VR-Guided Skull Base Surgery

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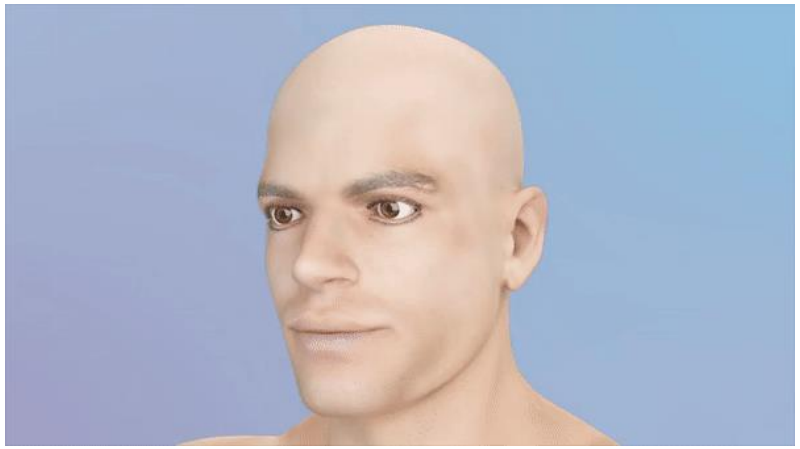
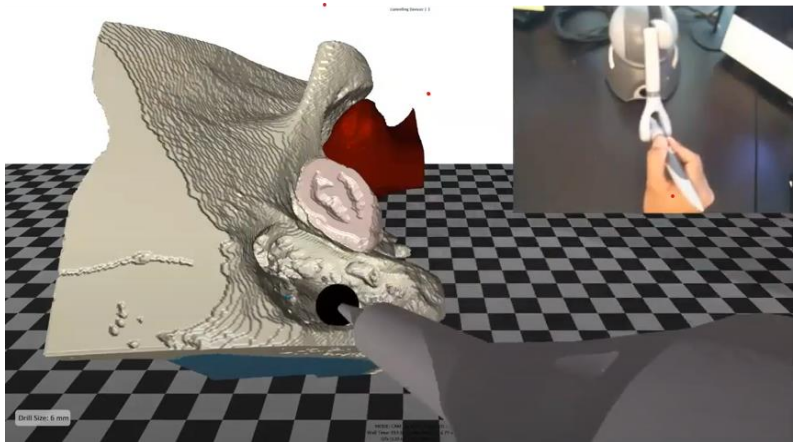
Mentors: Max Li, Dr. Adnan Munawar, Dr. Francis Creighton, Prof. Mathias Unberath, Prof. Russ Taylor

Project Background



Context Situation Awareness



Actual Surgical State

Simulated Surgical State

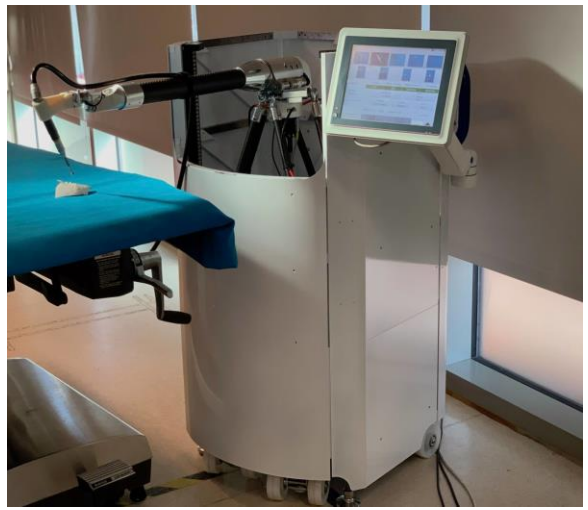
Video credit:
[1] https://www.youtube.com/watch?v=jnonLwxW2Cg

[2] Munawar, A., Li, Z., Kunjam, P., Nagururu, N., Ding, A.S., Kazanzides, P., Looi, T., Creighton, F.X., Taylor, R.H. and Unberath, M., 2021. Virtual reality for synergistic surgical training and data generation.

