Collateral Control for Surgical Training

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Background

https://www.researchgate.net/profile/HWR_Schreuder/publication/23657822/figure/fig1/AS:276991791124480@1443051397492/da-Vinci-S-HD-robotic-system-surgeons-console-patient-side-card-with-robot-arms-InSite.png

1. https://davinci.imedhospitales.com/en/robotic-system-da-vinci/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6924504/
3. https://futurism.com/the-byte/surgeons-barely-trained-operating-robots

- Approximately 3800 Da Vinci Surgical Systems have been deployed around the world (1).
- Current training curriculums are composed to minimum hours under training modules, certification of passing training modules every 6 months, bedside experience with robotic surgeries, minimum number of operations as console surgeon under supervision and a few other requirements (2).
- Although some programs are effective, standardization of robotic surgical training is still lagging far behind, with many licensed operators lacking thorough training (3).
- Much of this lack of training comes from the inability to get hands on experience with the machines for actually practice (3).

Goals

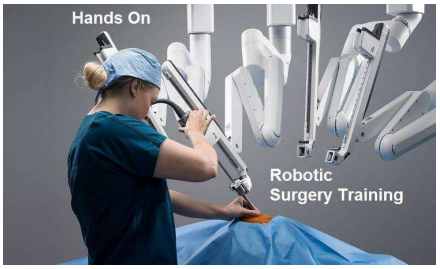
We have 3 main goals for this project:

1. Implement dual console control in the AMBF simulator
2. Create new training puzzles of varying difficulties to test different skills and operations in AMBF simulator
3. Conduct user studies to evaluate the effectiveness of varying levels of shared control on

Significance

- With over 170 surgeons worldwide operating Da Vinci machines world wide, it is crucial that thorough and effective training techniques are widely available to everyone (3).
- Creating new, innovative shared control systems may significantly decrease training times and acquisition of proficiency by surgical residents, allowing them to hone their skills and gain more efficient hours of training under simulations.
- This would allow for more standardized robotic surgery training curriculum practices, improving overall care provided, increasing procedure effectiveness and streamlining surgical training processes.

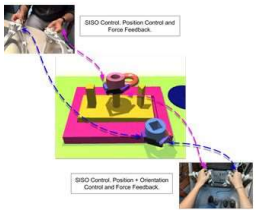
https://www.abc.net.au/news/image/8446084-3x2-700x467.png

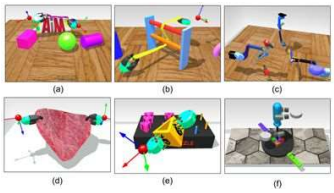


https://www.laparoscopyhospital.com/slide/upload/22_r2.jpg

Approach

- Using the AMBF (Asynchronous Multibody Framework) simulator and its existing shared control systems, 2 new shared control schemes will be developed in an effort to help improve learning efficiency and instructive collaboration
- 6 puzzles of varying difficulty (Easy, Medium, Hard) will be developed in order to test proficiency in performing certain manipulations in the simulator
- Use dVrk to test shared control systems and puzzles ourselves during development
- A user study will be performed with approximately 30 candidates and 2 experts (surgeons or surgical residents with experience) in order to determine whether shared control systems help with learning efficiency and effectiveness, in comparison to individual practice.
- Data for the user study will be collected through built in scripts, some of which already existing in the framework





Deliverables

Minimum	Implementation of a dual console/shared control with dVRK system and AMBF simulator, 5-6 puzzles to be used in study, design user study and collect mock data.
Expected	Dual console/shared control, puzzles, data acquisition script, and conduct user study with actual subjects.
Maximum	All of the above along with writing a paper on results of user study.

Dependencies

Item	Description	Importance (out of 5)	Needed By	Status	Alternatives	Main Contact
Homewood IRB approval	Approval to conduct user study	4	4/17	In progress	Use mock data to prove concept	Dr. Russ Taylor
Blender Software	Used to create puzzles for simulator	3	2/19	Resolved	Google Sketchup or similar software	Dr. Adnan Munawar
AMBF Simulator source code	Environment for puzzles and dVRK inputs	5	2/19	Resolved	N/A	Dr. Adnan Munawar
Computer running MacOS or Linux	For general computing purposes	5	2/19	Resolved		

Dependencies cont.

