§19. Study for Remote Participation System Providing Bidirectional High-presence with a Wide View of Control Room

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The SNET is logically built on SINET4 as an academic collaboration virtual private network dedicated for the Japanese fusion research. Nowadays, not only the LHD remote participation (RP) but also the QUEST experiment at Kyushu University and the GAMMA10 of University of Tsukuba are participating in this bilateral relationship. The other participating sites are also mutually connected through at least 1 Gbps high bandwidth, thus they can access the common experimental data platform without becoming aware of any difference of their geographical distances.

Recently, the RP importance continues growing still more; however, the present technology does not give enough good presence of the remote control room. The preceding SNET collaborative studies had coped with the following three RP requirements:

i. Remote data access and share
ii. Remote machine/device control
iii. Mutual human communication.

However, it never provided the on-site good presence to the remote site, for instance, by means of video conferencing (VC) system.

In this study, the idea of "Augmented Reality (AR)" or "Mixed Reality (MR)" has been applied to improve the presence of the remote control room by showing the whole view on the remote graphical multi-screen. It covers the majority of the effective viewing field of the participant almost as same as a local participant can see in the control room. It simultaneously provides some working windows in the foreground view as if a local participant uses a pc console in the control room.

This study is expected to realize the high presence RP terminal system, which may contribute not only the present SNET collaboration but also the next generation fusion experimental projects such as ITER.

We found that ever used cameras for VC systems are basically designed for capturing the view of target "objects" and are not for the whole scenery of the room. Therefore, this study proposes that the scenery of the remote control room would be shown as the desktop background of the multi-screen display in real time, and also that the size of multi-screen should be optimized as almost the same as the effective range of a human sight. This consequently provides a small "cave-like" virtual reality environment for a single remote participant giving less visual stress (Fig. 1).

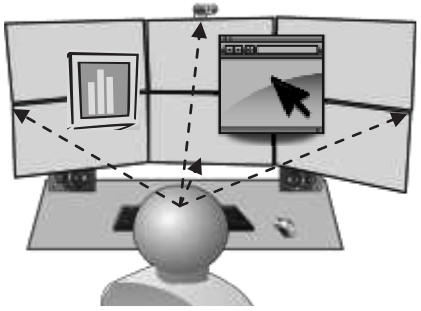

Fig. 1. Multi-screen desktop display to show the scenery of remote control room as if the participant sees really in site. 90 degree horizontal and 60 degree vertical sight should be covered. A small camera, speaker and microphone are also needed for human interactive tele-communication. It is also used to provide the working windows as the foreground.

Since the flat panel screens are at present very reasonable in price and such the RP system will not cost much.

For the most important part of this RP terminal development, EIZO FlexScan EV2455 24.1 inch flat panel display has been selected as it has almost "frame-less" form, and therefore six of them can make a formation of a big multi-screen having almost zero-gap. Oppositely, we found that selecting the scenery capturing camera was rather difficult because by using a single camera it is not easy to capture a wide range of sight of a person's eye. Therefore, some wide-angle-lens cameras and composite scenery made by two cameras have to be tested to choose the best camera system for capturing the remote control room.

On the other hand, it is also indispensable to RP communication to show "tele-presence" of the remote participant in the real control room. This produces an inverse-direction video stream of presenting the control room scenery. A prototype tele-presence system has been designed to show the participating presence of the remote user for more than 180° sight angle in the real control room, and also to provide interactive tele-communication on both audio and video (Fig. 2).

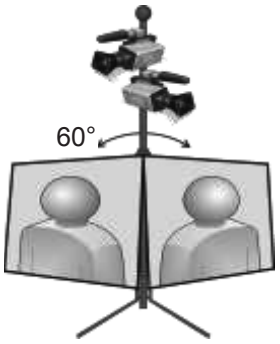

Fig. 2. Conceptual design for the tele-presence projection stand using two small display panels. Cameras capture the control room view and audio from the virtual eye point of the remote participant.

The most difficulty of this development has been found to exist in making the mixed reality view on the pc multi-screen desktop, which requires inevitably dedicated software. It is planned to be carried out in the consecutive R&D.