Master’s Research Proposal

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The fields of computer assisted surgery and technology assisted medicine are rapidly growing due to the promise they have already shown towards the improvement of medical procedures and protocols. Computer assisted surgery can deliver these improvements by increasing the efficiency and accuracy of various tasks while reducing invasiveness and recovery times. The ability to bring together various types of medical imaging and planning and making it usable during a procedure is one of the many ways that protocols can be improved.

To be able to use the available technologies effectively frameworks must be put in place to allow for efficient procedures. 3D Slicer is an open source software platform to that allows for easy, efficient and versatile development of applications in the fields of medical image informatics, image processing, and 3D visualization [2]. By being an open source platform groups from across the world have been able to expand the capabilities of the platform contributing to the over 100 published Slicer extensions. Additionally, with the integration of the PLUS toolkit 3D Slicer can easily interface and receive real time data from various devices; most notably ultrasound machines and optical tracking cameras [6]. All these qualities make 3D Slicer an ideal platform through which to design technical frameworks for new computer assisted workflows [1].

Ultrasound imaging is a minimally invasive imaging modality which has been effectively used to allow for surgeons to guide various interventions such as biopsies. The 3D Slicer platform has implemented extensions that enable the use of 2D ultrasound guided procedures by allowing the real-time ultrasound image to be displayed in 3D space relative to the tracked tools for the intervention and the target site [1]. By having the real-time positions of all the surgical implements and the ultrasound image the surgical tools can be guided to the target site with the goal of completing the procedure with smaller incisions and with less trauma to the target area [4]. A Slicer extension called LumpNav has already been implemented for use in 2D ultrasound-guided breast tumor resection [3] and has been shown to be rapid to set and deploy [5]. The testing of the LumpNav extension in a practical surgical workflow has shown that they were able to achieve sufficient accuracy for surgical applications [5]

3D ultrasounds can capture more information than their 2D counterparts due to them being able to record data from one-time instance in a given volume rather than a single slice. This can potentially give a significant advantage to an ultrasound guided intervention if the information is displayed in an intuitive and effective manner. The main objective of this project is to develop a framework in 3D slicer that will facilitate the use of 3D ultrasound for navigation of percutaneous interventions. Different aspects that must be considered to allow for the framework to be feasible in a surgical setting include making a user friendly framework that clearly outlines all steps in the workflow while ensuring that the updated workflow improves on pre-existing percutaneous intervention navigational protocols without disrupting protocol.

References:

1. Kikinis R, Pieper SD, Vosburgh K (2014) 3D Slicer: a platform for subject-specific image analysis, visualization, and clinical support. Intraoperative Imaging Image-Guided Therapy, Ferenc A. Jolesz, Editor 3(19):277–289 ISBN: 978-1-4614-7656-6 (Print) 978-1-4614-7657-3 (Online)
2. Fedorov A., Beichel R., Kalpathy-Cramer J., Finet J., Fillion-Robin J-C., Pujol S., Bauer C., Jennings D., Fennessy F.M., Sonka M., Buatti J., Aylward S.R., Miller J.V., Pieper S., Kikinis R. 3D Slicer as an Image Computing Platform for the Quantitative Imaging Network. Magn Reson Imaging. 2012 Nov;30(9):1323-41. PMID: 22770690. PMCID: PMC3466397.
3. Lasso A., Vaughan T., Ungi T., Yan C., Lund S., Brudfors M., and kanyala. “SlicerIGT/LumpNav.” GitHub, SlicerIGT, 14 Nov. 2018, github.com/SlicerIGT/LumpNav.
4. Ungi, T., Lasso, A., & Fichtinger, G. (2016). Open-source platforms for navigated image-guided interventions.
5. Harish, V., Baksh, A., Ungi, T., Lasso, A., Baum, Z., Gauvin, G., ... & Fichtinger, G. (2016, March). Measurement of electromagnetic tracking error in a navigated breast surgery setup. In *Medical Imaging 2016: Image-Guided Procedures, Robotic Interventions, and Modeling* (Vol. 9786, p. 97862K). International Society for Optics and Photonics.
6. Queen's University, Plus Toolkit Community, & PerkLab. (2011). take your image-guidance system from bench to bedside. Retrieved from https://plustoolkit.github.io/