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# RadVision integration with TRUS robot for Brachytherapy

## 600.446 Computer Integrated Surgery II

Project Proposal

Team Members:  Adam Clayton

Team Mentor: Peter Kazanzides

## Project Summary

The main goal of this project is to integrate the RadVision treatment planning software with the (Trans-Rectal Ultrasound ) or TRUS brachytherapy robot.  This integration should allow the surgeon to position the needle of the robot more accurately with the new system.  In addition to the integration with RadVision, I intend to participate in an accuracy study in which the accuracy of the TRUS robot in needle placement will be assessed.

## Motivation and Significance

The American Cancer Society reports that 240,890 cases of prostate cancer were diagnosed  and about 33,720 men will die from it.[1]  Prostate Brachytherapy is a minimally invasive radiation therapy that used to treat prostate cancer.  The therapy involves the injection of radioactive seeds directly into the prostate near the tumor using fine needles.  Unfortunately, attaining the level of accuracy required often takes the surgeon more than one attempt at inserting the needle.  Increasing the accuracy of the needle insertion with a robotic system would allow faster surgeons with better results.

The conventional approach uses a grid of holes (template) located over the prostate to position and guide the needle for insertion.  The needle itself is monitored in real-time by an ultrasound probe positioned below the prostate.  Since the seed insertion must be very accurate and the final location of the end of the needle cannot be predicted, the surgeon often must insert the need multiple times using multiple holes in the grid.  The TRUS robot replaces the function of the grid of holes by using two 2-dimensional servo mechanisms to position and guide the

needle.    The two dimensional grid allows the user to control both the 2 dimensional insertion location as well as the angle of the needle.
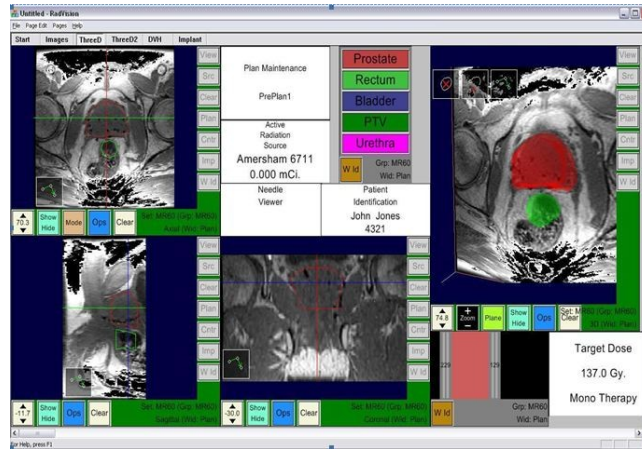


In addition to the integration with RadVision, the accuracy study in which I plan to participate will assess the accuracy of the TRUS robot in needle placement.  The results of this assessment could be used to compare this robotic system with other robotic systems that are used in the same procedure.

## Technical Approach

The TRUS robot is a 4 degree of freedom robot.  Two degrees of freedom come from each of the two 2-axis Galil servo mechanisms.  Each servo mechanism holds one end of a aluminum tube that holds the needle.  This setup allows for both 2D needle positioning as well as orientation.  The base of the robotic system consists of a pivot that allows the whole system to be manually pivoted.  On top of the pivot mechanism lies the ultrasound probe.  Since the ultrasound probe is being held at a fixed distance from the servo mechanism the mechanism can be registered to the robot.
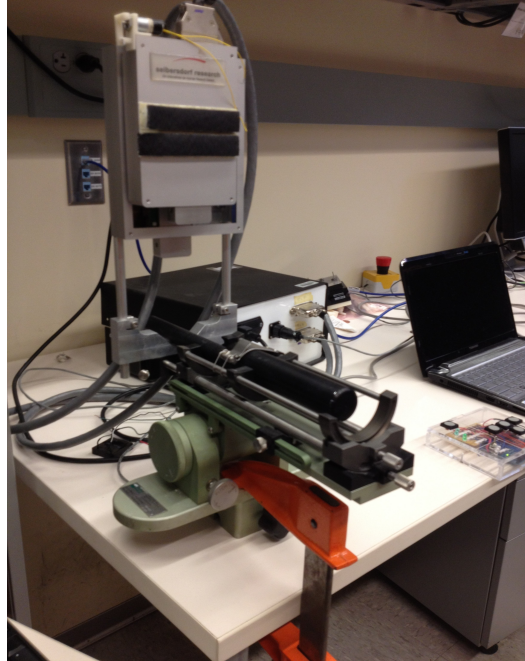
*TRUS robot 1*

The first step in the project is to rebuild the setup for the TRUS robot currently in the robotorium. Since I have chosen to use my laptop as the computer to complete this step I must install all of the necessary drivers and resolve any compatibility issues between my laptop and the TRUS robot. Since my laptop runs Windows 7, and the old Galil drivers were not compatible with windows 7, I was forced to rewrite the CISST wrapper for the new Galil drivers.

