Towards Augmented Reality Visualization of Mastectomy Specimens for Breast Reconstruction Surgery

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Rationale

Autologous breast reconstruction often requires multiple procedures in order to achieve an acceptable aesthetic result, increasing risks and costs to the patient. The number of subsequent aesthetic revisions depends on the effectiveness of the initial reconstruction procedure, which relies on the surgeon's ability to plan how they will reform the breast shape. Currently, reconstructive surgeons rely on pre-operative patient photographs and measurements, which do not account for the anatomical changes to the breast during and after mastectomy. The extracted mastectomy specimen can provide information about the post-mastectomy breast, but is unfortunately unavailable to reconstructive surgeons due to the need for prompt histological analysis. Our hypothesis is that providing reconstructive surgeons with an intra-operative stereoscopic image of the mastectomy specimen using augmented reality glasses will enhance their ability to make surgical decisions to improve the aesthetic outcome and reduce the number of subsequent procedures.

Methods

We have previously collected 3D scans of mastectomy specimens with a handheld 3D scanner (Go!Scan 3D Scanner, Creaform, Canada) from 12 patients undergoing mastectomy at The University of Texas MD Anderson Cancer Center. Image processing of the 3D scans was performed with Meshlab. With these preliminary images, we used the UCSF Chimera package to create stereoscopic rotating images of the mastectomy specimens and presented them to reconstructive surgeons at MD Anderson with Epson Moverio BT-200 smart glasses (Epson, Japan) under mock surgery conditions. The Moverio BT-200 smart glasses have a see-through display, stereoscopic viewing, and adequate processing capabilities for displaying images. The surgeons' perception of image quality and system effectiveness was evaluated using the established System Usability Scale and through open-ended interview questions.

Results

We displayed four rotating image movies that display different image rotation sequences, measurements of the specimen, color schemes, and varied specimen sizes to determine what features are optimal for 1) learning from the image and 2) utility in the operating room. The movies are generated automatically by running a Python script through UCSF Chimera. The reconstructive surgeon is ready to shape the reconstructed breast approximately 2-5 hours after the mastectomy is performed. Thus, the minimum time available to obtain the 3D specimen scan, process the image, and generate the movie is 2 hours, so we aimed to implement as much automation as possible. Figure 1 shows a frame of a movie with a high contrast color scheme and specimen measurements. The 3D viewing function of the Moverio smart glasses combines the left and right images for a stereoscopic visualization. Surgeons' concerns with the system include the impact of lighting in the OR on their ability to see the image clearly and hands-free operation of the AR glasses during surgery.

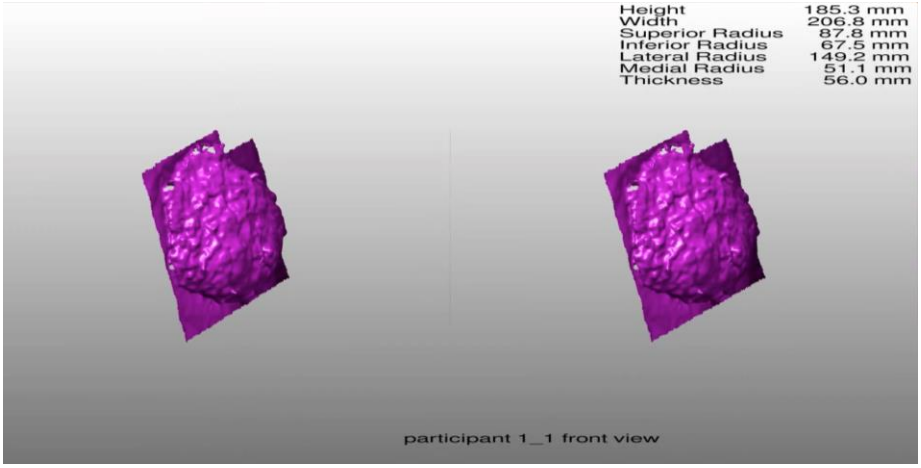

Figure 1: Stereoscopic movie of a rotating mastectomy specimen image with related measurements.

Conclusions

We successfully created a stereoscopic visualization system that allows 3D scans of mastectomy specimens to be viewed on Epson Moverio BT-200 smart glasses. Reconstruction surgeons evaluated the system for effectiveness and future usability in an intra-operative setting. Future work includes optimization of movie schemes and smart glasses function based on surgeon input, improving hands-free operation, and developing the possibility of user-interaction.