Robotic Limb Repositioning with Supervised Autonomy

Human-Centered Robotics Lab

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THIS WORK IS OUR INITIAL EFFORTS TOWARDS DEVELOPING **A ROBOTIC LIMB REPOSITIONING SYSTEM**.

Our approach combines programming by demonstration and end-user programming in a tele-manipulation system that includes the user in the loop. The system is based on a general-purpose mobile manipulator and a web interface where a user can select, edit, preview and execute different repositioning exercises based on the selected limb. This approach shows the potential to empower people who have mobility impairments to be more involved in an activity of daily living.

Motivation & Background

> Globally +1 billion people have a disability, ~15% of the world population. [1]

> There is a severe global shortage of 7.2 million healthcare providers. [2]

> Repositioning patients every 2 hours is important to prevent pressure sores that cause serious infections and life-threatening complications. [3]

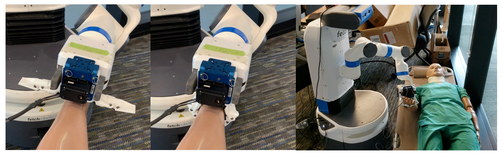
> Robots have immense potential to provide repositioning assistance.

> Robot tele-operation with Rviz Interactive markers is slow and inaccessible. [4]

Platform

Robot	Fetch Mobile Manipulator
Gripper	EZGripper™ from SAKE Robotics
Mannequin	Simple Simon Patient Care Mannequin from 3B Scientific

EZGripper™ from SAKE Robotics



EZGripper™ attached to Fetch is grasping the wrist of the human mannequin.

Approach: Programming by Demonstration

HOW OUR SYSTEM FUNCTIONS CONCEPTUALLY:

STEP ONE

> Caregivers manually move the robot arm to complete limb repositioning movements.

> Trajectory of the movements are stored as waypoints in database.

STEP TWO

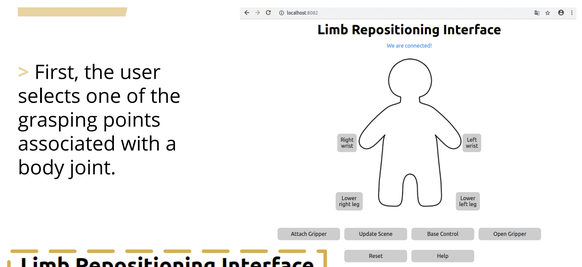
> User selects a limb repositioning movement.

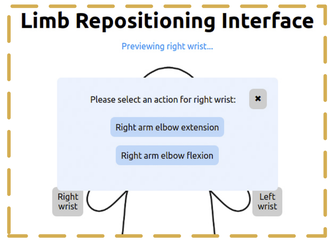
> The program aligns the trajectory to the current grasping position.

> Robot performs the action.

Approach: Web Interface

> First, the user selects one of the grasping points associated with a body joint.

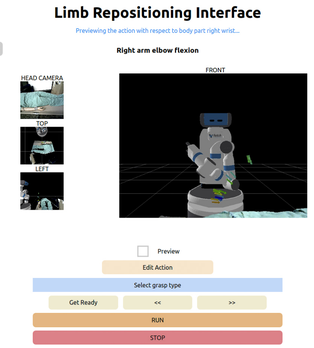


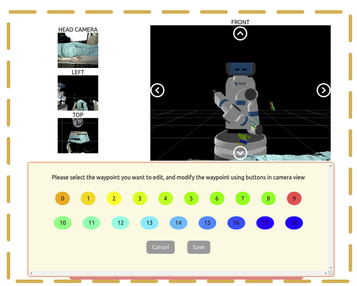


> Then, a menu appears displaying all available movements for that grasping point.

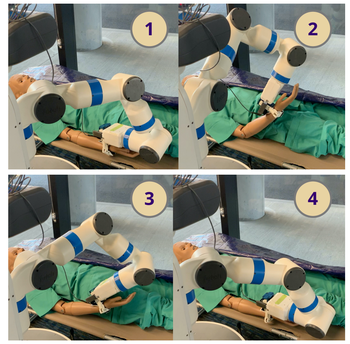
> Once a movement is selected, the interface shows multiple views from the robot's perspective and a visualization of the selected trajectory in space.

> The user can choose to step through each waypoint of the trajectory or execute the whole trajectory at once.

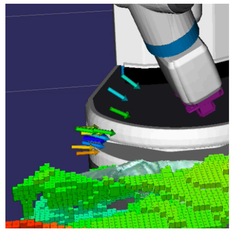




> Users can also choose to adjust existing waypoints on the trajectory using arrow buttons from each camera view to customize repositioning movements.



Fetch Mobile Manipulator performing right arm elbow flexion



Visualization of waypoints in Rviz

Future Work

> Improve accuracy of the robot grasping body parts.

> Evaluate the safety robustness and success rate of the system performing limb repositioning actions.

> Evaluate the system by stakeholders such as occupational therapists, physicians and potential end users to gather their feedback and use it for a user study.

References

[1] https://www.worldbank.org/en/topic/disability
[2] http://www.who.int/mediacentre/news/releases/2013/health-workforce-shortage/en/
[3] https://medlineplus.gov/pressuresores.html
[4] Story, Molly Follette, Erin Schwier, and June Isaacson Kailes. "Perspectives of patients with disabilities on the accessibility of medical equipment: Examination tables, imaging equipment, medical chairs, and weight scales." Disability and health Journal 2.4 (2009): 169-179.

Acknowledgement

This work was supported by the National Science Foundation (USA) award IIS-1552427 "CAREER: End-User Programming of General- Purpose Robots."