LA-UR-18-27673

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Title: Improving Human-Robot Interaction and Control Through Augmented Reality

Author(s): Manning, Levi H.
Pederson, John Monroe
Potts, Dillon Gabriel

Intended for: Los Alamos Dynamic Summer School final presentation

Issued: 2018-08-10

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Improving Human-Robot Interaction and Control Through Augmented Reality

Levi Manring
John Pederson
Dewey Potts

Mentors:
Beth Boardman
Alessandro Cattaneo
Troy Harden

LADSS
Engineering Institute

8/8/2018

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Motivation

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Motivation: standard robot controls are difficult to learn

The Yaskawa Motoman SIA5D controller has 62 buttons and a touchscreen.

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Augmented Reality (AR) opens the door for creative solutions to robotic control

AR combines the real world with holograms which the user can interact with

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Project description

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Goal: create an intuitive AR interface to control a robot

**Intuitive
Manual
Control**

**Preplanned
Automatic
Control**

**Torque
Predictions**

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Project goal: implement our interface using a 7 DOF robotic arm and a head-mounted display

**Microsoft
Hololens**

ROSbridge

ROS

**Yaskawa
Motoman
SIA5D**

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Literature Review

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AR has been applied using different hardware

Touchscreen devices (game-development)

Surgeon training

Hololens

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Connections between ROS and Unity are useful for AR development

ROS A set of software libraries and tools that assists in robotics application development

unity Enables 3D virtual scene development

ROS **unity** Communication via ROSbridge

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Methods

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Methods: Connections

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Connecting a 7 DOF robotic arm and a head-mounted display

SIA5D

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ROS Operates with Nodes, Topics, and Messages

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Connection Overview in ROS

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Methods: Control

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Control methods can enhance user experience

Automatic control

- Send goal state, plan, execute when ready

Manual control

- Send joint angles, move to those angles

Both control methods

- Simple: just move hologram robot

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Unity can create an intuitive user interface

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Unity can create an intuitive user interface

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Methods: Torque Simulation

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Torque feedback is useful for robot operation

A user can receive visual feedback on the simulated joint torques and make a decision whether or not to execute.

****Colors do not represent an actual torque simulation**

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Simulink Robotics System Toolbox can be used for inverse dynamics calculations

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Simulink Robotics System Toolbox can be used for inverse dynamics calculations

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Torque visualization is useful because of different torque thresholds for each joint

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Implementation of torque simulation has issues

.urdf file is incomplete (mass and inertia)

External forces are often unknown

Goal: proof of concept

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Results: Hololens Demonstrations

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Hololens Demonstration: Place Robot

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Hololens Demonstration: Manual Control

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Hololens Demonstration: Automatic Control

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Conclusions

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Simple control of a SIA5D robotic manipulator with an AR headset

User-friendly control methods

Torque Simulation Feedback

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Future Work

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Feature Development

Collision avoidance (mapping the environment with the Hololens mesh capability)

Using Vuforia to automatically place hologram

Gripper functionality

Additional control methods (waypoints)

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Acknowledgements

**Beth Boardman
Alessandro Cattaneo
Troy Harden
David Mascarenas
James Riback
Carlos Santacruz-Rosero
Allison Cognetti
Anita Jaramillo**

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Questions?

Levi Manring levihmanring@lanl.gov

Dewey Potts potts@lanl.gov

John Pederson jmpederson@lanl.gov

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Reference Slides

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Hololens can transmit and receive over websockets

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Robotics Systems Toolbox: Inverse Dynamics Calculation

Input: moveit_msgs/RobotTrajectory

Includes positions, velocities, and accelerations for discrete points on a trajectory

Inverse Dynamics Calculation, infers torques

$$I\ddot{\theta} + b\dot{\theta} + k\theta = \tau(t)$$

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