Integration of LARS and Snake Robots and System Development

600.446 Computer Integrated Surgery II

Project Proposal

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1) PROJECT SUMMARY

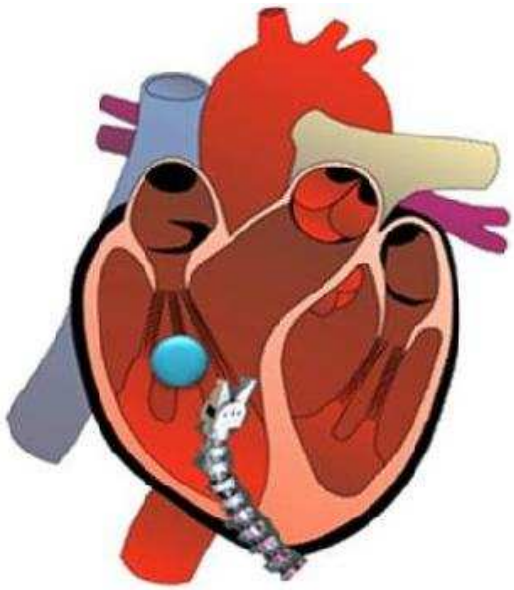

Figure-1

In case of explosions and various similar incidents, some particles such as shrapnel or bullet fragments can get stuck in the heart and impede cardiac function. The conventional approach is removal of the foreign body through open heart surgery, which comes with high perioperative risk and long recovery time.

To solve this problem, a minimally invasive surgical system is proposed for removing the foreign objects from a beating heart. Also it is claimed that, using this approach can reduce the mortality risk, improving postoperative recovery, and potentially reduce operating room times.

With the aim of solving this problem, the first thing to do is the integration of LARS Robot and Snake Robots in physical and software environments.

2) BACKGROUND & SPECIFIC AIMS

In this phase of the project that is summarized above, the aim is to integrate the LARS robot and Snake robot in the fashion shown on the above figure. So far both LARS robot and Snake robot are working on their own environments such that LARS and Snake Robots are accessible only in

WINDOWS environment and RTLinux environment respectively. The main focus of this project can be seen Figure-1 below.

In gathering information about the current LARS system "Teleoperation of LARS Robot" project proposal materials will be used. This project material may be used to come up speed with current status of LARS software.

The specific aims of the project can be listed as below:

1) Making the physical assembly of the system,
2) Getting to know the two software environments of both robots,
3) Making a kinematics analysis of the overall system,
4) Implementing the software integration,
5) Debugging the system software,
6) Using the united robot in the imaging experiments.

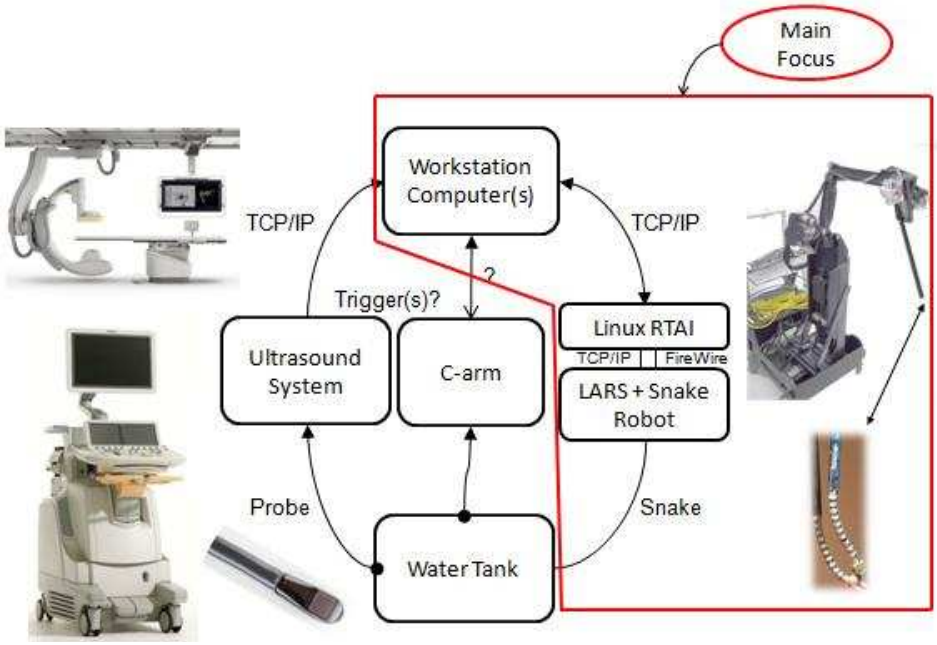

Figure-2

3) DELIVERABLES

Minimum:

1. Software development
2. Kinematics analysis of the integrated system
3. Software integration
4. Partial debugging of the integrated systems

Expected:

