Customizing Semi-Autonomous Nursing Robots using Human Expertise

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Summary

- Collaborative project between UIUC Engineering (Hauser) and Duke School of Nursing (Shaw) to develop trainable supervisory control interfaces for tele-nursing robots
- Direct applications: nursing in quarantine areas; infectious diseases, immunocompromised patients
- UIUC: fabricating the TRINA 2.0 hardware platform, devising semi-autonomous primitive tasks, and trainable user interfaces (UIs)
- Duke: user studies with RNs (experts) customizing the UI for nursing students (novices) in nursing tasks

Prior work

Tele-Robotic Intelligent Nursing Assistant (TRINA)

- Developed with NSF RAPID funding in response to 2014 Ebola outbreak [1]
- Bimanual mobile manipulator, with bidirectional telepresence, vision sensors, health monitoring eqpt

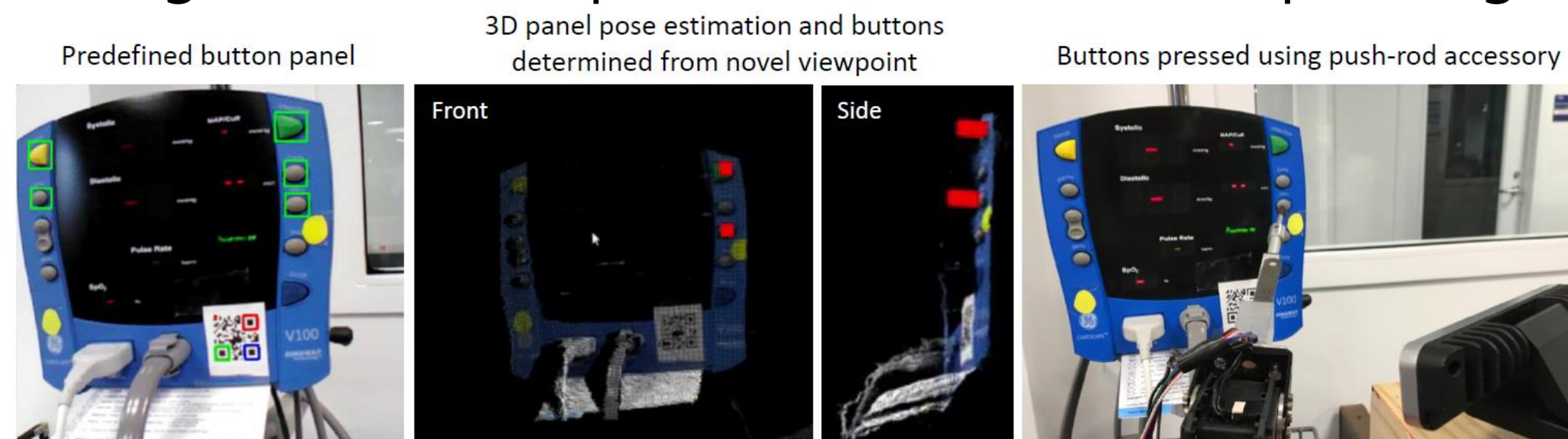*Direct teleoperation:* 19/26 nursing tasks feasible, but 50-200x slower than a human nurse

Automated task: Personnel Protective Equipment (PPE) donning and doffing via PbD [2]

Project Vision

Primitive tasks

Navigation, button panel identification and pressing [3]

Predefined button panel | 3D panel pose estimation and buttons determined from novel viewpoint | Buttons pressed using push-rod accessory

This year: pick and place, articulated object manipulation, wiping, force controlled pulling, pushing

