Kinesiological Control of Teleoperated Robot Manipulators

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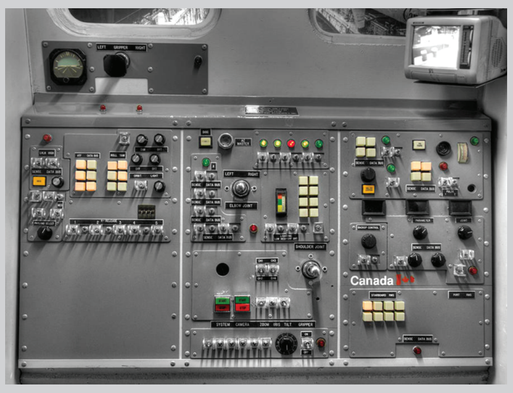
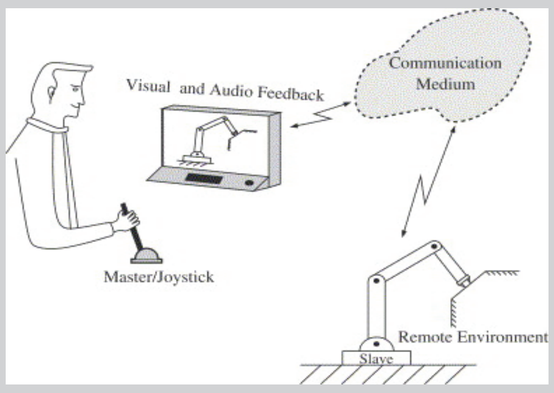
Motivation

As telepresence becomes more pervasive, it would be advantageous to allow physical interaction with the environment. Today robot arms are operated using joysticks and knobs. Is there a better way?

In this work we study the effect of kinesiological robot arm control on novice user task performance and perception for different task modalities.





Results

Performance

Performance was similar for joystick control and kinesiological+ control for both task types.

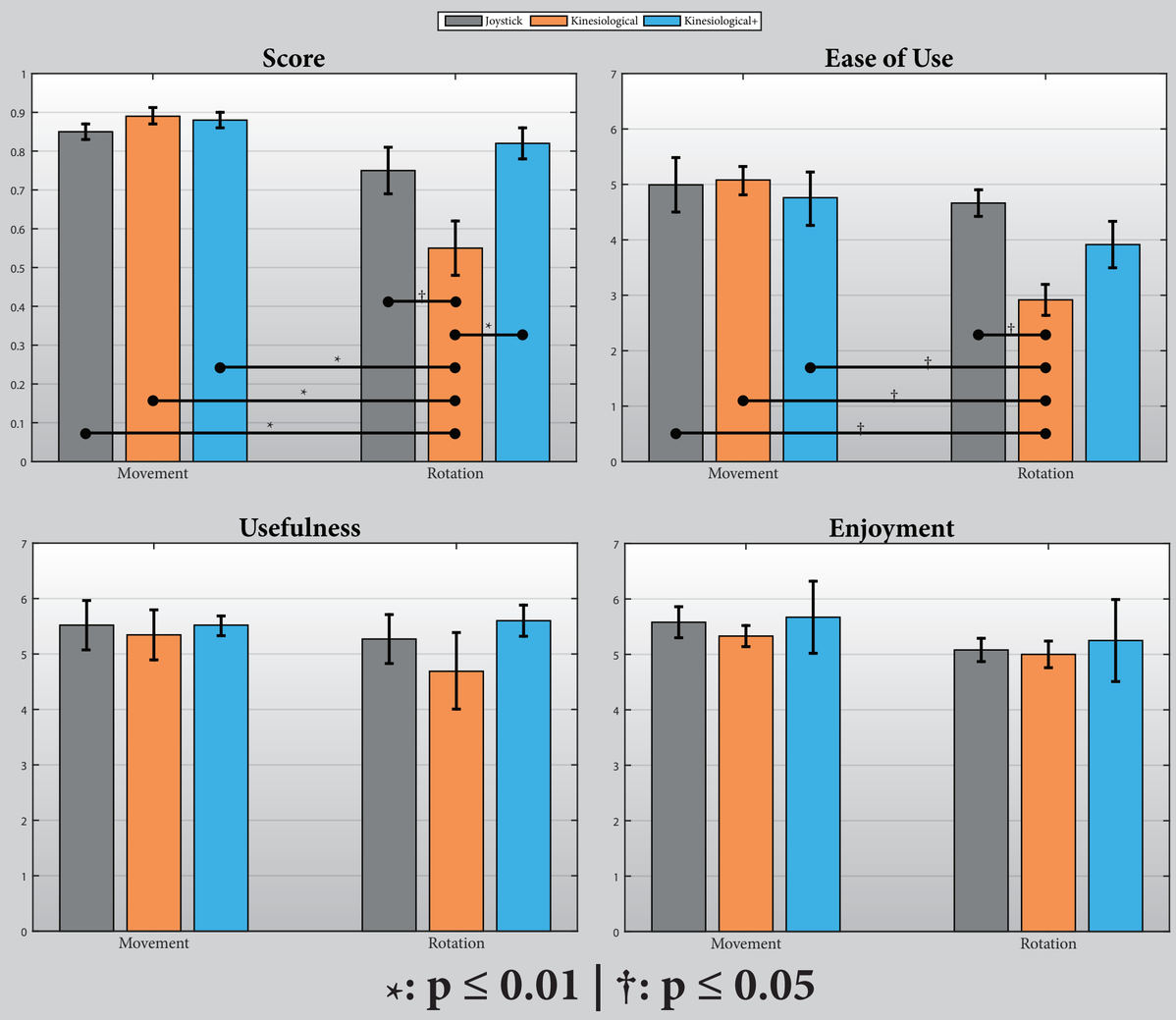
Performance for the movement task was not effected by control type.

