The Virtual Office of the Future: Are Centralized Workplaces Obsolete?

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The worldwide spread of coronavirus is vigorously affecting our everyday life and many industries. Unforeseen, a significant number of workforces are required to work from home, impacting creativity, work performance, and social interaction. Video conferencing is consequently substituting in-person meetings, and new workplaces are arranged in domestic environments, causing a fundamental shift in how employees work and interact. To lower the unfavorable impact of continuous telecommuting, we highlight virtual reality technology as a potential solution to enhance domestic workplaces. In this position paper, we discuss the opportunities and current challenges for working in virtual reality. We focus on two application scenarios and present recent solutions to enable knowledge workers to work and interact in virtual reality and trends on how virtual reality services could substitute video conferencing. As a result, we envision a virtual office of the future, making centralized workplaces obsolete and highlight open research questions to realize productive and pleasant work in virtual reality.

1 INTRODUCTION

The worldwide spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) resulted in curfews, quarantines, lockdowns, or similar restrictions in many countries. The pandemic is vigorously affecting our everyday life and many industries. While systemically important industries like energy, communication, essential services, and particularly healthcare, continue working on-site, other companies transition a significant number of workforces to work from home as an alternative [6]. In the worst-case, governments forced businesses like gastronomy, congress, or event businesses to temporarily suspend their operations, resulting in unemployment or reduced working hours.

The opportunities and challenges introduced by telecommuting are widely discussed [2]; however, never before so many employees were asked to work from home on such short notice permanently. For knowledge workers, for instance, programmers, technical writers, or engineers, this transition seems uncomplicated in the first place since their main capital is knowledge, and their physical workspace demands are rather minimal. Telecommuting can increase employee satisfaction and personal work balance due to reduced travel time and commuting stress. Nevertheless, it introduced several limitations for employers and employees. Besides privacy and security issues resulting from remote connections, workers could potentially abuse paid time on non-work-related activities [3]. Additionally, telecommuting requires employees to be particularly self-disciplined. Working from home offers several potential distractions like household chores or unrestricted access to the internet and TV. In the current pandemic, kids that are around due to closed kindergarten and schools present an additional challenge. Finally, telecommuting can drain innovation and individual creativity [11]. Often, moments of creativity are sparked between meetings and during chats in corridors or cafe kitchens. The elimination of these situations hinders individual performances in creativity and overall innovation.

The prevailing pandemic changes traditional telecommuting in that sense that the isolation is permanent all week long. By today, the SARS-CoV-2 forced us to attend meetings, conferences, and collaboration in a digital realm. In this position paper, we will discuss the challenges and potential solutions established by shifting telecommuting towards a virtual reality (VR) enhanced experience. Using the latest MR devices can enable employees to work from home but sit virtually in their familiar working environment or attend business meetings far away. We believe that emerging MR technology can overcome some of the telecommuting limitations and foster new, improved working environments that do not require a centralized physical workspace.

In the following, we give a short introduction to current research results focusing on virtual and augmented reality experiences that support knowledge workers in the virtual world. We highlight the current challenges and opportunities followed by implications for future developments. The core aspects addressed are interaction with computing systems while being immersed in a virtual world and how physical meetings can be substituted.

2 WORKING IN VIRTUAL REALITIES

The vision of shared telecollaboration between distant individuals [1] and spatially augmenting the office space [10] to enhance the working environment is not novel. However, the current pandemic fundamentally changes the initial parameter since employees are required to work from home. Further, today's head-mounted displays (HMDs) are capable of presenting rich virtual environments while blocking visual or auditory distractions. This offers several advantages, including full control of the virtual office space without physical limitations, enhanced privacy, and location flexibility [4].

Fig. 1. Left: A virtual office workspace resembling the physical exemplar (built with Unity 3D Engine). Right: Stationary apparatus comprising a workstation, VR headset, and accurate optical tracking system to enable text input in virtual reality.

A fundamental requirement is an effortless interaction with the computer interface to enable employees to work as efficiently in a virtual environment as in a real office. This includes, in particular, text manipulations. To enable virtually immersed employees to do fast generic text manipulations, they need to localize and reach out for the keyboard and understand the keyboard's location in relation to their own fingers [8]. Previous research presented several solutions for text input while being immersed in VR.

