Simulated Virtual Lighting in Augmented Reality Environments

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Problem
To simulate lighting and shadows projected by virtual light sources onto surfaces in the physical space in HoloLens.

Overview

- Spatial Mapping mesh
- Virtual lights and objects
- Spatial Processing
- Surface Shader program for lighting and shadow effects on processed mesh
- Render on HoloLens Additive-Light Display
- Augmented Reality with simulated lighting and shadows

Implementation

- **Spatial Processing**: Extract important surfaces from the SpatialMapping mesh like floor, tables, walls and ceiling and create planes for them.

- **Surface Shader**: Pseudo-transparent Unity Surface Shader, using Blinn-Phong lighting model and Alpha Blending for transparency effect, is applied to surfaces.

- **Voice-controlled Lighting**: Gaze at light and say "on" and "off" to turn the light on and off respectively.

- **Object Manipulation and Positioning**: Objects can be moved, rotated and scaled. They also collide with the SpatialMapping mesh. The objects retain their positions across sessions.

Results

- **700 lumens flashlight**: Virtual area light on Unprocessed mesh.

- **Virtual spot light on Unprocessed mesh**: 700 lumens flashlight.

- **Virtual spot light on Processed mesh**: Virtual area light on Unprocessed mesh.

- **Virtual area light on Processed mesh**: Virtual spot light on Processed mesh.

Conclusions

- **Spot light**: Lighting and shadows good including specular effects.

- **Area light (approximated by a point light)**: Lighting not very good because of the low-poly scanned mesh of environment. Shadows are of low resolution and have "jaggies".

- **Unprocessed mesh** shows visual artifacts and has a generic color. Processed mesh is smooth and is assigned suitable color depending on the type of surface identified.

Future Work

- Real-time area light shader instead of approximating with a point light.

- Enhance Spatial Processing to handle more than rectangular geometry.

- Determine color and texture information of surface from HoloLens camera.

- Lighting and shadow effects considering lights in the physical world.

References