Item	Description	Importance (out of 5)	Needed By	Status	Alternatives	Main Contact
J-Card Access to JHU Robotarium	For access to dVRK consoles	4	2/28	In progress	Arrange times with Adnan to be let into Robotarium	Dr. Adnan Munawar
Subjects for user study	Consenting surgeons and/or trainees to participate in study	3	4/10	In progress	Generate mock user data for proof of concept	Dr. Russ Taylor
Data Collection Script	For collecting user study data	3	4/10	In progress	Collect data manually	Dr. Adnan Munawar
Repo for puzzles and shared control schemes	Shared repo for team to have access to all files	4	2/28	Resolved		

Timeline

Task	Planned Start Date	Expected Finish Date	Status
Familiarization with AMBF simulator and dVRK environment	2/12	2/28	In progress(On time)
Complete request for Homewood IRB approval	2/22	2/28	In progress(On time)
Implementing dual-console control in AMBF simulator	2/28	3/27	Not started
Design puzzles for user study	2/28	3/27	Not started
Testing dual-console collateral control with dVRK	3/9	3/27	Not started

Timeline cont.

Task	Planned Start Date	Expected Finish Date	Status
Write and test data acquisition script	3/30	4/10	Not started
Finalize procedure for user study	3/30	4/17	Not started
Conduct user study	4/20	5/1	Not started
Write final report/paper/poster	5/1	5/5	Not started
Write user study paper	5/5	5/13	Not started

Milestones

Milestone	Achieved by
Submit Request for Homewood IRB approval	2/28(at the very latest)
Dual Console control in AMBF and Full set of puzzles created	3/27
Data acquisition script written	4/10
User study	5/1
Final Report/Paper/Poster	5/5
User Study paper	5/13

Management

Bryan's Responsibilities:

- One shared control system
- 3 puzzles
- Design User study
- Create final poster presentation and paper
- Write paper on user study results (time permitting)

Joao's Responsibilities:

- One shared control system
- 3 puzzles
- Code data collection script
- Create final poster presentation and paper
- Write paper on user study results (time permitting)

- Arranged bi-weekly team meetings on Wednesdays and Fridays (3-4:30pm or longer if available)
- Created team slack workspace for communication amongst ourselves and Dr. Munawar with an average of one meeting a week (times may vary)
- Coordinated with Adnan for use of dVrk when necessary after Robotarium access has been granted

Reading List

Bric, Justin D, et al. “Current State of Virtual Reality Simulation in Robotic Surgery Training: a Review.” *Surgical Endoscopy*, U.S. National Library of Medicine, June 2016, www.ncbi.nlm.nih.gov/pubmed/26304107.

Bric, Justin, et al. “Proficiency Training on a Virtual Reality Robotic Surgical Skills Curriculum.” *Surgical Endoscopy*, U.S. National Library of Medicine, Dec. 2014, www.ncbi.nlm.nih.gov/pubmed/24946742.

Lerner, Michelle & Ayalew, Mikias & Peine, William & Sundaram, Chandru. (2010). Does Training on a Virtual Reality Robotic Simulator Improve Performance on the da Vinci (R) Surgical System?. Journal of endourology / Endourological Society. 24. 467-72. 10.1089/end.2009.0190.

Moit, Harley, et al. “A Standardized Robotic Training Curriculum in a General Surgery Program.” *JSLS : Journal of the Society of Laparoendoscopic Surgeons*, Society of Laparoendoscopic Surgeons, 2019, www.ncbi.nlm.nih.gov/pmc/articles/PMC6924504/.

Sridhar, Ashwin N, et al. “Training in Robotic Surgery-an Overview.” *Current Urology Reports*, Springer US, Aug. 2017, www.ncbi.nlm.nih.gov/pmc/articles/PMC5486586/.