Foundational components

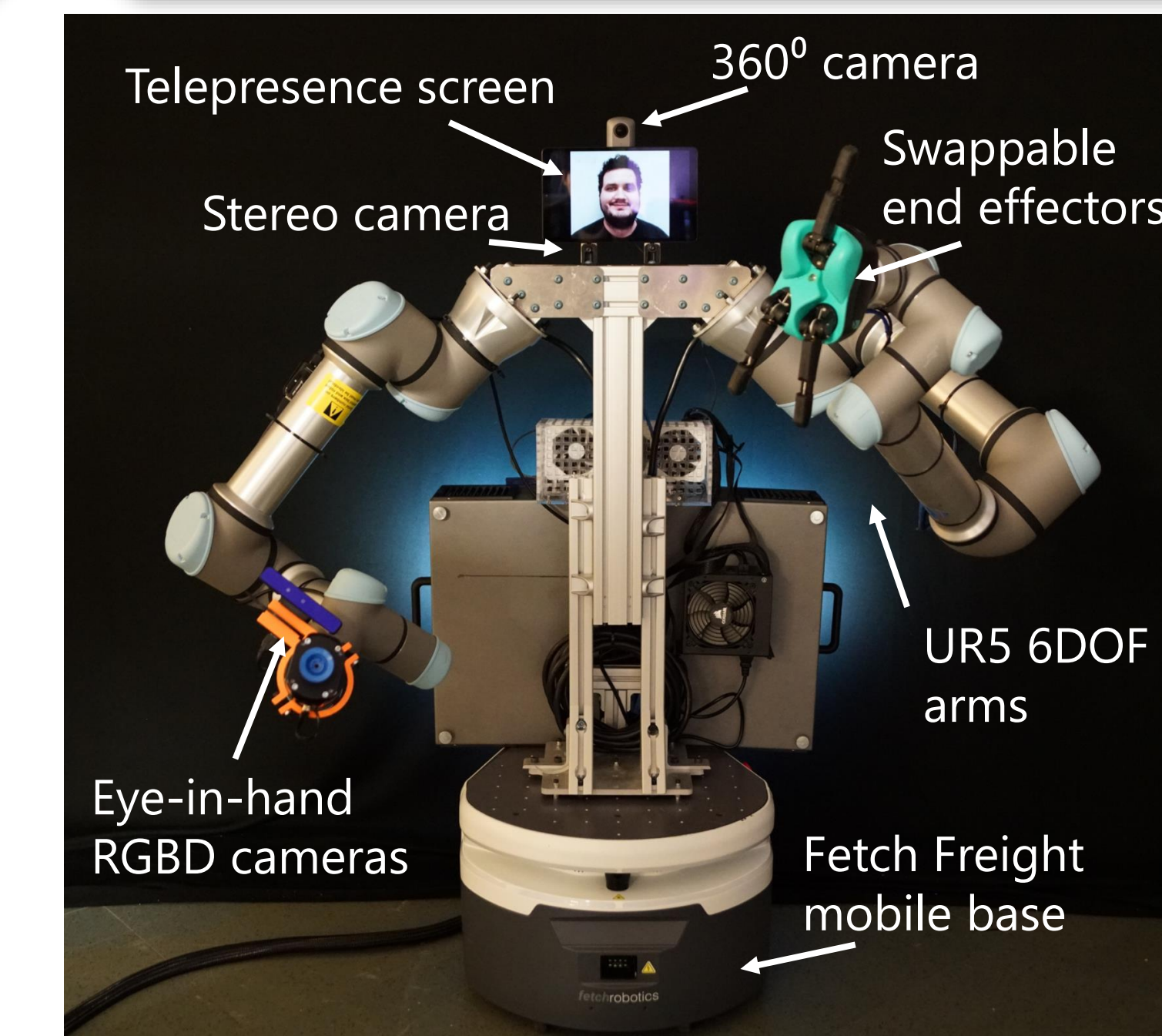Rapid object