Telepresence Wall: An Ultra High Resolution, Wall-Sized Telepresence Display for Groups

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The Challenge

Imagine finishing a late lunch in the corporate break room when your west-coast colleague walks in for a mid-morning cup of coffee.You immediately greet each other and start chatting about project issues as if you were in the same room, but in fact your colleague is 2,500 miles away and you are viewing each other on a wall-sized telepresence display.

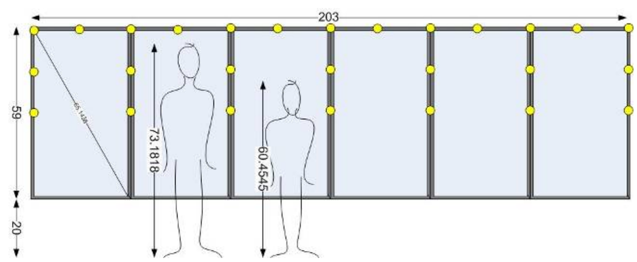
Videoconferencing systems and large format displays are not new, but such a vision is difficult to achieve with the standard 1-camera to 1-display conferencing paradigm. Resolution issues aside, there are perspective and gaze issues that cannot be solved with a single camera mounted on or slightly behind the display wall. What is needed is a synthesized camera perspective some significant distance behind the screen.

In this new project, our research is focused on the challenges of camera-display integration and the development of a multi-camera view synthesize algorithm capable of generating a novel camera view without the disturbing spatial and temporal artifacts that have characterized earlier research in image-based rendering and 3D scene reconstruction.

A mockup of a future telepresence wall display using five 65” displays in a typical meeting room.

Highlights

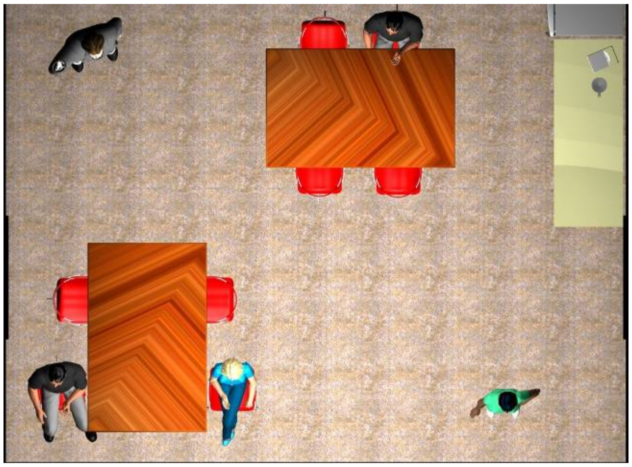
- **Development of view synthesis algorithms appropriate for a large telepresence wall.**
- **Initial view synthesis algorithms and camera placements studies are based on virtual sensing cameras and 3D spaces modeled in 3ds Max.**
- **Analysis of sampling requirements for view synthesis to inform camera choice and placement.**
- **New techniques including overhead camera arrays, structured light, model-based methods and hybrid 2D-3D algorithms are being explored.**



A 6-panel display telepresence wall design, showing the participant scale.

The Approach

The first stage of telepresence wall development is the determination of possible algorithms for view synthesis. Many current research or commercial systems that claim to support 3D teleconferencing are in fact using a 2.5D approach called “billboarding,” where the input video streams are posted on 2D planes. Alternatively, there are avatar based systems for simple 3D teleconferencing where virtual figures represent participants. While these two approaches may provide some three-dimensional cues about the spatial relationship of the participants, neither can achieve a level of realism that is comparable to traditional 2D teleconferencing. Other view synthesis techniques include stereo reconstruction, visual hulls, and light fields, but these have various latency and quality drawbacks as well. We are developing two types of algorithms for improved view synthesis: a plane sweeping approach and a hybrid 2D/3D approach. Before implementing these two methods with live cameras views and full resolution displays, we are developing synthetic 3D models, simulating the synthesis algorithms, and using a projected mock-up display wall.



Overhead view of simulated remote room

Perspective view from camera 48’ behind display wall.

Orthographic view

Modeling of Break Room Environment. The remote scene is generated with 3D modeling software and rendered from various viewpoints corresponding to virtual camera positions centered in the local room at a given distance from the display wall. The images include the borders corresponding to the 2” display bezel for each of the five 65” flat panel displays. Total display size is 15’ wide by 5’ tall, with the bottom 20” from the floor.

Initial results of plane sweeping view synthesis (48’ perspective view).

Plane SweepingView Synthesis. This output-oriented approach to view-synthesis estimates the most likely color for each display pixel. Given a set of calibrated input images, we synthesize new views as follows: We discretize the 3D space into a set of parallel planes, and for each plane we project the input images onto it. If there is an object surface located in the plane, the images projected at that spot should have the same color. We compute the mean color and variance for each pixel in each of the plane images. The final output color for a pixel in the rendered view is the color with minimum variance, or best color consistency among camera views.

This rendering method provides a unified framework for handling people, objects, and the room. We can improve the quality of the rendering with knowledge of object location probabilities obtained from other sources, such as 3D model databases or tracking devices, and use adaptive plane sweeping only in changing regions. We can then update a volume data structure with new 3D position information from the plane sweeping results for more accurate rendering in the future

Initial results of hybrid view synthesis (48’ perspective view).

Hybrid 2D-3D View Synthesis. This approach builds on our current work with rendering camera imagery onto plane proxies that are then inserted into a static 3D model of the environment. The 3D room model is acquired from preliminary vision-based stereo reconstruction algorithm or active 3D capture device such as the 3rdTech DeltaSphere laser scanner. There is no real-time requirement for this step so this model could be updated at off-hours or when no motion is detected. In real-time, we segment new objects, such as people and chairs, from the empty room in the camera images. We then evaluate the approximate 3D geometry of the objects to create a proxy model. The camera views of the objects are projected onto the proxies and composited with the static 3D scene model, and rendered from the virtual camera viewpoint.

The hybrid rendering approach might also incorporate a plane sweeping algorithm running in the background, to improve the 3D room model or to generate the background image itself. The textured proxies from the hybrid approach would then be rendered on top.

Current Project Members

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