Performance for the rotation task was impaired by kinesiological control.

Perception

Ease of use was significantly reduced by kinesiological control for the rotational task compared to joystick control.

No significant differences were observed between control types for usefulness or enjoyment.

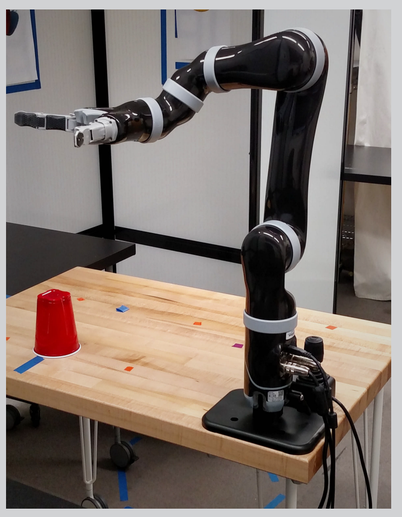


⋆: $p \leq 0.01$ | †: $p \leq 0.05$

Implementation

We implemented a kinesiological control system using a Microsoft Kinect to collect hand position data and a VML data glove to collect hand orientation.

Hand pose updates were sent via Robot Operating System (ROS) to a Kinova Mico 6-DOF arm at 4Hz.



Experimental Design

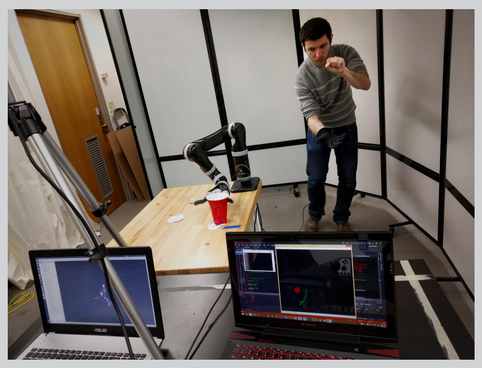
Hypotheses

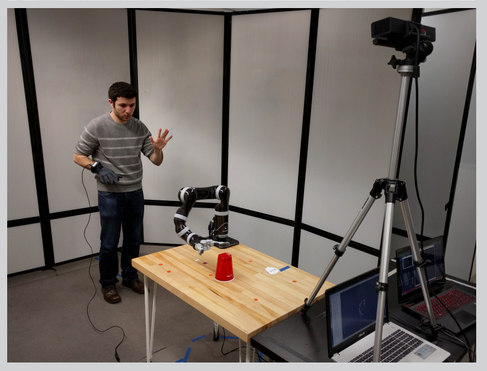
H1: Kinesiological robot arm control will have better task performance on tasks with 1-to-1 mappings, while joystick control will have better performance on tasks without 1-to-1 mappings. A combined control method will perform as well or better than kinesiological or joystick control.

H2: The same relationships as **H1** will be found for perceptions of Ease of Use, Usefulness, and Enjoyment.

Study Design

We designed a 3x2 mixed methods study.





Control Type (between subjects)

- *Kinesiological* - End effector position and orientation match the user's
- *Joystick* - End effector position and orientation are controlled by the built-in joystick
- *Kinesiological+* - End effector position is controlled kinesiologically and orientation is controlled by the joystick

Task Type (within subjects)

- *Movement* - Pick and place (1-to-1 human mapping)
- *Rotation* - 360° rotation (no 1-to-1 human mapping)

Measures

To measure task performance we scored the trial by normalizing task completion time by 5 minutes. Questionaires were used to measure Ease of Use, Usefulness, and Enjoyment.

Conclusions

Kinesiological control performs as well as and is perceived similarly to traditional joystick control if the kinesiological control is combined with special abilities provided by the robot.

Designers should consider additional abilities afforded by the robot when implementing retargetting and provide these abilities to the user.