scanning via in-hand object manipulation [4]
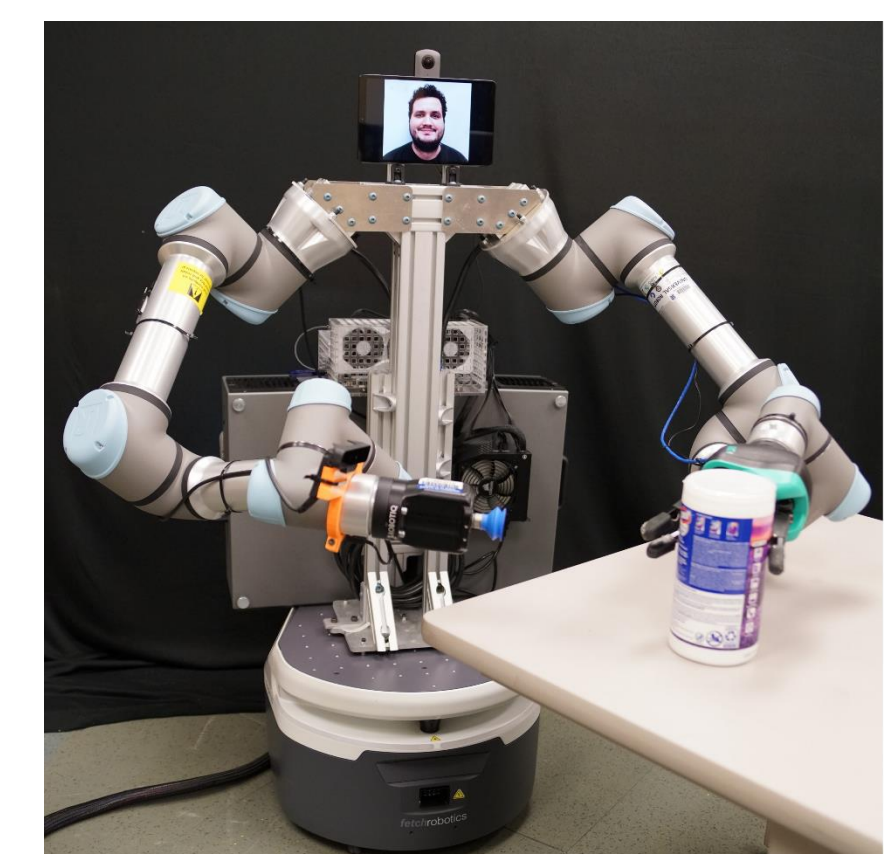