Current State

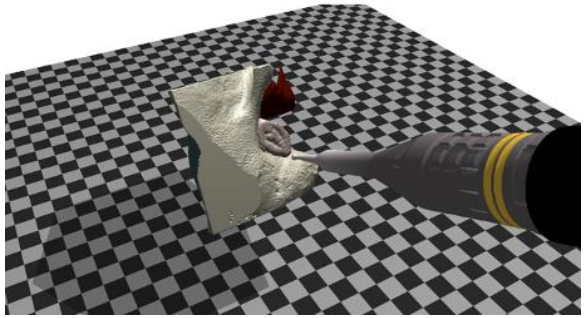
Galen Surgical System:

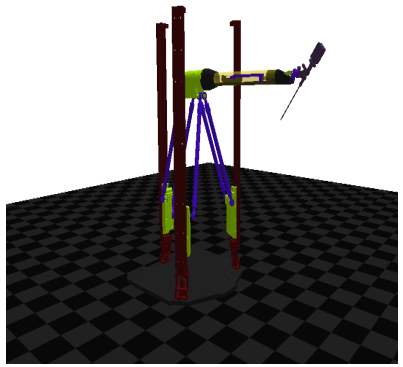
- 5-Dof: 3 translation, 2 rotation
- Admittance based control using 6-Dof force sensor



Simulator:

- Asynchronous Multi-Body Framework (AMBF)
- Volumetric drilling
- Galen robot model
- Haptic force feedback



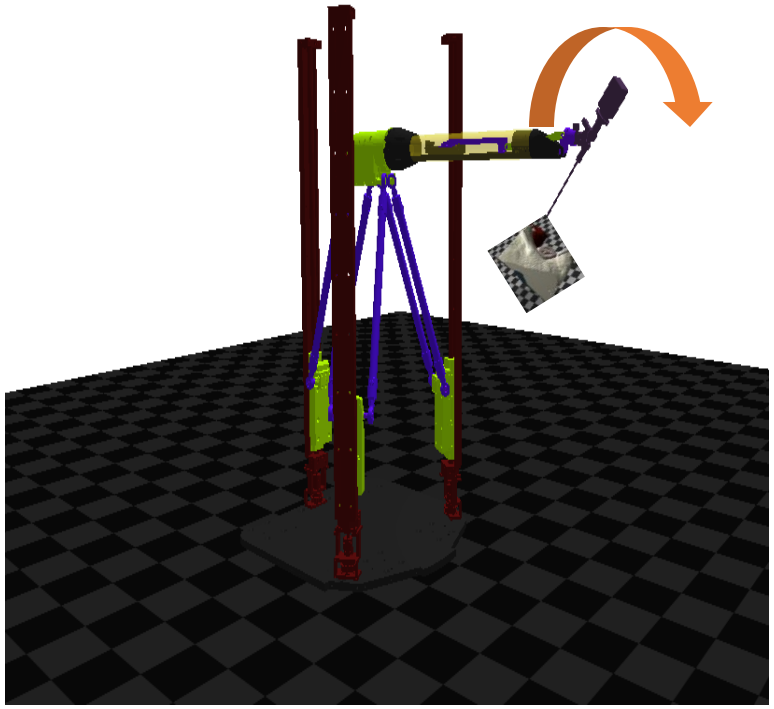


Source: https://github.com/LCSR-SICKKIDS/volumetric_drilling

Project Goals

- Create virtual environment in AMBF for skull-base surgery with at least the following components:
  - Galen Robot
  - Skull-base Model
- Sync Galen robot in VR space with physical Galen robot.
  - Establish mode of communication between robot and AMBF simulation
  - Develop control scheme to keep both in sync:
    - Movement in physical robot is mapped to the virtual space.
    - Movement and constraints in virtual space reflected in physical robot.

