kinetic vision

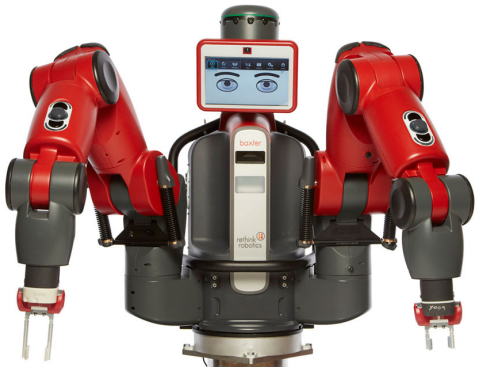
RevolutionUC - 2023 Challenge

Robotic Data Visualization

Kinetic Vision works with a variety of partners to develop innovative solutions to complex engineering problems. Our Data Engineering and Robotics team specifically works with companies that develop, test, and utilize robots in industrial and medical research sectors. For our challenge, we want you to develop some system to visualize the data that these robots return from testing.

The Challenge

Using the provided public dataset, create some program that can visualize the rotational position, rotational velocity, and torque of a robotic arm with 7 degrees of freedom. This program could be a web or desktop application, using 2D and/or 3D visualizations and models. The easier it is for the user to intuit the **robotic arm movement** and **torque readings**, the better!



The Data

The following dataset consists of trajectory recordings from two different robots: the Kuka LBR iiwa (above left) and a single arm of the Baxter (above right). The linked repository contains two folders, but our primary interest is the “ForwardDynamics” directory. This contains two MATLAB files, one for each of the robots, performing ten iterations of a pick-and-place task. You can read more about the task and the associated research in “Real Robot Manipulation Datasets For Learning Dynamics”[2]. Direct links to the files in question are also provided below for you convenience.

Dataset URL: https://bitbucket.org/athapoly/datasets/src/master/
Dataset Files:

- /ForwardDynamics
    - BaxterDirectDynamics.mat
    - KukaDirectDynamics.mat
- /InverseDynamics

Each file contains a dictionary of 10 iterations of a pick and place task, with each iteration being a table of robot sensor output and control/target input (sampled at 100Hz). Each robot has 7 degrees of freedom (or joints), and the tabular data has the following structure:

Sensor Data

- Columns 1-7: joint 1-7 position (radians)
- Columns 8-14: joint 1-7 velocities (radians/second)
- Columns 15-21: joint 1-7 torques (Newton-meters)

Target Data

- Columns 22-28: next/target joint 1-7 position (radians)
- Columns 29-35: next/target joint 1-7 velocity (radians/second)

Getting Started

First thing's first, explore the data! Try to open it up in your preferred plotting language, like Python, R, or MATLAB, and see what it looks like, then decide how you might want to visualize it. Stick with 2D plots, trace the trajectory in 3D space, or even model the whole robot with visualizations for torque magnitude! Put it on the web, a game engine, or another visual platform. If your target platform doesn't support reading *.mat files very well, you can convert them to something else using one of the above languages (or whatever you want!).

Let us know on the Discord if you need any help or guidance!

Prizes

The group with the most informative, intuitive, and innovative visualization will win a mechanical keyboard for each team member, with a custom Kinetic Vision keycap.

Sources

1. A. S. Polydoros and L. Nalpantidis, “A reservoir computing approach for learning forward dynamics of industrial manipulators,” 2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Daejeon, 2016, pp. 612-618, doi: 10.1109/IROS.2016.7759116.
2. Gabriella Pizzuto. “Real Robot Manipulation Datasets For Learning Dynamics,” August 14, 2020. https://gabriellapizzuto.github.io/Real-Robot-Manipulation-Datasets-For-Learning-Dynamics/

Information for the Kuka LBR iiwa
Product Page:
https://www.kuka.com/en-us/products/robotics-systems/industrial-robots/lbr-iiwa
Datasheet:
https://www.kuka.com/-/media/kuka-downloads/imported/6b77eecacfe542d3b736af377562ecaa/0000246832_en.pdf?rev=3217a00d6a9a4c2f95b088d832f50784&hash=1E6136098A5AA7013F2628C0FFD0E4C7
Kinematic Details:
https://www.research-collection.ethz.ch/bitstream/handle/20.500.11850/237831/2/IFAC2017_KUKA_Identification.pdf

Information for the Baxter
Product Overview: https://robots.ieee.org/robots/baxter/
Kinematic Details (see pages 7-9 for dimensioning):
https://www.ohio.edu/mechanical-faculty/williams/html/PDF/BaxterKinematics.pdf