Presentation:

Impedance Control Implementation on UR5e under ROBOSUITE simulation

Impedance Control and compliance control with UR5 robot

1. Challenge description

* The insertion operation of robot using traditional PID control might have low robustness when the location of the hole is uncertain, which results in damage in robot arms and working objects. (impulse in joint load, exceeding maximum material strength, etc)
* Need impedance control to avoid such a situation

Example: 2D project

1. Environment

* ROBOSUITE: Introduction; Download & installation (Shir’s Git??)
* 16mm diameter aluminum rod & rectangular hole (using build-in modeling to ensure working normally)
* Doing whole process: for future development, can do multiple tasks

1. Algorithm:

* Impedance control: 2D project
* OSC on ROBOSUITE (challenges we met)

1. Tuning of parameters and Experimental Results
   1. To test range of parameters for successful inserting

Criteria:

* Run time: consider exceeding 30s as failure, to achieve a more effective control.
* External force in x, y, z direction: applying the impedance control, the reaction force changes more smoothly, and the maximum force is not too high.

Variables:

* Kp & Kd in x,y,z prismatic and torsional directions
* Perception error (dislocation of the hole as percentage of the diameter of the rod)

Result:

* X Y direction:
* Z direction:

Kp: 600

Kd:2.5

* 1. To test robustness of particular parameters

Perception: dislocation of the hole as ratio of rod diameter in percentage

Perception test:

Xy – center of band - kp

|  |  |  |
| --- | --- | --- |
| kp | kd |  |
| 1500 | 2 |  |
| 2000 | 2 |  |
| 2500 | 2 |  |

Xy – center of band - kd

|  |  |  |
| --- | --- | --- |
| kp | kd |  |
| 2000 | 1.5 |  |
| 2000 | 2 |  |
| 2000 | 2.5 |  |

Xy – edges

|  |  |  |
| --- | --- | --- |
| kp | kd |  |
| 600 | 1.5 |  |
| 1000 | 2.75 |  |
| 2000 | 4 |  |

Z – kp

|  |  |  |
| --- | --- | --- |
| Kp | kd |  |
| 450 | 6 |  |
| 600 | 4 |  |
| 750 | 2 |  |

Z – kd

|  |  |  |
| --- | --- | --- |
| Kp | kd |  |
| 450 | 6 |  |
| 600 | 4 |  |
| 750 | 2 |  |

Z – cross the band

|  |  |  |
| --- | --- | --- |
| Kp | kd |  |
| 450 | 6 |  |
| 600 | 4 |  |
| 750 | 2 |  |

1. Performance under assumed best parameters
2. Future Development