Dynamic Texture Mapping of 3D models for Stiffness Map Visualization

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***Abstract*—Robot-assisted minimally invasive surgery has the potential to perform a variety of surgical procedures with precision, flexibility and control. However, lack of direct visual access can result in a cognitive overload for the surgeons. To overcome this issue, we have developed an augmented reality display that shows critical information overlaid on intraoperative model. We demonstrate our capabilities by dynamically updating the stiffness distribution over the surface of the anatomy being palpated intraoperatively.**

I. Introduction

Tumors are stiffer than the surrounding soft tissues, and their stiffness can be determined using forceful palpation [1]. The estimated stiffness is often represented in the form of a map, with brighter colors representing the stiffer regions and the darker colors representing softer regions (See Fig. 2) [1]. The map is typically displayed on a monitor different from the stereo viewer that the surgeon uses to view the anatomy [2]. As a result mental transformation is required to find the correspondence between stiffness maps and intraoperative anatomy. To reduce the gap between the working space and the visualization, we develop an augmented 3D view of the anatomy with the stiffness map draped onto it. Such an approach would allow surgeons to directly relate the functional tissue information to the real view showing the anatomy and instrument position. We believe that our approach would offer some new possibilities for augmented reality applications in medical robotics.

II. Related Work

Augmented reality for medical applications has been an active area of research for over a decade. Some approaches use special hardware to directly project ultrasound or microscope images on visible anatomy [2], while others display image slices over the visible anatomy [3, 4].

III. Approach

We use the concepts of texture mapping and projective geometry on a 3D model, to wrap the stiffness maps. ROS visualizer (Rviz) was used as a platform for 3D visualization. Rviz camera plugin is used to generate the stereo view. We have created a user-friendly plugin interface for dynamic texturing, to allow real-time changes to information being displayed.

IV. Key Contributions

The plugin developed in this work has the ability to load a preoperative model, select the region of interest (ROI) and project the textures in given ROI while dynamically updating the stereo view from time to time.

V. Results

The sequence of images in Fig. 2 shows the development of a stiffness map over time on the 3D model of a liver. The stiffness maps are generated using the approach of Srivatsan e*t al.* [1]. Fig. 3 shows the stereo view of the augmented stiffness map on to a representative anatomy.

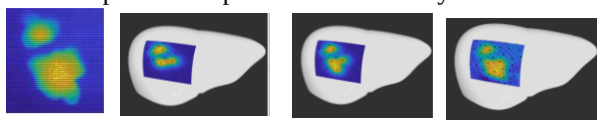

Fig. 2. On the left is the stiffness map obtained after palpating the ROI. Snapshots of stiffness maps at different stages of palpation.

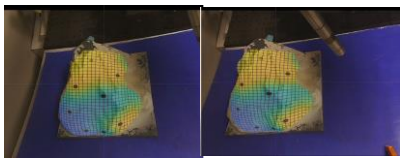

Fig. 3. Left and right views from a stereo camera, of anatomy with overlaid stiffness map

VI. Future Work

Future work will involve development of a visualizer plugin to enable real time interaction with the augmented model. This opens up new possibilities in medical imaging applications of virtual reality.

VII. References

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