Universität Rostock

Traditio et Innovatio

Multi-Camera Acquisition and Placement Strategy for Displaying High-Resolution Images for Telepresence Systems

Motivation

Life-size high-resolution telepresence systems, used for remote collaboration, face the problem of transmitting huge data from multiple viewpoints. We have seen works related to efficient bandwidth consumption for telepresence system [1] and model- driven telepresence system [2]. We propose a model-driven and bandwidth-efficient smart camera placement and acquisition model which captures motion data at lower resolution and enhance them, at the receiver site, for obtaining higher resolution image using super-resolution (SR)[4] methods.

Problem analysis

Contents of the problem domain (see figure 1)

1. two sites – local and remote.
2. virtual space between the sites.
3. a display screen on both sites.
4. cameras at certain positions.

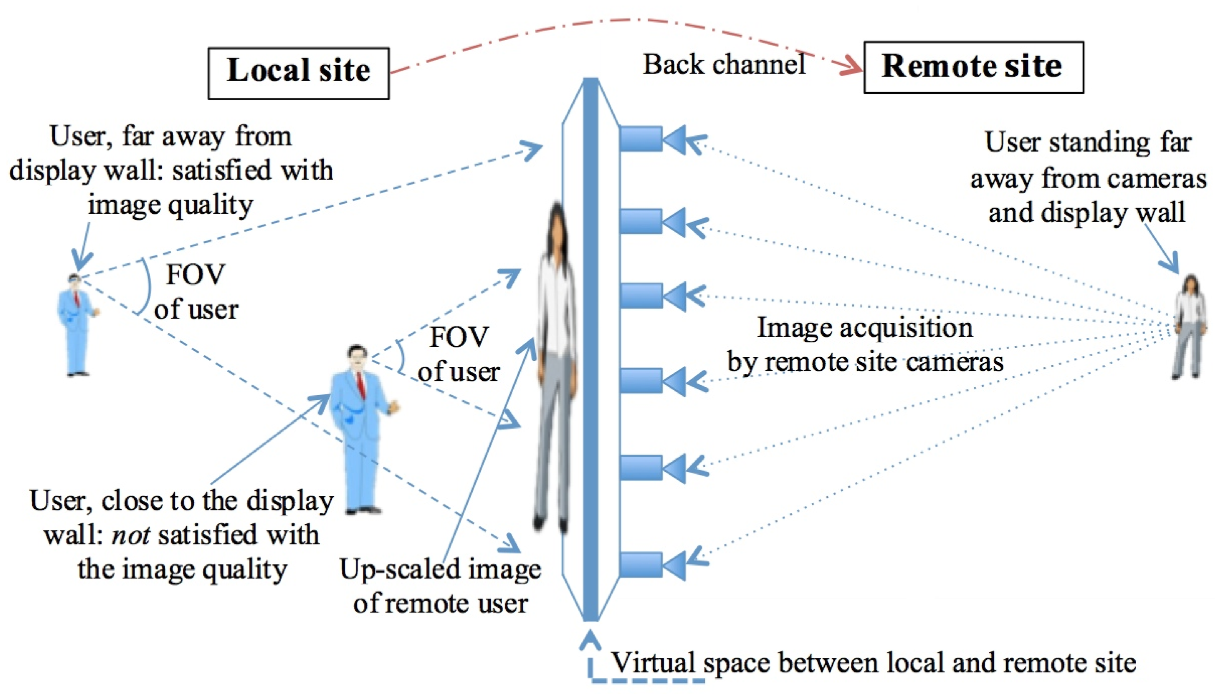

FIGURE 1: Illustration of display resolution considering different positions of the local user.

Challenges

1. recorded resolution of remote user depends on her position from camera.
2. required resolution depends on the viewpoint defined by the local user's position.
3. back-channel inclusion increases latency, not always a good choice.
4. avoid sending data that contribute only little to the reconstructed viewpoint.

Our Strategies

Main idea: We propose the following strategies to design a model-driven and bandwidth-efficient camera acquisition and placement model which aids to avoid sending data that contributes very little to the recosntructed viewpoint and enhance image data, at the receiver site, for obtaining higher resolution image using SR methods.

Camera selection based on surface angle

We select those cameras which make minimum angle, ψ in figure 2, with the surface of the user's image patches. We use tracking position and camera geometry to calculate ψ. We transmit the entire scene covered in the FOVs of the selected cameras and combine them for achieving a SR image.

