ERC | CISST

APL The Johns Hopkins University APPLIED PHYSICS LABORATORY

LABORATORY FOR Computational Sensing + Robotics THE JOHNS HOPKINS UNIVERSITY

Interfacing APL Snake End Effector to LARS Robot

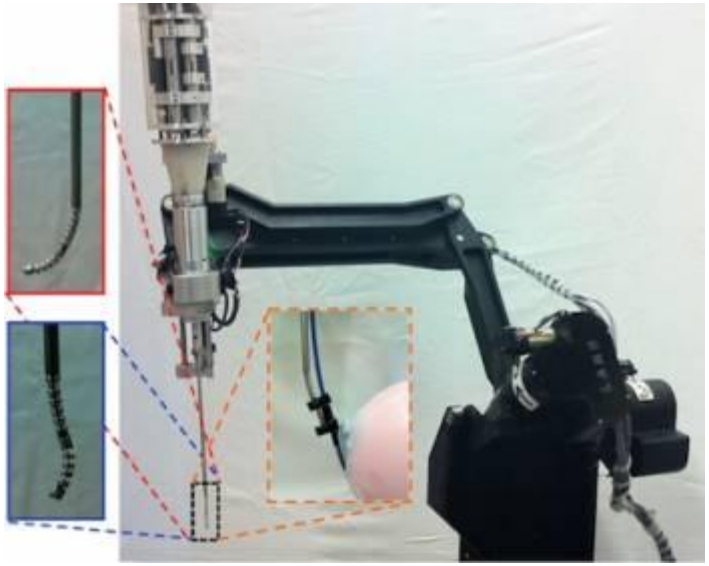


Image from: Tutkun Şen: *Elastography with LARSnake Robot*

Group 3

Team Members:

Piyush Routray
(MSE candidate in CS dept.)

Ashish Kumar
(MSE candidate in CS dept.)

Mentors:

Ryan Murphy

Ph.D Candidate
Dept. of Mech. Engg.
And
Associate Staff Member,
JHU/APL

Mike Kutzer

Senior Staff Member,
JHU/APL

Mehran Armand

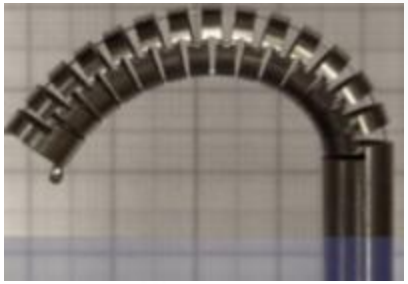
Adjunct Professor,
Dept. of Mechanical Engg.
and
Senior Scientist,
JHU Applied Physics Laboratory

Aim of The Project:

The main and static aim of our project is to interface the APL Snake end effector to the LARS and achieve end-point control of the same.

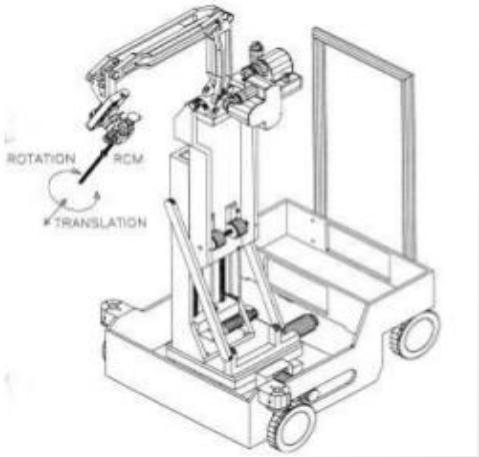
APL Snake:

- A surgical manipulator intended to be used in hip osteolysis removal surgery.
- It is capable of translating, rotating, and bending various degrees.



LARS:

- The Laparoscopic - Assisted Robot System
- 7 DOF Robot, facilitated by 7 motors and encoders for precision control.
- Controlled using DMC 40x0 controller provided by Galil Motion Control. (We are using DMC 4080.)



