarios. This approach represents a natural extension of the present work, paving the way toward a seamless and effective transition to real-world usage of LVAs.

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