Remote Design Collaboration Leveraging Body Motions and Robotic Proxy

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Fig 1. (left) A remote reviewer points at a design board to give feedback to a presenter, (center) a local presenter can see where the reviewer is pointing and looking on the design board through the embodied proxy, and (right) three common interactions in design review (Critique): looking at each other, pointing while looking at each other, and pointing and gazing at the same time to contrast or relate different design aspects.

Background

Interactions during a design review (critique) encompass a complex combination of verbal and non-verbal communications (Figure 1 right). While many options (e.g., Beam, Double, Kubi) are available to conduct a remote meeting using a physical proxy, their control interfaces are often ill-suited for more dynamic setting such the kind of interactions during a design critique. In this project, we present a remote collaboration system designed to support design critique by leveraging body motions and robotic proxy.

Related Work

The focus of our work is closely related to systems such as a kinetic proxy proposed by Sirkin et al. [1] or MeBot [2] which use eye tracking (or head orientation respectively) to automatically operate a kinetic display. These systems as well as MMSpace [3] still require the participants to sit around a table often in front of a laptop, which gives a similar experience to the one using a videoconferecing tool for remote participants. We extended these interfaces to the more dynamic use of a design review.

Architecture

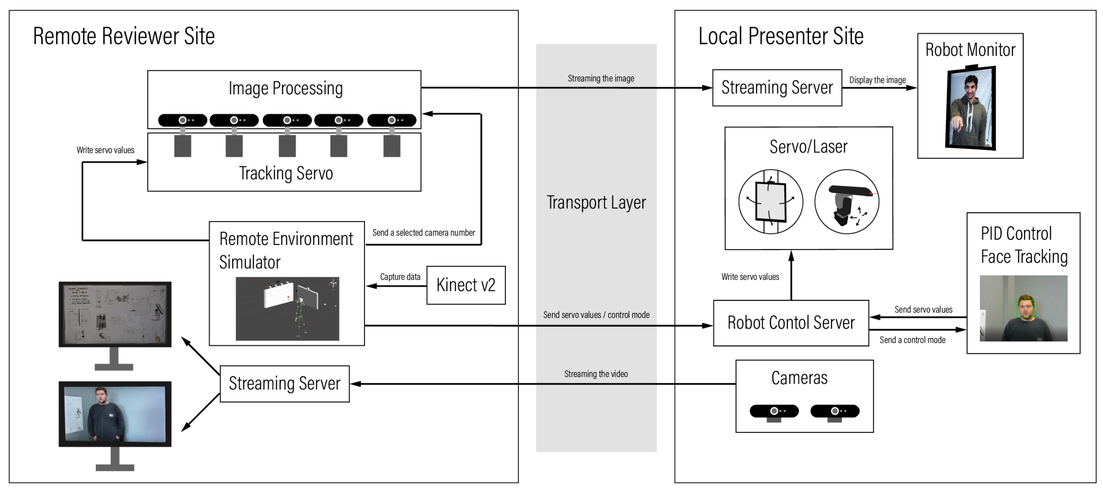

Fig. 5. The overall configuration of our ReMotion prototype.

Figure 5 shows the overall configuration of the ReMotion system. Each side is controlled by one computer, both connected to the building's network.

Key Features of the Proposed System

ReMotion automatically tracks both the reviewer's head direction and pointing gestures and translates them on the presentation site using a robotic proxy which is in the form of a 2-DOF animated monitor and 2-DOF laser pointer. Instead of controlling a robot with external controls, the reviewer can use their own body to automatically manipulate the embodied proxy. This novel control technique affords the capability of the basic interactions in design review.

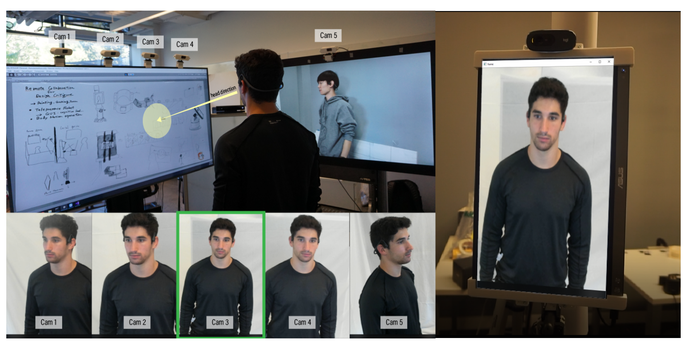

Fig. 3. Camera selection for the medium shot of the reviewer.

