Test report 23.05.2018

Date & Time	23.05.2018, 15:30-18:00
Tester	Abhishek Padalkar
Software versions	ROS Indigo
	OpenCV 3.1.0
Hardware configuration	KUKA youbot 4
	ASUS Xtion Pro Live
Tested feature	Acquisition and repetion of dynamic motion primitives
Test setup / environment	C025 lab, HBRS, RoboCup@Work arena
	15cm platform

Test procedure:

On the robot:

1. Switch on the youbot
2. Launch the robot bringup: `roslaunch mir_bringup robot.launch`
3. Launch moveit: `roslaunch mir_moveit_youbot_brsu_4 move_group.launch`

On an external machine:

1. Export the `ROS_MASTER_URI`: `export ROS_MASTER_URI=http://youbot-brsu-4-pc1:11311`
2. Run the script *demonstrated_trajectory_recorder.py* in order to record a trajectory: `rosrun demonstrated_trajectory_recorder demonstrated_trajectory_recorder.py`
3. In the command prompt, press ENTER to start recording; this will open a window that shows the current view of the camera
4. Demonstrate a trajectory by moving the aruco marker board
5. When done demonstrating, press q in the window and write a trajectory name in the command prompt
6. Copy the recorded file to `ros_dmp/data/recorded_trajectories/23_05`
7. Run the script `ros_dmp/src/learn_motion_primitive.py` to learn the weights of the motion primitive; the weights will be saved to `ros_dmp/data/weights/weights_<trajectory_name>.yaml`.

8. For safety reasons, move the robot to open space before repeating any demonstrated trajectories.
9. To repeat a demonstrated trajectory, change the initial and goal position in `ros_dmp/src/test.py` and then run `test.py`. If multiple goal poses are specified, the robot will go to each one of those; however, each pose will first be repeated a given number of times. After finishing each trial, press ENTER to go to the next trial. The data for each trial (both the planned and executed trajectories) are saved to a specified location.

Test assumptions:

- There are no obstacles in the environment
- The demonstrated trajectory is within the manipulator's dexterous workspace
- The camera used for recording the trajectory is calibrated
- The camera frame rate is low (~5fps), so the trajectory has to be demonstrated slowly
- The test environment is static
- Trajectories are recorded in the base link frame
- The joint encoders are working properly and their measurements are considered ground truth values (there is no external robot pose observer, so the encoder measurements are used for measuring the position of the manipulator)

Test 1:

Test objectives:

- Acquiring a demonstrated trajectory (inverse parabolic curve)
- Repeating the demonstrated trajectory with five different goal locations. The different goal locations are specified as follows: **goal 1: x same as demonstrated final position, y same, z same** goal 2: x - 3cm, y same, z same **goal 3: x same, y - 3cm, z same** goal 4: x - 3cm, y + 2cm, z same ** goal 5: x + 3cm, y - 2cm, z same

Test parameters:

- Number of basis functions: 50
- tau = 50
- Number of trials: 10

Observations:

- If some part of a trajectory is out of the dexterous workspace or near its limits (e.g. the goal position is at the limits of the workspace), the motion is unpredictable due to degraded inverse kinematics solutions; this limits the ability to generalise a learned primitive.
- A similar observation holds near the joint limits.
- Since the demonstrated trajectory has initial and final z values that are practically equal to each other, varying z creates infeasible resulting trajectoreis; this primitive is thus limited to scenarios in which the initial and final z position are the same (e.g. moving

an object from one side of a table to another)

Test 2:

Test objectives:

- Acquiring a demonstrated trajectory (step function in Y-Z plane)
- Repeating the demonstrated trajectory with five different goal locations. The different goal locations are specified as follows: **goal 1: x same as demonstrated final position, y same, z same** goal 2: x same, y - 3cm, z same **goal 3: x same, y same , z + 3cm** goal 4: x same, y + 3cm, z + 2cm ** goal 5: x same, y - 5cm, z - 5cm

Test parameters:

- Number of basis functions: 50
- tau = 50
- Number of trials: 10

Observations:

- If some part of a trajectory is out of the dexterous workspace or near its limits (e.g. the goal position is at the limits of the workspace), the motion is unpredictable due to degraded inverse kinematics solutions; this limits the ability to generalise a learned primitive.
- A similar observation holds near the joint limits.
- Since the demonstrated trajectory has initial and final x values that are practically equal to each other, varying x creates infeasible resulting trajectoreis; this primitive is thus limited to scenarios in which the initial and final x position are the same (e.g. cleaning a whiteboard)

General observations

- Increasing tau too much (e.g. 100) causes overshoots at sharp turns.

Test 3:

Test objectives:

- Acquiring a demonstrated trajectory (step function in Y-Z plane)
- Repeating the demonstrated trajectory with five different goal locations. The different goal locations are specified as follows: **goal 1: x same as demonstrated final position, y same, z same** goal 2: x - 2cm, y + 2cm, z -2cm **goal 3: x -5cm, y + 5cm , z - 3cm** goal 4: x same, y + 8cm, z - 1cm ** goal 5: x same, y + 13cm, z same

Test parameters:

- Number of basis functions: 50

- tau = 50
- Number of trials: 10

Observations:

- If some part of a trajectory is out of the dexterous workspace or near its limits (e.g. the goal position is at the limits of the workspace), the motion is unpredictable due to degraded inverse kinematics solutions; this limits the ability to generalise a learned primitive.
- A similar observation holds near the joint limits.
- Since the demonstrated trajectory has initial and final x values that are practically equal to each other, varying x creates infeasible resulting trajectoreis; this primitive is thus limited to scenarios in which the initial and final x position are the same (e.g. cleaning a whiteboard)

General observations

- Increasing tau too much (e.g. 100) causes overshoots at sharp turns.

Test 4:

Test objectives:

- Acquiring a demonstrated trajectory (step function in Y-Z plane)
- Repeating the demonstrated trajectory with five different goal locations. The different goal locations are specified as follows: **goal 1: x same as demonstrated final position, y same, z same** goal 2: x + 2cm, y same, z same **goal 3: x same, y - 2cm , z same** goal 4: x same, y same, z + 3.5cm ** goal 5: x + 2cm, y - 2cm, z - 1cm same

Test parameters:

- Number of basis functions: 50
- tau = 50
- Number of trials: 10

Observations:

- If some part of a trajectory is out of the dexterous workspace or near its limits (e.g. the goal position is at the limits of the workspace), the motion is unpredictable due to degraded inverse kinematics solutions; this limits the ability to generalise a learned primitive.
- A similar observation holds near the joint limits.
- Since the demonstrated trajectory has initial and final x values that are practically equal to each other, varying x creates infeasible resulting trajectoreis; this primitive is thus limited to scenarios in which the initial and final x position are the same (e.g. cleaning a whiteboard)

General observations

- Increasing tau too much (e.g. 100) causes overshoots at sharp turns.