



JOHNS HOPKINS
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Evaluation of Virtual RCM for MIS

Team members:

Yernar Zhetpissov

Mentors:

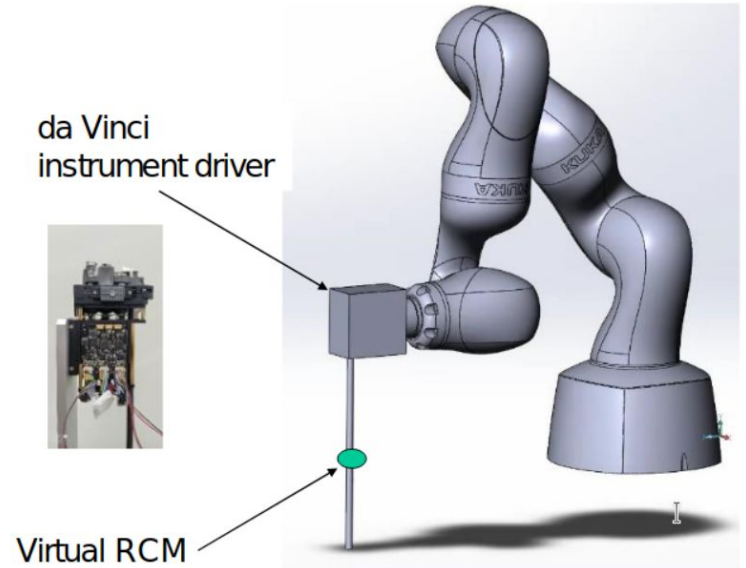
Peter Kazanzides, Adnan Munawar

03/01/2022 Computer Integrated Surgery II

Project background

- ▶ Minimally invasive surgery (**MIS**) requires Remote Center of Motion (**RCM**)
- ▶ Not everyone has access to special MIS surgical systems
 - ▶ daVinci
- ▶ Feasibility of robot manipulators (e.g. UR5) applied for MIS task?
- ▶ Dynamic simulator **AMBF**

Project Goal: Implement and evaluate virtual RCM for MIS in AMBF simulator.



Asynchronous Multi-Body Framework (AMBF)

- ▶ multi-body framework offering a real-time dynamic simulation of robots
- ▶ real-time haptic interaction via several haptic devices



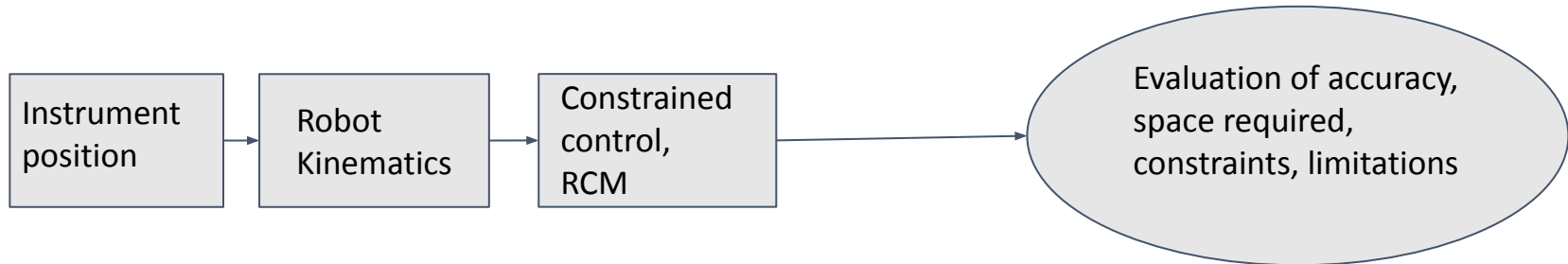
Tasks

Goal/Importance: The project would help to evaluate feasibility (and constraints) of manipulator arms applied in bimanual MIS tasks

- ▶ **Implement** UR5 kinematics models and plugins (RCM) in AMBF
- ▶ **Implement** constrained optimization for virtual RCM implementation
- ▶ **Evaluate** space constraints, joint constraints