Cooperative real-time motion planning

Technical Challenges

- Design and fabrication of TRINA 2.0
- Implementation of reliable (95%) autonomous primitives
- Human-interpretable database of objects, locations, poses, motions
- Hierarchical task customization involving conditions, loops
- Contextual, most-likely task inference
- Implementation and testing on mobile GUI

Current progress

Telepresence screen · 360° camera · Stereo camera · Swappable end effectors · Eye-in-hand RGBD cameras · UR5 6DOF arms · Fetch Freight mobile base

TRINA 2.0 90% complete. Lift/bend torso, torso laser sensor in development
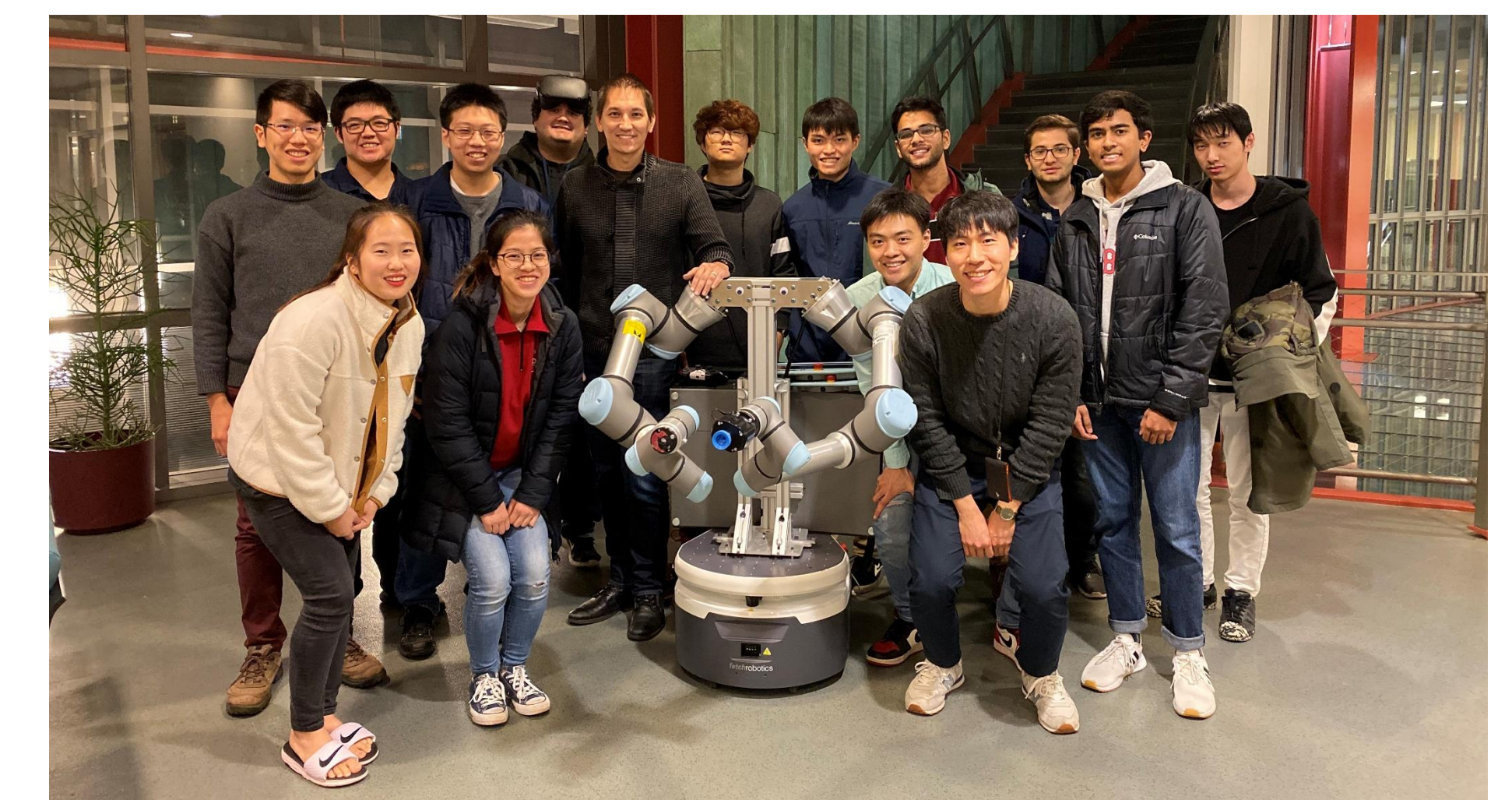
Enable operator control using commodity VR devices + tablets

SW infrastructure for direct teleoperation complete, now refining semi-autonomous primitives

Synergistic relation with ANA AVATAR XPrize

Fall 2019 UIUC TRINA group (9 UG, 1 Master's, 3 PhD)

References

[1] Z. Li, P. Moran, C. Dong, R. Shaw, and K. Hauser. *Development of a Tele-Nursing Mobile Manipulator for Remote Care-giving in Quarantine Areas.* ICRA, 2017

[2] T. Lu, H. Bader, and K. Hauser. *The Design and Doffing of Personal Protective Equipment for Healthcare Robots.* Military Health Systems Research Symposium (MHSRS), August 2018.

[3] F. Wang, K. Hauser. *Robot Button Pressing in Human Environments.* ICRA 2018

[4] F. Wang, K. Hauser. *In-hand Object Scanning via RGB-D Video Segmentation.* ICRA, 2019.