- Creating a front shot

The system has 5 cameras with a servo that keep tracking the user's head position by using a Kinect sensor. A camera is selected among the 5 cameras according to the reviewer's head direction to create the medium shot image which is played on the robot's monitor on the presenter site (Figure 3).

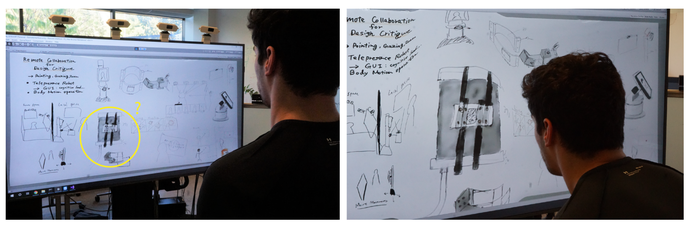

Fig. 4. A remote reviewer can zoom in a certain portion of a board just by approaching a screen.

- Zooming the Material

The display uses a Focus +Context zoomin system driven by the position of the reviewer with respect to the screen so that the reviewer could have a closer look at the information presented on the board. This also prevents the reviewer from being too close to the screen, which would stop the cameras from constantly capturing the medium shot.

Evaluation Plans

- Pointing & Gaze Estimation:
Figure 6 shows the results of our preliminary study that evaluated the pointing and gaze estimation accuracy. The results imply that the *Mona Lisa effect* caused by a flat monitor [4] affects the accuracy of the gaze estimation while the system accurately visualizes the pointing. We will further investigate how we can mitigate the effect.

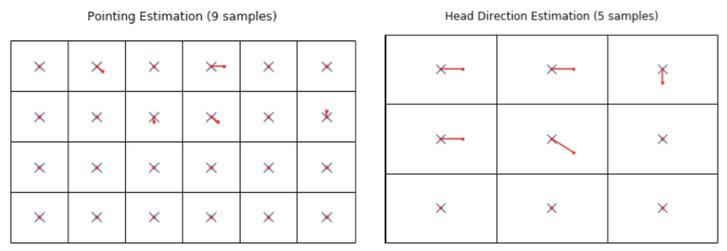

Fig.6.Preliminary results that show bias over different locations on a board. The blue cross is the reviewer's pointing (left) or gaze direction (right) and the red line indicates the presenter's pointing or gaze estimation bias.

- Comparison with Common Platforms:
To understand how the system can benefit in remote collaboration during design tasks, we will compare the proposed system with common telepresence platforms, such as Beam and Skype.

Conclusion

We present the design of ReMotion, which leverages body motions and an embodied proxy to enable remote collaborators to engage in design activities. In contrast to traditional telepresence robot interfaces, our system does not require remote participants to sit in front of a monitor and operate a robot using any input devices such as a keyboard or mouse, but instead, allows automatic control of the remote embodied proxy.

[1] David Sirkin, Gina Venolia, John Tang, George Robertson, Taemie Kim, Kori Inkpen, Mara Sedlins, Bongshin Lee, and Mike Sinclair. 2011. Motion and Attention in a Kinetic Videoconferencing Proxy. In Proceedings of the 13th IFIP TC 13 International Conference on Human-computer Interaction - Volume Part I (INTERACT'11). Springer-Verlag, Berlin, Heidelberg, 162–180. http://dl.acm.org/citation.cfm?id=2042053.2042074
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[4] Ikkaku Kawaguchi, Hideaki Kuzuoka, and Yusuke Suzuki. 2015. Study on Gaze Direction Perception of Face Image Displayed on Rotatable Flat Display. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15). Association for Computing Machinery, New York, NY, USA, 1729–1737. DOI:https://doi.org/10.1145/2702123.2702369

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