Background and Significance

- The APL Snake was initially developed with an intention of use in hip osteolysis removal surgery.
- Various potential applications have been thought of since development, such as use in heart surgeries etc.
- Constantly being upgraded to be a self sustained surgical tool.
- Intuitive control interface for the manipulator, has since, been designed and integrated with the snake using PHANTOM® Premium haptic controller.
- LARS is an ideal system to aid autonomous operation of the APL Snake due to its mobility, dexterity, and versatility of use with various end-effectors.

Technical Summary of Approach

- Understanding 'Galil Suite' and DMX Controller of the LARS.
- Develop understanding of CISST Library .
- Repair the LARS and get it up and working.
- Calculate the inverse kinematics equations of the LARS.
- Simulate the above on MATLAB.
- Implement end-point control using a dummy snake.
- Achieve 3D registration and alignment with the insertion axis.
- Come up to terms with Snake Robot control software.
- Configure snake in desirable positions.

List of Deliverables

Minimum: (Expected by ___?)

Fix the LARS———————————————————-→(Feb 28th)

End-point control———————————————→(Mar 28th)

Expected:

3D Registration and alignment with insertion axis– →(Apr 18th)

Maximum:

Configure the Snake in any desirable alignment—-- →(May 2nd)

Demonstration of the same on cadaver————— →(May 9th)

Key Dates and Assigned Responsibilities

Date	Milestone to be achieved	Responsibility
Feb 7th	Finalization of 'Aims to be achieved'	Both
Feb 12th	Presentation of planned workflow	Both
Feb 14th	Understanding 'Galil suite' and DMX controller of the LARS	Both
Feb 28th	Getting the LARS completely ready	Piyush
Mar 7th	Algorithm for Registration	Ashish
Mar 14th	Calculation of Inverse Kinematics equations for the LARS.	Piyush
Apr 4th	End Point Control (with dummy snake)	Ashish
Apr 18th	Achieving alignment with insertion axis	Both
May 2nd	Configuration of snake in desired alignment	Both
May 7th	Preparation of Report & Poster	Both
May 13th	Final presentation	Both

List of Dependencies & Plan for Resolving

- **Requirement of parts/tools for replacement in the LARS.**

Prof. Taylor will be notified about the same by 15th February, 2013. We hope to have the items with us within the following two weeks. We can carry out the repairs with the resources, already available, till then.

- **Working platform/software with the snake.**

We hope to have a working platform/software which can control the snake's precision by 18th April 2013. This will allow us to implement accurate control of snake after mounting it on the LARS.

Management Plan

- Regular meeting with mentor(s) to summarize the developments **on Wednesdays, every week.**
- Updating the wiki by **every weekend** to reflect the work (thus updating the TA and Prof Taylor about our work).
- Maintaining a collection of literature review of publications in related field at the rate of at least **two papers per week**.

Reading List

- M. D. M. Kutzer, S. M. Segreti, C. Y. Brown, R. H. Taylor, S. C.Mears, and M. Armand, “Design of a new cable-driven manipulator with a large open lumen: Preliminary applications in the minimallyinvasive removal of osteolysis,” in *Robotics and Automation, 2011. ICRA 2011. Proceedings of the 2011 IEEE International Conference* on, 2011.
- J. Funda, R. Taylor, B. Eldridge, S. Gomory, and K. Gruben, “Constrained Cartesian motion control for tele-operated surgical robots,” *IEEE Transactions on Robotics and Automation,* vol. 12, pp. 453-466, 1996.
- Segreti, S.M.; Kutzer, M.D.M.; Murphy, R.J.; Armand, M.; , "Cable length estimation for a compliant surgical manipulator," *Robotics and Automation (ICRA), 2012 IEEE International Conference on* , vol., no., pp.701-708, 14-18 May 2012

- Further reading list shall be updated on the project wiki

THANK YOU