Advanced Computer Integrated Surgery

Project Proposal

Intraoperative Fiducial Tracking in TORS

Project number: 15

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Mentors: Wen P. Liu, Anton Deguet

- Project Background and Topic:

Transoral robotic syrgery (TORS) is a minimally invasive surgical intervention for resection of base of tongue tumors, which has become a significant health care concern. Because most base of tongue tumors are buried deep in the musculature of the tongue, when doing the TORS, expert surgeons always rely on experience to remain correctly oriented with respect to critical anatomy. Such practice leaves considerable room for improvement[1].

So, a method that integrates a preoperative surgical plan with the intraoperative endoscopic video as video augmentation in the operating room is proposed. The rough steps of this method is as below.

First, a detailed surgical plan is made from the preoperative CT or MR of the patient. Second, when the patient is positioned for the surgery, a CBCT image is acquired immediately to capture the intraoperative deformation. Third, using the deformable registration between the preoperative CT and the intraoperative CBCT to get the intraoperative surgical plan on CBCT. Then, a rigid transformation resulting from the tracking of the fiducial, which is attached directly above the resection area at the beginning of the surgery, between the CBCT and the

[1] Credit to Wen P. Liu

endoscopic video could be got. Using this transformation, the planned data can be registered to the robotic endoscopic video, and the augmented video can provide the surgeon with more accurate information during the surgery.

The essential parts to achieve this is showed in figure1.

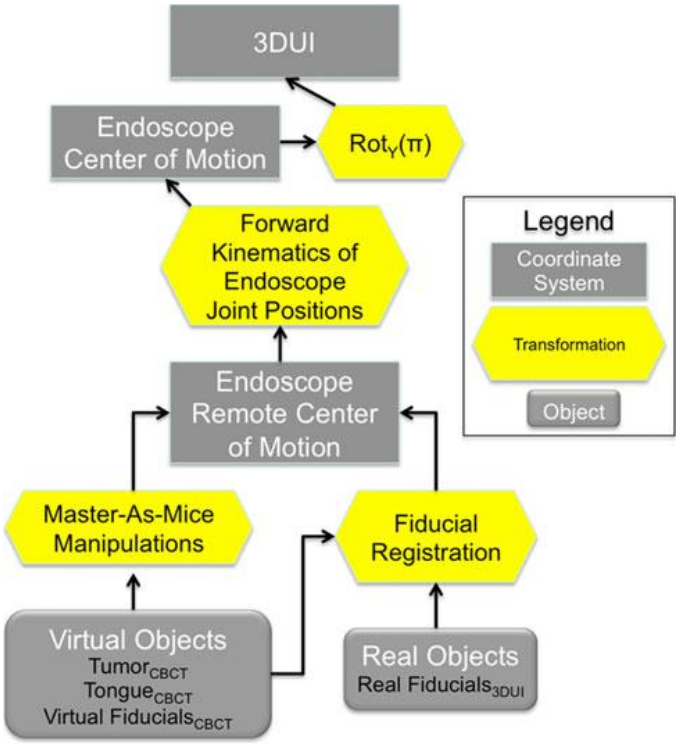

Figure 1

- Project Importance and Goal:

A rigid transformation between CBCT and the endoscopic video relies on the tracking of the fiducial, so the accuracy of the fiducial tracking is essential for the surgery video augmentation, as showed in figure 2.

For this project, the goal is to develop an intraoperative fiducial tracking system in TORS that can accurately track the fiducial in the field of endoscope.