1. Software development
2. Kinematics analysis of the integrated system
3. Software integration
4. FULL debugging of the integrated systems

Maximum:

1. Expected + imaging experiments on medical school

4) TECHNICAL APPROACH

In implementing the integration of two robots the following procedures will be followed:

1. Counterweight fixture for snake on LARS robot and robot assembly
2. Software development.
   - I. Come up to speed with :
     - a. CISST Library
     - b. Snake Robot Control
     - c. LARS Robot Control
   - II. Devise some schemes of integration e.g. :
     - a. Programming both robots on RTLinux,
     - b. Running only the snake robot on the slave computer such that Windows runs the overall system.
3. Kinematics analysis of the overall system. **(milestone-1)**
   - I. Set up the kinematics equation of the overall system
   - II. Make a visual demonstration of the system as a verification tool
     - a. Using MATLAB, MATHCAD or Excel
4. Software integration. **(milestone-2)**
   - I. Learn API for the Snake robot and test its API in the LARS robot (the test may be running on the LARS robots with just RTLinux)
   - II. Integrate the software of both LARS and Snake robots
   - III. Modify the system code using new kinematics
5. Debugging the systems and testing it.**(milestone-3)**
   - I. Develop different tests for different parts.
     - a. Offline text output files.
     - b. Inline hardware simulator.
   - II. Test the individual joints or actuators and compare the results with their old software.
   - III. Use Phantom Omni to make sure that it is working properly.
6. Making imaging experiments in the medical school.

5) PROJECT TIMELINE

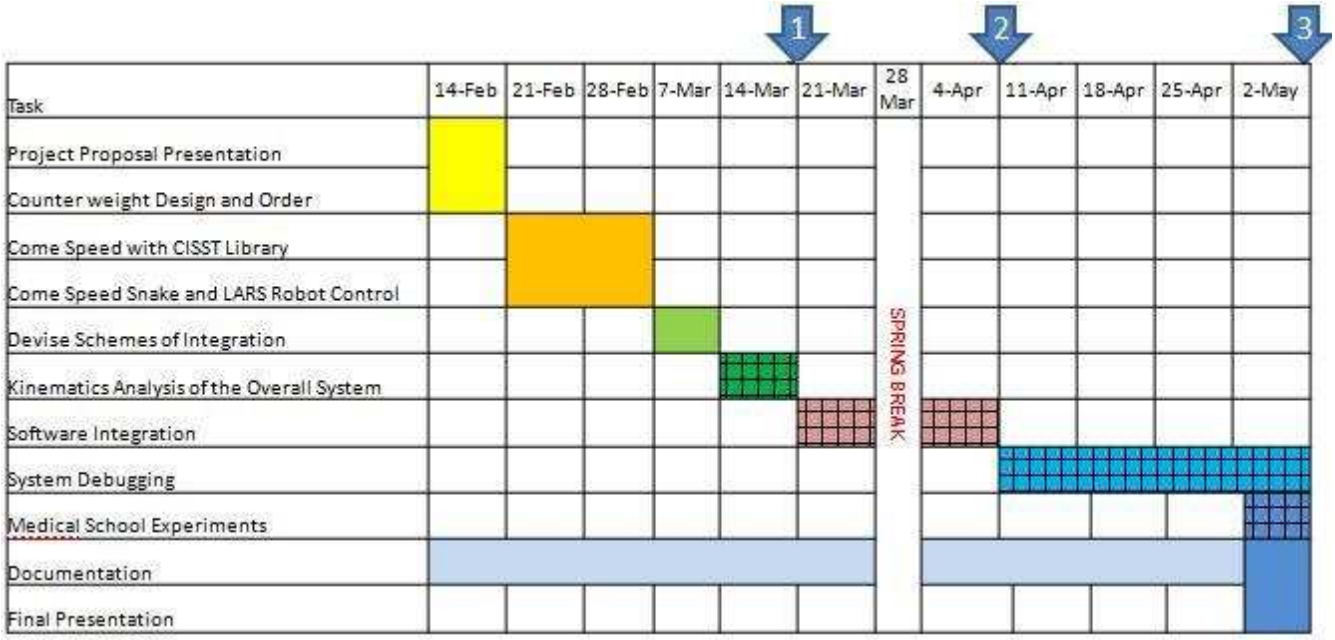

Table 1

The project timeline can be seen in the above Table-1.

6) PROJECT BIBLIOGRAPHY

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[2] A. Kapoor, M. Li, and R. Taylor. Constrained Control for Surgical Assistant Robots. IEEE Int'l Conf. on Robotics and Automation. pp. 231-236. May 2006.

[3] A. Kapoor. Motion Constrained Control of Robots for Dexterous Surgical Tasks. Johns Hopkins University Ph.D. Thesis. Sept, 2007

[4] Additional readings on Seth Billings and Ehsan Basafa CIS 2 project proposal report on " Teleoperation of LARS Robot"