# AR/VR for conferencing and remote assistance

Hans Stocking[1], Simon N.B. Gunkel[1], Tom De Koninck[1], Michel van Eersel[2], Bart Kok[2]

[1] TNO, Den Haag, Netherlands, hans.stokking@tno.nl, simon.gunkel@tno.nl, tom.dekoninck@tno.nl
[2] The Virtual Dutch Men, Almelo, Netherlands, bart@tvdm.com, michel@tvdm.com

**Corresponding author:** Hans Stocking, hans.stokking@tno.nl
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## Abstract

AR and VR headsets can be used for communication purposes. People can be brought together in a virtual environment, either as avatars in a more game-like environment, or photo-realistic using cameras and video streams. The immersion of a shared environment brings people closer together, and life-like and life-size user representations allow for 'normal' group interaction, which resembles more to a face-to-face meeting compared to desktop-based video conferencing due to gaze awareness and full body language. Furthermore, such a system is quite flexible in use. It requires either a PC with VR-HMD (head mounted display) and camera, or soon a standalone VR- HMD and optionally a smartphone as capture device. Compared to high-end video conferencing systems, it does not need a fixed space and can be used anywhere. Given the immersion and naturalness of the communication, AR and VR offer a new opportunity for remote communication.


**Figure 1: Example of photo-realistic VR conferencing with 3 users, sharing a PowerPoint presentation**

## 1. Introduction: AR/VR has added value for telecommunication services

One of the interesting uses of VR and AR is for social interaction with other people, i.e. it has a big potential for use in telecommunication scenarios. Our focus is on two main telecommunication use cases in the business domain: conferencing and remote assistance.

**Video conferencing** has for many years the promise of offering more flexibility in working in remote and dynamic teams, reducing travelling costs and thereby also reducing a company's ecological footprint. Even though both high-end video conferencing systems and desktop-based video collaboration tools see a lot of usage, they still do not replace face-to-face meetings. High-end systems offer a good experience but are not widely available. Desktop-based solutions are flexible, but often fail to support good group dynamics.

AR/VR based conferencing systems may fill this gap between high-end and desktop-based systems. They can offer the flexibility of desktop-based systems, requiring only a PC with a VR headset and possibly a camera, while allowing a high degree of immersion and social presence. Multiple participants are arranged in a natural way in a virtual environment. Sharing a single (virtual) environment amongst participants immediately gives a sense of co-presence. Gaze awareness allows for normal turn taking and group dynamics, and the inclusion of a full-body avatar allows for more natural body language. Seeing who is talking to whom and how much people are involved all comes natural to us in a face-to-face meetings. With the help of AR/VR, this is now also available in remote meetings (Oh et al., 2018).

**Table 1 Differences between different communication systems**

| | DESKTOP CONFERENCING | ROOM-BASED CONFERENCING | POINT-CLOUD CONFERENCING | AVATAR-BASED SYSTEM |
|---|---|---|---|---|
| **TECHNICAL REQUIREMENTS** | PC<br>Webcam<br>Headset | Room with fixed displays and cameras | VR HMD<br>Camera<br>High-end PC | VR-HMD<br>VR controllers (or hand-tracking) |
| **GAZE AWARENESS** | No gaze awareness | Natural gaze awareness | Gaze awareness with 3D avatars | Limited Gaze awareness through HMD tracking |
| **BODY LANGUAGE** | Limited body language, only upper torso visible | Full body language and face expressions | Full body language and face expressions | Limited via head and hand movement tracking |
| **SYSTEM COMPLEXITY** | Low complexity, quality depends mainly on audio headset | high complexity requiring fixed room calibration | some complexity, e.g. additional functions such as HMD removal | limited complexity, similar to VR games |

**AR/VR for remote assistance.** There are many examples where a specific expertise is needed to accomplish a certain task. Examples range from (industrial) maintenance, medical analysis, consumer support, crisis management (i.e. emergency sector). The ability to remotely consult an expert can enhance performance, in case problems are encountered or specific expertise is needed. Such remote assistance can be enhanced by using AR/VR. First, the physical environment can be shared through VR by setting up and sharing a (360) camera. This allows a remote expert to look around freely to analyze the situation. Secondly, the remote expert can virtually join the environment e.g. by 3D projection in an AR headset. This allows for consultation in the actual environment, including the ability to point at specific things in this environment. By using an AR/VR system for remote assistance, expertise can be instantly available anywhere in an effective manner.