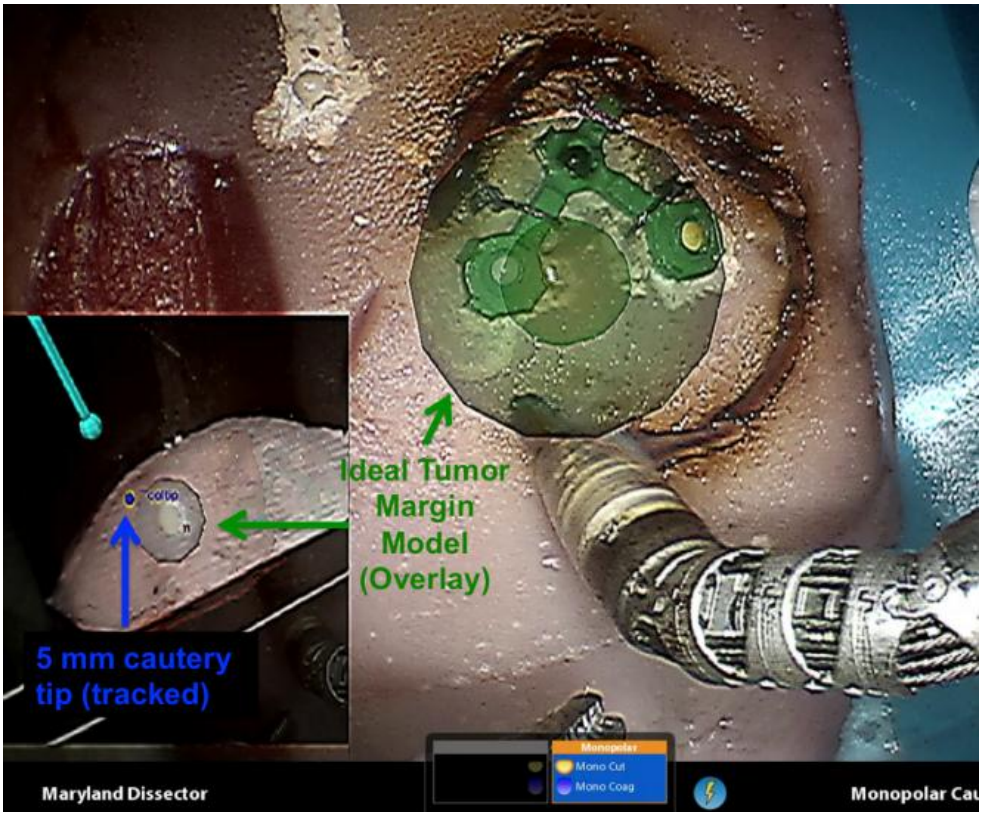

Figure 2

- Technical Summary of the Approach:

First, an easy-to-track fiducial, similar to which showed in figure 3, should be designed using CAD and the 3D printer.

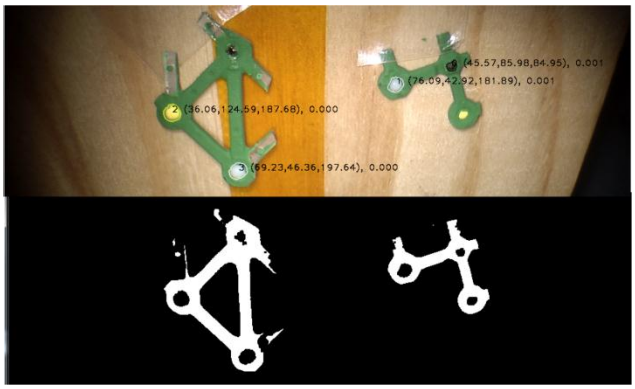

Figure 3

Second, a robust algorithm to detect and locate the 3D fiducial using binocular visual system of the endoscopic camera should be designed.

Third, the algorithm should be implemented using C++ and the cisst libraries.

Fourth, the implementation of the algorithm should be tested on the robot and be optimized.

Fifth, a video showing the tracking process should be recorded.

- Project Deliverables:

Minimum: The algorithm for fiducial detection be designed and be implemented using C++ and cisst libraries.

Expected: Besides the minimum deliverables, the algorithm implementation be tested on the robot using the endoscopic camera and be optimized.

Maximum: New fiducial for better detection be designed and produced and the video be recorded, besides the expected deliverables.

- Key Dates:

Feb. 20: Software Installation: Visual Studio, cisst, CMake, SVN, OpenGL
Feb. 21: Begin algorithm design
Feb. 23: New fiducial design (optional)
Feb. 28: New fiducial produced (optional)
March. 10: Algorithm design complete
March. 15: Begin algorithm implementation (coding) with cisst and C++
April. 10: (Minimum deliverable) Algorithm implement complete, begin optimization of the algorithm
April. 25: (Expected deliverable) Optimization of the algorithm complete
April. 28: (Maximum deliverable) Record video for the new fiducial and begin to prepare for the report and post session
May. 9: Presentation and report

- Dependencies:
  Current algorithm for automatic fiducial tracking
    Solution: Ask Wen for this
  Cisst Understanding
    Solution: Ask Wen or Anton
  Access to 3D printer and knowledge of CAD
    Solution: Read books to recall and ask Wen

- Management Plan:
  Once two week tele-conference with Wen before March. Once a week meeting with Wen afterwards through the completion of the project.
  (Intended) Once two week meeting with Anton.

- Reading List (continuing):
  We P. Liu et al, "Toward intraoperative image-guided transoral robotic surgery". J Robotic Surg
  Wen P. Liu et al, "Intraoperative Cone Beam CT Guidance for Transoral Robotic Surgery"
  Deguet A et al, "The cisst libraries for computer assisted intervention systems". MICCA Workshop
  Stoyanov D, "Stereoscopic scene flow for robotic assited minimally invasive surgery". MICCA-2012
  Desai Sc et al, "Transoral robotic surgery using an image guidance system". Laryngoscope