Technical Overview



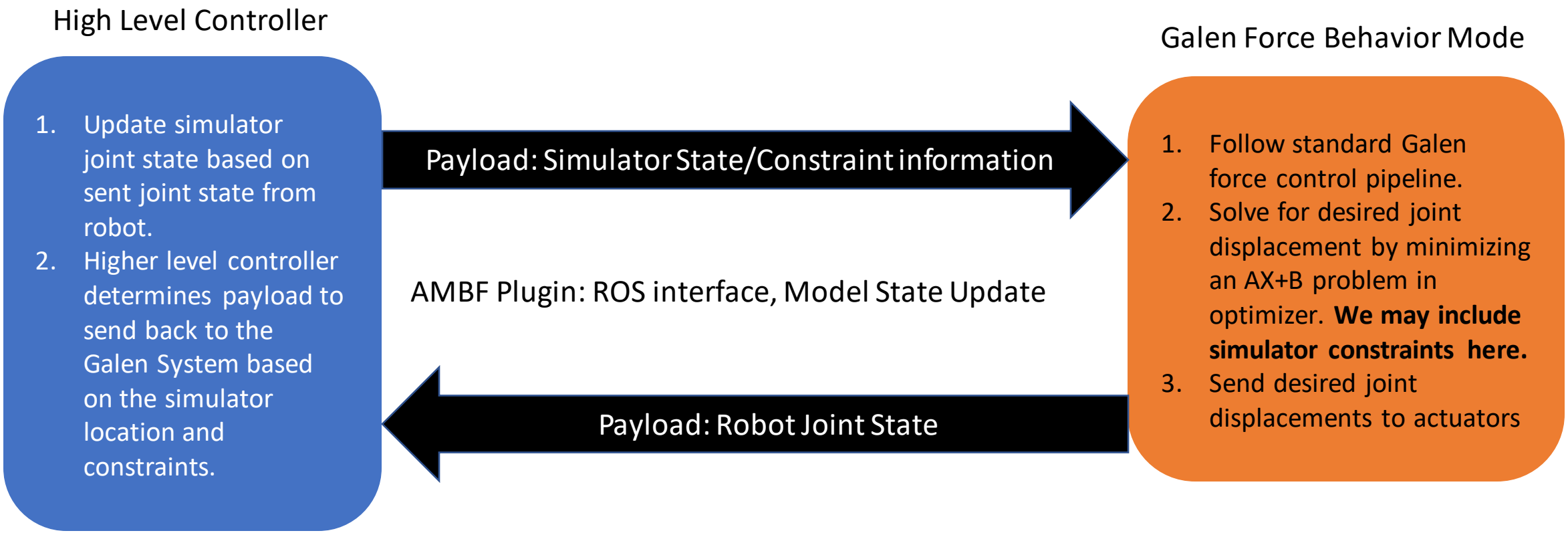
Constraints

Robot State

[3]

[3]: Cohn, M. (2019, November 6). *This tech company is the first to get a boost from moving to a Baltimore Opportunity Zone. are more coming?* baltimoresun.com. Retrieved February 15, 2022, from https://www.baltimoresun.com/business/bs-bz-opportunity-zone-business-20191106-n7fxg3wpuvah5fyuoulf47kes4-story.html

Technical Approach



Deliverables

- **Minimum:** Working Software and Documentation for VR - robot communication, including:
  - Controls to keep physical Galen in sync with simulated Galen
  - AMBF simulated environment with all relevant components. Registration assumed to be provided/fixed.
- **Expected:** Interfaces developed for ease of integration with registration and SDF teams. Any additional UI components or scripts for updating settings/modes to improve usability.
- **Maximum:** Conduct Internal User Study

Dependencies

Dependencies	Who to contact	Status/Date	Failure Consequences	Resolution
Mentor Availability	Mentors	Meetings Schedule Set	Insufficient feedback may impact quality of project	Weekly meetings set up with mentors
Linux System	LCSR	Acquired	Available in MockOR. Availability issues may set timeline back.	Schedule ahead of time on shared calendar for shared use
Galen Surgical System	Galen Robotics, Inc	Acquired	Available in MockOR. Availability issues may set timeline back.	Schedule ahead of time on shared calendar for shared use
Desktop and monitors for running software	LCSR	Acquired	Available in MockOR. Availability issues may set timeline back.	Schedule ahead of time on shared calendar for shared use
Surgical Drill	LCSR	Acquired	Testing Synchronization could be impacted.	Reach out to LCSR for acquiring tool if unavailable.
C++, Python, OpenGL, ROS	Open Source	Acquired	Publicly available	N/A
HTC Vive Pro VR Headset	Max Li	Acquired	Available in MockOR. Availability issues may set timeline back.	Schedule ahead of time on shared calendar for shared use

Management Plan

- Team communications over Slack
- Weekly group member meeting on Wednesday
- Additional weekly meeting with mentors on Friday
- Files and resources stored in team One Drive.
- Source code will be controlled in Github/Bitbucket repository

Timeline

#Week 1-3	4	5	6	7	8	9	10	11	12	13	14	15-16
Preparation	Presentation											
	Simulation follows robot											
		Robot gets feedback from simulation										
			Add “Volumetric Drilling” to Galen World	Finetune Robot mesh models in virtual world								
				Assemble and test combined virtu al environment	Testing synced Robot and simulation							
						VR Support						
							Interface for combining other groups' work					
							Usability improvement					
								Working towards maximum deliverables				Final Report Final Presentation

Questions?