Developing a Microsoft HoloLens Application for Mastectomy Specimen Visualizations

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Introduction: Autologous breast reconstruction requires multiple revision procedures for a satisfying breast shape. Presently, there is no current standard of care for how reconstructive surgeons plan and shape an abdominal tissue flap for breast reconstruction. Our hypothesis is that the mastectomy specimen, the breast tissue removed during mastectomy, might provide useful information[1], but it is usually unavailable to the surgeons. Our solution is to acquire 3D scans of the specimens and then show them to surgeons on the Microsoft HoloLens (Microsoft, USA), an augmented reality device that allows the user to move around in their environment and interact with digital images simultaneously (Figure 1A). The objective of this study was to develop an application that can present images of specimens to reconstructive surgeons with the ability to translate, scale, and rotate the specimens using gaze and gestures.

Materials and Methods: The images used in this study were 3D surface scans of mastectomy specimens from patients at The University of Texas MD Anderson Cancer Center using the Go!Scan handheld 3D scanner (Creaform, Canada). The 3D scans were converted to FBX files in Unity (Unity Technologies, CA, USA), a cross-platform game engine that can develop applications for the HoloLens. The specimen images have metric annotations and color orientation indicators.

The HoloLens application was designed in Unity, and presents four different 3D specimen models with functions from the Microsoft Mixed Reality ToolKit (MRTK) (https://github.com/Microsoft/MixedRealityToolkit-Unity). Figure 1 is a snapshot of the view through the HoloLens showing the specimen images in our application. We incorporated the Bounding Box Rig, Box Collider, and Hand Draggable functions to each of the four models. The Bounding Box Rig and Hand Draggable functions adds scaling, rotating, and translating capabilities through hand gestures. The Bounding Box Rig places a bounding box around each model with cubes and spheres (see Figure 1B), which can be selected with gaze and adjusted with hand gestures to control scaling (cubes) and rotation (spheres). The Box Collider function is necessary to customize the size of the bounding box, which affects how sensitive the device is to the hand gestures for rotating and scaling. The Bounding Box Rig function also includes a default toolbar, which can be accessed with gaze and hand gestures. We customized the toolbar to include fixed rotation buttons as well as turning on and off metric annotations through editing the C# source code.

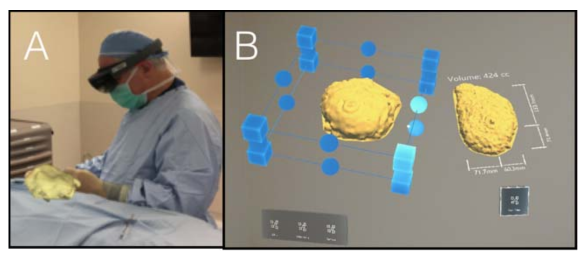

Figure 1. A) A reconstructive surgeon uses the HoloLens during a breast reconstruction procedure. **B)** Examples of specimen images displayed within the application, as seen through the HoloLens. The left specimen image has a bounding box for manipulating rotation and scale. The right specimen image has metric annotations of length, width, and projection.

Results and Discussion: We successfully developed an application for the HoloLens for viewing mastectomy specimen images. It supports translating, scaling and rotating the specimen images with gaze and gesture. An issue that needs to be resolved is that the color orientation indicators do not render properly in the correct location on the model.

Conclusion: The HoloLens application shows promise as a viable interface to present information about mastectomy specimens to reconstructive surgeons. With the basics of the application tailored for rotating, translating and scaling capabilities, more functions can be pursued that expand the potential of the application, such as creating scripts that show the specimens in specific views and animations.

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References:

[1] O. J. Garcia, "The Mastectomy Specimen as a Model for TRAM Flap Fabrication in Immediate Breast Reconstruction," *Ann. Plast. Surg.*, vol. 42, no. 1, pp. 27–33, Jan. 1999.