Dynamics of Non Linear Robotic Systems

Homework Assignment 2

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Abstract

This HW is dedicated to working with the robot KR 3 R540. And below you can see the main tasks.

Tasks

1. Look through manual for the robot KR 3 R540
2. Look through manual for KUKA System Software 8.3 (KSS). Pay more attention to sections 4, 7-11.
3. Operate robot in different coordinate frames:
    - Joint space. Move each joint independently.
    - World frame. Move end-effector along each of axis. Move end-effector around each axis.
4. Create program that will move robot along trajectory consisting of different chunks (lines, arcs, etc). For this program change tool to marker. Robot should draw some curve on a paper fixed on table.
5. (*) Create program that will shuffle small cubes - additional task.
6. Write report

Additional information

I conducted this work with my colleagues to draw the next sentence: "**NO MORE LIFE**". And each group wrote their chosen word from this sentence by a robot:

- Group 1:Ilia Sevostianov and Ramil Khafizod. Word: ~~**LIFE**~~
- Group 2:Alexander Osipov and Albert Nasybullin. Word: **MORE**
- Group 3:Me. Word: **NO**

Useful links

1. KUKA Robot Laboratory Practice 1 - [1]
2. KUKA Robot Laboratory Practice 2 - [2]

Requirements

1. Operate robot on small velocity (less than 30%), until you are experienced
2. Provide video of robot movements
3. For your programs create folder named as your e-mail (part before @).
4. For drawing task bring paper with you. You can move paper frame. Reflect paper frame coordinates in report. For every report these coordinates should be different.
5. Upload texts of your programs.
6. (*) You can organize in groups of two (reflect this in report).
7. Please clean up workplace after your exercises. Take used paper with you.
8. You can conduct your homework only when some of the staff is in the lab (usually from 9 a.m. to 6 p.m. there is somebody).

Solution

Robot operation

Drawing a word

1. I used manual for KUKA System Software 8.3 (KSS) to understand how to switch it on/off (**section 4.3**).
2. I used section **4** to understood how to work with smartPAD and moved each joint of the robot.
3. I used section **7** to create a new program and file (subsections **7.1** and **7.2**) to make a program for point-to-point movement
4. Then I moved to one point, saved this point (state) to the program and moved to other point to make a trajectories:
   (a) Trajectory 1: from Home state(initial condition - point) move to the whiteboard marker and grab it via pneumatic tool

(b) Trajectory 2: from whiteboard marker point move to the point so that the operator would be able to remove the cap from the marker.

(c) Trajectory 3: from above point move to the paper layer an do a point-to-point movement to draw word "**No**" - eight points in the word.

- Also to not draw the line between letter "**N**" and letter "**O**" (avoid their connection) I moved to point (between them and on the higher level) and saved that point in the program.

5. After that I moved the whiteboard marker to the point via tool so that the operator would be able to put cap on the marker (see **Trajectory 2**)

6. And, to finish the job with this robot, I put the marker back in its place by the tool of robot and moved the robot to its initial condition (**Home state**).

Shuffling the cubes

It was done as the closed loop program that allow us to move cubes with loop.

Results

Below you can see received results:

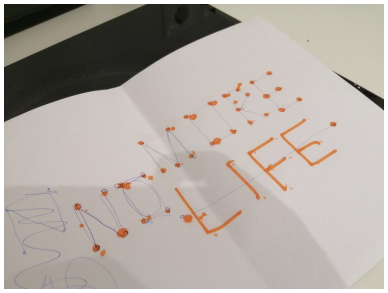
Video of how robot draw the word

- Draw

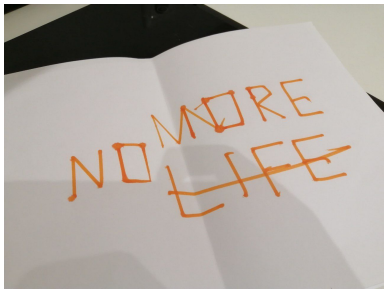
Video of how robot do shuffling the cubes

- Shuffle

Received words



(a) A picture of points in sentence for doing a point-to-point motion



(b) Received sentence that is written by the robot

Figure 1

Program code

The program code you can see on my github : Program code for operation with the robot

Conclusion

As a result of the work, I have complete all the necessary requirements, learned how to work with the manipulator and completed the following tasks: draw a word with by the tool of the robot and also completed an additional task: shuffle the cubes.