The second step in this project is to integrate the software that currently controls the TRUS robot with the RadVision software I should receive from the company (Acoustic MedSystems). The RadVision software will provide the target positions for the robot. It will also receive movement adjustment commands from the button interface of the TRUS robot, and then send the position changes to the software that controls the TRUS robot. Communication between the robot control software and Radvision will be handled by the OpenIGTLink protocol. Communication between the computer and the robot is handed by an Ethernet link.
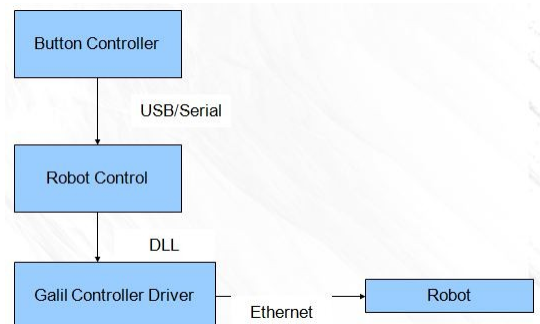


*System Design before 1*
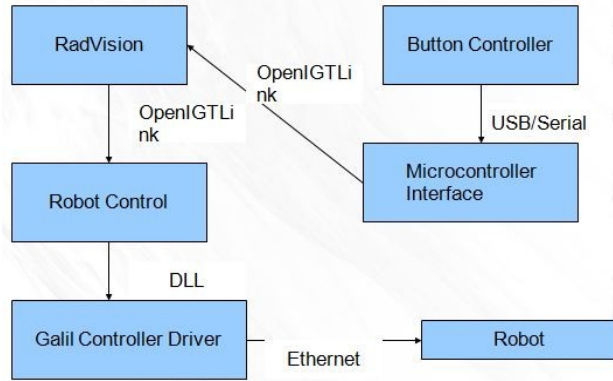
*System design after 1*
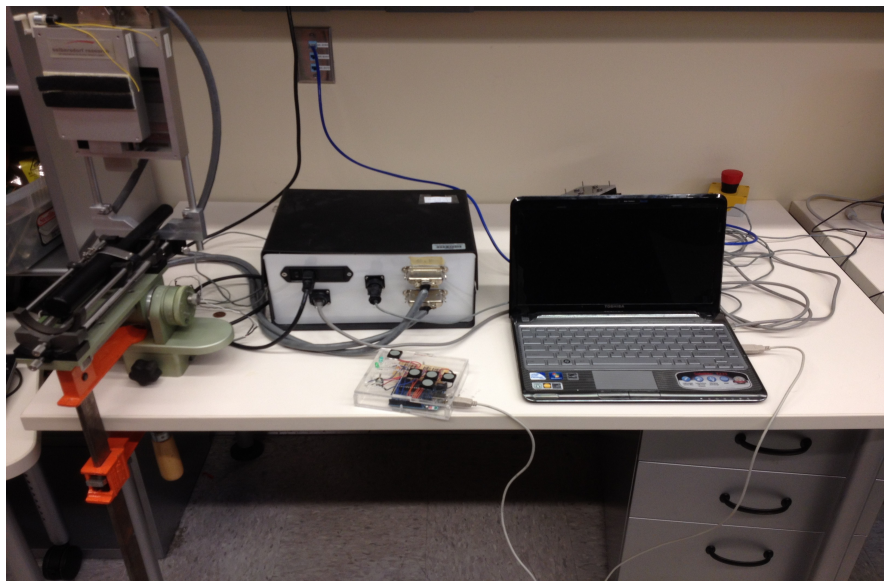


*Entire system 1*

The accuracy study will performed on the robot before or after the integration with RadVision.  The accuracy study has two parts.  The first part involves poking graph paper reinforced by Styrofoam with a needle in a specific pattern.  A high definition camera is used to take pictures of the needle insertion to measure accuracy.  The second part involves inserting dummy radioactive seeds into a phantom jet.  The seeds are placed in a pattern.  After the insertions the phantom is imaged by a CT machine in order to measure the accuracy of the insertions.

# List of deliverables

- ⚔ Minimum Deliverable

  - ○ Demonstrate complete system with gel phantom, using proxy components if necessary (i.e., if dependencies are not resolved in time). Use 3D Slicer or some other interface as a proxy for Radvision, and use a camera as a proxy for the ultrasound.

  - ○ Accuracy Study using TRUS Robot. (AAPM task group 132 protocol)

- ⚔ Expected Deliverable

  - ○ Using RadVision and real ultrasound with phantom gel. (or with 3D Slicer if dependencies are not available in time)

  - ○ Using button box to send commands to RadVision

- ⚔ Maximum Deliverable

  - ○ IRB approved system ready for clinical trial

# Key dates

- ⚔ Project Proposal Due – 2/23/2012

- ⚔ Project Presentation Due – 3/01/2012

| Task\Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assemble System | 🟥 | | | | | | | | | | | | | |
| Develop new CISST wrapper | 🟥 | | | | | | | | | | | | | |
| Integrate RadVision | | 🟥 | 🟥 | 🟥 | 🟥 | 🟥 | 🟥 | 🟥 | | | | | | |
| Accuracy Study | | | | | | | | | 🟥 | 🟥 | | | | |
| Testing with Gel and Ultrasound | | | | | | | | | | | 🟥 | 🟥 | 🟥 | 🟥 |

## List of dependencies & plan for resolving

- RadVision software – Currently waiting on company

- TRUS Robot – Already have robot

- Ultrasound equipment - Provided at hospital

- Phantom gel  - Going to get from Danny Song (designer of accuracy study)


## Management Plan

- Meeting every other week with Professor Kazanzides

## Reading List

- Gabor Fichtinger, Jonathan P. Fiene, Christopher W. Kennedy, Gernot Kronreif, Iulian Iordachita, Danny Y. Song, Everette C. Burdette, Peter Kazanzides, Robotic assistance for ultrasound-guided prostate brachytherapy, Medical Image Analysis, Volume 12, Issue 5, October 2008, Pages 535-545, ISSN 1361-8415, 10.1016/j.media.2008.06.002.

  (http://www.sciencedirect.com/science/article/pii/S1361841508000613)

  Keywords: Medical robotics; Image guided surgery; Prostate cancer; Brachytherapy


## References

1. 02/27/2012. What are the key statistics about prostate cancer? American Cancer Society. 5/4/2012, from http://www.cancer.org/Cancer/ProstateCancer/DetailedGuide/prostate-cancer-key-statistics