Approach summary

- AMBF plugins/ROS packages using **C++**
- UR5 **control** using ROS UR5 driver OR <https://github.com/jhu-saw/sawUniversalRobot>
- Constraint optimization for controlling an instrument respecting RCM constraints
- Use sawConstrainedController package to implement RCM [<https://github.com/jhu-saw/sawConstraintController>]
- Evaluate implemented virtual RCM using recorded positions of instruments while performing bi-manual MIS task

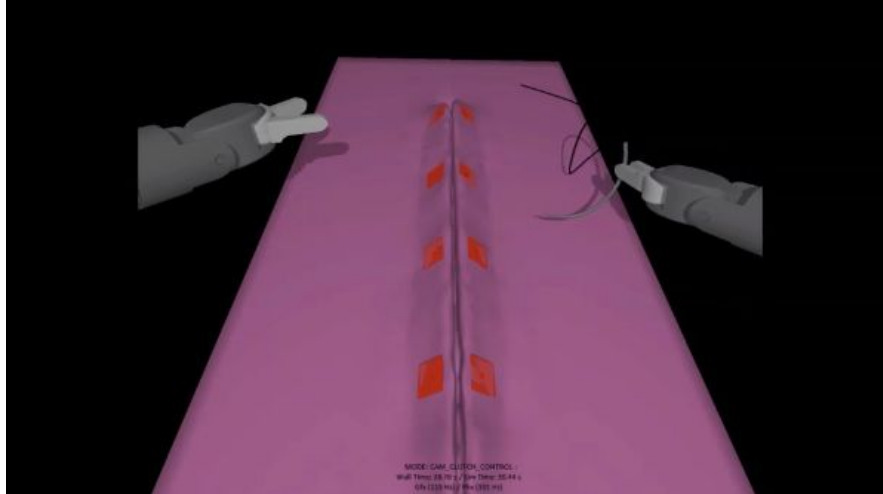


Deliverables

min: UR5+dVrk instrument kinematics models and RCM plugins/packages integrated with AMBF

expected: Evaluation report using recorded bag data on UR5

max: Demonstration on real UR5 with mock instrument driver attached



Milestones+Schedule

		Weeks 3-5	Week 6	Week 7	Week 8	Week 9	Week10	Week11	Week12	Week13	Week14
Setup	AMBF Installation										
	Study AMBF wiki										
UR5 model	UR5 CAD model import										
	Forward & inverse Kinematics										
	Manipulator Jacobian										
UR5 control+RCM	study sawConstraintsControl pkg										
	integration of UR5 control driver with AMBF										
	RCM implementation										
Evaluation	Testing stage										
	Evaluation stage										
	Evaluation report										
Demo on real UR5											

List of dependencies

1. Linux workstation (**done**)
2. Recorded Cartesian motion of two da Vinci instruments working on a bimanual task, such as the suturing task in the AccelNet Surgical Robotics Challenge. **Ready recorded data to be provided OR will record by myself**
3. Robot and daVinci instruments (provided by prof.Kazanzides)

Management plan

- Progress tracking Zoom meetings with mentors (every 2 weeks):
 - Peter Kazanzides (RCM)
 - Adnan Munawar (AMBF)

- On-demand Zoom meetings for clarifications and questions

- Communication through emails
- Implementation management via Github
- Files management through OneDrive

Reading list

A. Munawar and G. S. Fischer, "An Asynchronous Multi-Body Simulation Framework for Real-Time Dynamics, Haptics and Learning with Application to Surgical Robots," 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2019, pp. 6268-6275, doi: 10.1109/IROS40897.2019.8968594.

A. Munawar, Y. Wang, R. Gondokaryono and G. S. Fischer, "A Real-Time Dynamic Simulator and an Associated Front-End Representation Format for Simulating Complex Robots and Environments," 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2019, pp. 1875-1882, doi: 10.1109/IROS40897.2019.8968568.