Improving robotic grasping agility using Iterative Learning Control

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Problem

In this technologically rich era, our lives are filled with robotics as well as automation. From as simple as an autonomous robot vacuum machine to a more sophisticated multi degree of freedom robotic arm, all these systems required a state-of-the-art controller. As a result, the needs for faster, more precise, and accurate controller are ever more demanding.

There are numerous controllers out there capable of doing 300 picks per hour. On the other hand, the average human can grasp 600 times per hour. This makes robotic grasping twice as slow as an average human. One of the reason robotic grasping is much slower is due to the limited research conducted on robotic grasping, especially ones that incorporates Iterative learning control (ILC). ILC is crucial for robots that does repetitive motions such as a robotic grasping arm as it enables the controller to learn and improves from its own error and mistakes due to imperfection or just environmental factor.

ILC is not a new concept, in fact, it has been successfully applied onto numerous systems such as industrial robots, CNC machines tools, injection-molding machines and many more. However, applying ILC onto robotic grasping is relatively new and to the best of my knowledge there have been no experiments conducted into robotic grasping.

Goal

This project aims to:

- Read up literature, journals to identify different controllers as well as their advantages and points of improvements.
- Model accurately a 3-axis gantry robot as well as a simple gripper arm using Simulink simscape multibody toolbox.
- Attempts to design a new control algorithm which includes ILC to improve the accuracy and speed of the robotic gripper and simulate it using the model built on MATLAB.
- Test the control algorithm onto a real 3-axis gantry robot and identify any improvement or changes to be made to improve the controller and compare the result to the ones obtained via simulation.
- Further test the performance of the controller on a 6-DOF robotic arm.

Scope

My project aims to learn and identify different controller's strengths and weaknesses and adapt or attempts to design a new controller which incorporates ILC to improve the agility of robotic grasping. The project will start off by researching on different controller as well as modeling the gantry robot for simulation testing. The new controller will be tested first on MATLAB via simulation and will later be put to the test onto a real gantry robot. Works done previously on the gantry robot such as the model will be used as a reference and be improved further should any mismatch arises.

Furthermore, as an additional test, the controller will be programed onto a 6-DOF robot and be tested on it after receiving satisfactory results from the gantry robot.

I hope to design a new controller that is optimized for robotic grasping while incorporating ILC to improve its agility.