Project Proposal

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Motivation

Most interactive displays that are widely available today are constrained to touch based input on a flat screen or projection surface, with haptics in the form of vibration. Moving beyond this into technology that mimics more natural objects requires us to move beyond conventional screens. Projector-based spatial augmented reality (SAR) systems have a lot of potential in this space because they have the ability to project onto objects of any shape and texture, with radiometric and geometric compensation to account for this. Furthermore, since almost any real world object can be used as a projection surface, this provides for a rich interaction environment with 3D objects and haptics. Furthermore, SAR can also create virtual geometry and lighting effects when the users perspective is known. The availability of miniature projectors and 6DoF tracking systems opens up the possibility of a SAR and/or interactive display system that moves with the user. It could update with the user's perspective for a natural, immersive experience that is capable of bringing familiar, physical interaction paradigms into digital media.

Related Work

Nayar, Shree K., et al. "A projection system with radiometric compensation for screen imperfections." *ICCV workshop on projector-camera systems (PROCAMS)*. Vol. 3. 2003.

Bimber, Oliver, et al. "The Visual Computing of Projector-Camera Systems."*Computer Graphics Forum*. Vol. 27. No. 8. Blackwell Publishing Ltd, 2008.

Marner, Michael R., et al. "Spatial user interfaces for large-scale projector-based augmented reality." *Computer Graphics and Applications, IEEE* 34.6 (2014): 74-82.

Grundhöfer, Anselm, and Oliver Bimber. "Real-time adaptive radiometric compensation." *Visualization and Computer Graphics, IEEE Transactions on*14.1 (2008): 97-108.

Project Overview

The main goal for the project is to be able to display media on the sides of a cube that the user can freely view from any side, with the projected content being updated in real time with the motion of the user. This requires a low latency and accurate tracking to keep the projected content properly aligned with the cube at the user moves which can be done using a magnetic tracker that provides position and orientation data. Other design goals will be to minimize the blurring caused by varying distance between the projector and target, and to take advantage of the known user perspective and SAR to have a sustained illusion of different geometry or lighting. Furthermore, adding a tracking device to the cube in addition to the projector could be done to implement basic interactivity to the system for user input.

This has a few immediate use cases. One example would be to expand the target to objects that aren't just boxes. For example, it could be a product that people want to buy, but are unsure of the color and texture they want. Another case could be a discoverable room, in which each person has a tracked projector that "reveals" what's in the room in the direction they're viewing. This could be used for a virtual gallery where people only see the displays if they're looking at them, or a gaming environment.

Lastly, and the one that will be pursued for the purposes of the demo, is to take advantage of user perspective to project onto the cube a different virtual geometry, specifically that of a hollow cube with an object inside. The projector and object can then be moved while updating the display, maintaining the illusion from the user perspective.

Timeline

- Next week: Calibrate projector for tracking and track the cube, try to get within a few mm of error (the tracker itself is accurate to only about ~1mm)
- Week 2: Implement perspective illusion from projector viewpoint while tracking both objects, then shift to arbitrary viewpoint relative to projector
- After: Buffer zone + polish + presentation work