Intraoperative Fiducial Tracking in TORS

CIS II Project #15
Check Point Presentation

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• **Project Goal:**

The goal of this project is to design and implement an intraoperative fiducial tracking algorithm in TORS that can accurately track the fiducial under the endoscope.

Images courtesy of Wen P. Liu
• Project Background:

  • TORS: TransOral Robotic Surgery

  • The base of tongue tumors 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 transoral surgery, expert surgeons always rely on experience to remain correctly oriented with respect to critical anatomy.

  • Such practice leaves considerable room for improvement and has brought TORS. It is a minimally invasive surgical intervention for resection of base of tongue tumors.

http://www.ohsu.edu/xd/health/services/comprehensive-robotics-program/surgical-services/transoral-robotic-surgery-tors.cfm
Project Overview (Continue)

• **Technical Summary:**

• **Implementation:**

  Coding with C++ (using cisst and saw libraries and OpenCV)

• **Testing:**

  Work on the da Vinci robot console

  Design of new fiducial
Project Dependencies

- Ciss and saw understanding
  
  Solution: Read tutorials and ask Wen and Anton
  
  Current Status: Still working on it. Need to keep on learning throughout the project. Have understood what is needed so far.

- Access to 3D printer and knowledge of CAD
  
  Solution: Read books and ask Wen
  
  Current Status: Got the handcraft material

- Access to the robot
  
  Solution: Ask Wen and Prof. Taylor for permission
  
  Current Status: Got it
Project Deliverables

• Minimum (Planned 4/10):
  Implementation of fiducial segmentation of the intraoperative recorded endoscopic images
  Implementation of fiducial tracking of the intraoperative recorded stereo video
  Test and optimize the implementation to confirm better result than the already existed tracking method

• Expected (Planned 4/22):
  Real-time fiducial tracking under the robot endoscopic camera
  Optimization of the implementation to confirm better result than the already existed tracking method

• Maximum (Planned 4/29):
  A more accurate tracking under intraoperative scenario
  Video recording for the intraoperative fiducial tracking process
  A new fiducial for better and more accurate tracking
Project Deliverables (Continue)

• Current State:
  Still working on the minimum deliverable

• Possible changes to the deliverable completion dates:

  Minimum (Planned 4/10) ➔ Might be delayed to 4/15
  Implementation of fiducial segmentation of the recorded endoscopic images ➔ Should be done by 4/10
  Implementation of fiducial tracking of the recorded stereo video ➔ Should be done by 4/15

  Expected (Planned 4/22) ➔ Should not be changed
  Real-time fiducial tracking under the robot endoscopic camera
  Optimization of the implementation to confirm better result than the already existed tracking method

  Maximum (Planned 4/29) ➔ Might be delayed to around 5/3
  A more accurate tracking under intraoperative scenario ➔ Should be done by 4/29
  Video recording for the intraoperative fiducial tracking process
  A new fiducial for better and more accurate tracking
Project Deliverables (Continue)

• Work Summary:

Software Implementation + Algorithm Design = Deliverables
Project Deliverables (Continue)

- Software

- Now Using: Cisst C++ OpenCV

- Need to build a stream for implementation:

```
Cam Source → Fiducial Detection Filter → Overlay Filter → Splitter → Image Writer
          ↓                     ↓                    ↓                      ↓
          Video Writer        Splitter
```

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Image Source: CIIS

Image Source: Intuitive Surgical

Image Source: Laboratory for Computational Sensing & Robotics
Project Deliverables (Continue)

• **Software**

  • The stream:

    - Cam Source
    - Fiducial Detection Filter
    - Overlay Filter
    - Splitter
    - Image Writer
    - Video Writer

    - The essential part of this project
    - A child class of svlOverlay
    - For the mono image from each channel, it detects the fiducials on the image, and store the information of the sphere fiducials as its member variable
Project Deliverables (Continue)

• Software Progress:
  
  • Have roughly built the stream
  
  • Now working on the fiducial detection function in the fiducialdetection filter
  
  • Problems:
    Have some questions about the reference and copy of the images
    Have some problems using OpenCV functions
    Solving:
    Schedule meetings with the mentors
Algorithm

- Have been using Matlab for algorithm design, since it’s more straightforward and has many similar functions as OpenCV
- Use both the color information and the edge detector to detect the frame
- Use the adjacency and color information to detect the fiducials from the frame
- For fiducial detection within the video and realtime camera, apply Kalman filter
Project Deliverables (Continue)

- Algorithm Progress
  - The detection of the fiducial frame contour
  - Still optimizing the fiducial detection part
Project Key Dates

Feb. 20: Complete Software Installation: Visual Studio 9.0, CMake, SVN, cisst saw library, OpenCV  
Feb. 21: Begin algorithm design  
Feb. 22: Begin software and cisst study  
Feb. 23: Begin new fiducial design (optional, might do it after testing the implementation on the robot)  
March. 1: Print the new fiducial (optional)  
March. 7: Algorithm study and design complete  
March. 10: Begin algorithm implementation (coding) with C++  
April. 10: (Minimum deliverable) Complete algorithm implementation and optimization  
April. 12: Begin testing on the robot  
April. 22: (Expected deliverable) Complete testing on the robot and get the intraoperative tracking result  
April. 29: (Maximum deliverable) Complete optimization and record video for the fiducial tracking during TORS  
May. 9: Post session and project report
Project Management

• Bi-weekly tele-conference with Wen before March.

  Weekly meeting with Wen afterwards through the completion of the project. Every Monday afternoon. With occasional exceptions. Keep contacting by emails.

• Bi-weekly Scheduled meeting with Anton after the beginning of implementation.
Thank You