To examine the ability to input text within a virtual environment, McGill et al. [9] attached a webcam to an HMD to blend the keyboard and hands of the user within the virtual reality. This approach only provides monocular depth cues that affect orientation. In contrast, Grubert et al. [5] synthesized the entire environment and presented the user's hands as semi-transparent spheres. A stationary tracking system provided the necessary location data. Similarly, we build a

stationary setup [8]; Despite that, we tracked and presented a detailed representation of a full interactive synthesized hand. With all these implementations, employees can facilitate almost the same text input speed they achieve in the physical world. Unfortunately, the proposed solutions and apparatuses are stationary, expensive, or require calibration (see Figure 1). Hence, they are, at the moment, not ready for mainstream use. Fewer requirements, an easy to use and portable solution is needed to empower people working and meeting in VR.

We recently presented such a low-fidelity apparatus that allows for untangled and calibration-free text manipulation on a physical keyboard while being immersed in VR. Our latest development offers similar performance while keeping the requirements low. The apparatus comprises only an off-the-shelf smartphone, VR viewer, and a wireless keyboard; hence, it is fully portable and can be used by a broad audience. We are using optical maker tracking (see Figure 2) to identify the keyboard and user's hands that are dynamically blended into the VR. Thus, allowing fast text input and manipulation [7].

Fig. 2. Left: Inspiring virtual office that is designed according to the employees' needs. Right: lightweight, mobile setup comprising a smartphone, VR viewer, and physical keyboard to enable text input in virtual reality.

Having the ability of general text manipulations, eg., composing an email, while being immersed in VR offers many new opportunities for the future of work. Since there are no technological or physical limitations for the screen arrangement or design, novel VR offices allow for the creation of entirely new environments with vast three-dimensional display space in any direction. Further, user interfaces are no longer bound to rectangular two-dimensional displays limited by our desks' size. Future VR offices could supersede current interaction paradigms and enable improved work performance.

We are confident that VR has the potential to change the way we work. We envision future office workers to be able to work productively in save physical isolation, but immersive head-mounted displays compensate physical limitations, loneliness, or the lack of social interaction. Moreover, the virtual office that may visually resemble their physical counterpart strengthen again the boundary between work and home that is currently dissolving.

3 THE VIRTUAL OFFICE OF THE FUTURE

Current research addresses the underlying challenge of text input while being immersed in a VR environment. After successfully addressing the challenge of generic input into a computing system while the user is immersed in a virtual environment, MR working environments could be realized. These potentially lead to enhanced performance due to a controlled environment with less audiovisual noise and distractions. Moreover, future virtual offices can overcome

the physical limitations of rectangular two-dimensional screen spaces. Future workspace can be arranged freely in three-dimensional space for new means of data visualization or collaboration.

Several research challenges need to be addressed to accomplish the vision of a VR office that sustains pleasant long-term working experiences. On the one hand, challenges like the lack of visual fidelity of the HMD must be resolved. Other technological challenges include weight, wearing comfort or portability, and mobile runtime.

On the other hand, there are interesting questions from a human-computer interaction perspective. The computing paradigm of windows, icons, menus, and pointers is still valid. It remains an open question how this translates to virtual realities. The visualization of the working environment, potential distractions, and threats existing in the physical world are still unclear. These questions unfold an interacting design space that requires further investigation. Working in virtual worlds using an HMD also creates a new paradigm for collaborating and communicating with coworkers. It is still actively being researched on how communication and collaboration can efficiently be recreated in VR.

In a future mobile setting, additional factors, including motion sickness, situational awareness, and the masking of the physical world, contribute to the user experiences. Future research is required to determine the relevant answers and potential solutions to create pleasant and productive working environments.

Addressing these challenges, the future knowledge worker will not require a centralized workspace anymore. The spread of SARS-CoV-2 fostered a critical rethinking of telecommuting and accelerates the widespread use of virtual reality technology.

4 CONCLUSION

The present pandemic requires drastic measures to curb. Consequently, many workforces operate from home, which manifests in old and new challenges for all involved individuals. In this position paper, we presented some of the emerging challenges and introduced virtual reality (VR) workplaces as a prospective solution to foster a productive and meaningful working environment. We highlight the potential of VR workspaces, including the freedom to develop the virtual office according to the employees' needs or resemble the original office to stick to a knows environment and keep the boundary between work and home. For designing the future virtual offices that are presented by VR devices, several challenges, including effortless input into computing systems, need to be addressed. We discussed some of the recent research tackling theses challenges. Resulting, we envision the virtual office of the future that leaped forward due to the current needs and accelerated digitization.

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