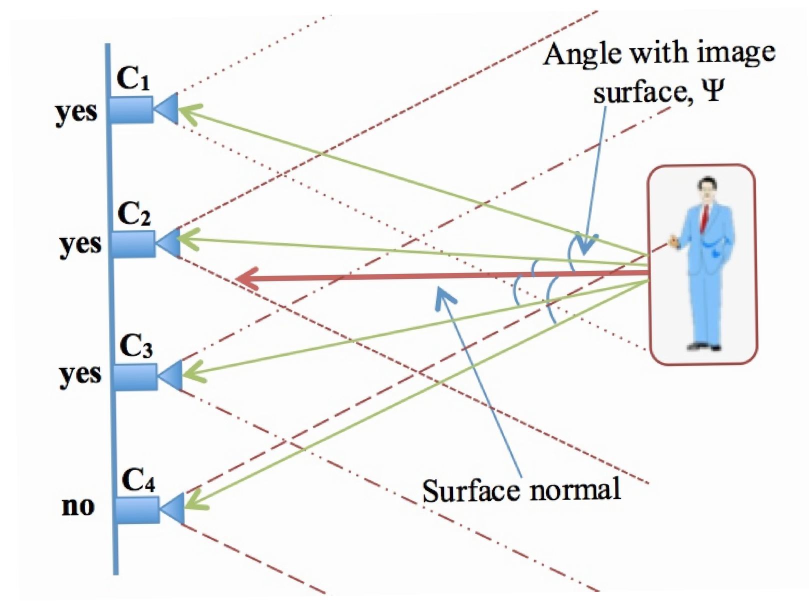

FIGURE 2: Camera selection based on camera angle with image surface normal.

Cameras are selected according to weight function in Eq.1:

$$w(C_i) = \sum_{p \in P} \frac{1}{1 + |\psi(p, C_i)|} \tag{1}$$

This strategy is applicable when there is no back channel between the local and remote sites to transmit the viewing angle of the local user; otherwise, cameras can be selected by estimating the view angle using the virtual camera strategy from [3].

Framerate adaptation

We explore the possibilities to run different cameras of the camera array at different framerates. This could be done in an unstructured data-driven fashion or with a predefined interleaving pattern, see figure 3a. At the local site, the image based rendering algorithms need to be modified to account for missing data. If a back channel is present, it can be used to steer the process by temporal downsampling of less important camera data only. Framerate Adaption can be implemented as a preprocess to standard compression schemes.

Optimizing camera resolution

To record a user in front of a very high-resolution display at different distances with the same resolution, a mixed focal length camera array can be used, see figure 3b. In case of a user close to the display, a wide angle lens must be used; whereas, for a distant user, a telephoto lens would be appropriate. We investigate different regular mixed focal length camera array configurations and their implications on image based rendering algorithms. Especially, we will evaluate the effect on known blending strategies.

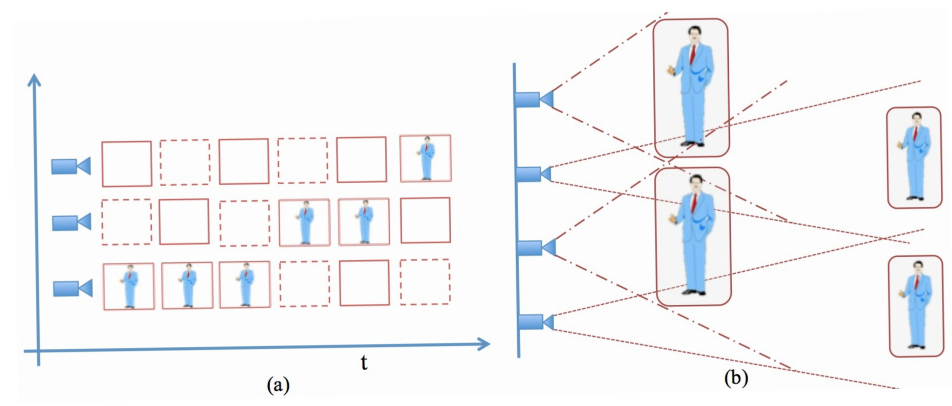

FIGURE 3: (a) Framerate adaptation (b) Camera array with different focal lengths and user position.

Conclusion

We have proposed a number of strategies for efficient camera selection and acquisition method to display life-size SR image, for teleconference systems, mantaining low-bandwidth usage. We plan to combine some of these strategies, such as combination of *framerate adaptation* and *optimizing camera resolution* strategies, for the collaboration system and evaluate its performance.

References

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[4] J. Yang, J. Wright, Y. Ma, and T. Huang. Image super-resolution as sparse representation of raw image patches. In *CVPR*, pages 1–8, June 2008.

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