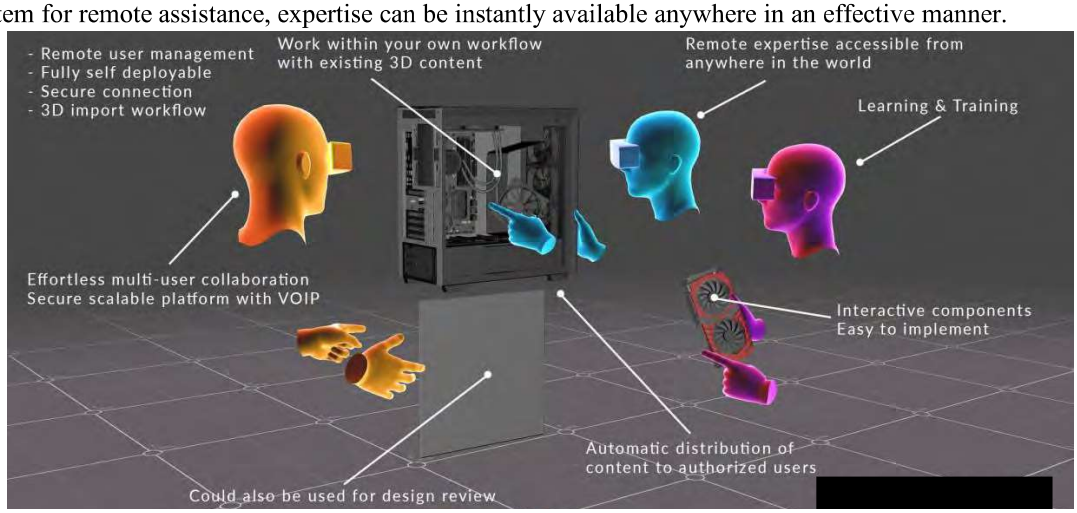


**Figure 2: Example of Social VR for remote assistance**

## 2. Current status: promising Social VR technology becomes mature

In the last few years, many VR conferencing solutions emerged[1]. Most solutions are based on graphical avatars, offering a high ease of use, using a VR HMD's built-in tracking and the VR controllers for controlling the avatar's movement. Other systems, such as one of our systems, include the use of (depth) cameras to create video / point-cloud avatars. This makes meetings more natural, offering a higher social presence, and full body language. Also, VR controllers are no longer needed for body language, which has many advantages.

Our point-cloud based Social VR system was built for research and allows conferencing usage for 8-16 users via a conferencing bridge that is mixing all video streams. The bridge reduces the processing burden on the

[1] VR communication comparison chart : https://ryanschultz.com/list-of-social-vr-virtual-worlds/

user equipment, as they only upload and receive a single video stream compared to one per remote participant in a peer-to-peer system. Also, we switched from using a 2D video avatar to a 3D point cloud avatar (Dijkstra-Soudarissanane et al, 2019). In initial user experiments (Gunkel et al, 2019), we compared our photo-realistic avatar with graphical avatars, face-to-face and Skype meetings. We were able to show that higher avatar realism increases the quality of remote communication. However, our system was still not able to fully compare with face-to-face meetings. Main drawbacks were a lack in high video quality, occlusion of the face by HMD and lack of interaction capabilities such as note-taking. Feedback we received for the Avatar-based communication system, are that users are completely immersed and totally forget where they are physically. People report they feel that they are together in that same VR space. With the avatar-based system, we want to create a platform where people can easily publish, share and discuss 3D content (i.e. 3d engineering models like Solidworks, 3d architectural models like Revit, but also 'simpler' 3D models created with SketchUp).With this in mind, we are already successfully testing it with several companies for the following purposes:

- Design review (i.e. the design of a complex space such as an operation room of a hospital).
- Training (i.e. the assembly of a complex machine).
- Remote expert (i.e. procedures that are not easy to comprehend).
- Saleskit (i.e. when dealing with products that are large/complex).
- VR meetings (i.e. when working in projects with stakeholders from all over the world/EU).

Currently, the avatar-based system has a lower threshold to use, is more stable and thus has a higher technology readiness level. Operationally, we foresee first market entry for avatar-bases systems, while in the longer term, a switch to photo-realistic avatars is certainly possible.

## 3. Future outlook: from trials to products and deployment

Given our current progress, we feel confident that our Social VR systems will be fully usable for business meetings. We are looking into lowering the threshold for use, by porting our solution to stand-alone HMDs such as the Oculus Quest (using mobile phones as cameras). The use of our systems should eventually be frictionless; it should become a non-technical solution that everybody is able to use. Challenges we are currently working on, include: photo realistic point-cloud avatars (including HMD removal with eye gaze), Automatically setup safe guardians based on the persons location (for physically moving around), natural hand-tracking and haptic feedback, various forms of interaction for supporting meetings (e.g. including virtual keyboards, VR stylus, etc), improved performance through cloud computing and 5G edge, including AR headsets (for mixing real environments with virtual participants similar to Orts-Escolano et al., 2016).
Given our progress, we are now setting up internal company use, and are talking to various companies for trials. Even though the technology is progressing rapidly, we firmly believe it is now mature enough to start offering real benefits to companies and society, and we are committed to pushing this forward.

## 4. Acknowledgments

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