Impact of Body Parameters on Dynamic Movement Primitives for Robot Control

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ai lab

RobotDoC
Robotics for Development of Cognition

Movement coordination in large DoF robots is complex - redundancy problems.
Dynamic Movement Primitives (DMP) :
- Learnable Dynamical System that can generate periodic or rhythmic trajectories at each DoF
- Planning and movement imitation technique inspired from biology (CPGs, Motor primitives in humans)

What is the effect of robot dynamics on the performance of DMPs? How can we quantify it?

Relevant Questions:

How to to coordinate large DoF robots?

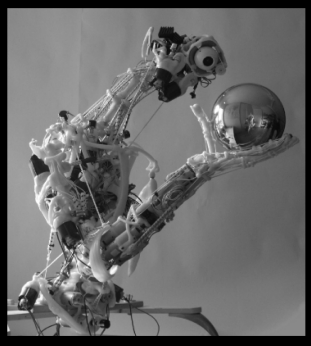
How to deal with redundancy?

How can we handle the "Curse of Dimensionality" in learning new movements?

How to handle real time control for large DoF systems?

How to deal with compliance?

How do biological agents solve these problems?

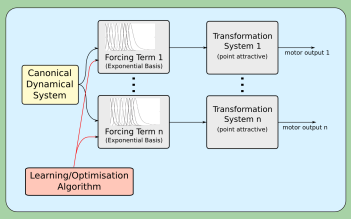


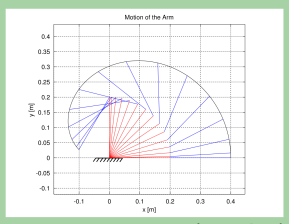
Dynamic Movement Primitives and Robot Simulator

Learnable nonlinear dynamical system for each DoF.

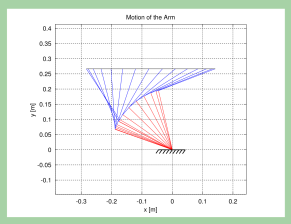
Components :

1. *Transformation System*
 - Basic underlying dynamical system, point attractive (the goal).
 - Output is encoded trajectory, fed to a low level controller.
2. *Canonical System*
 - Serves as an autonomous time variable common to all the DoF.
3. *Forcing Term*
 - Force on the Transformation System into a desired trajectory encoded as learned parameters

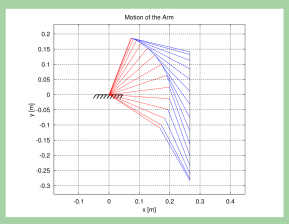




Bicep Curl



Horinzontal Line



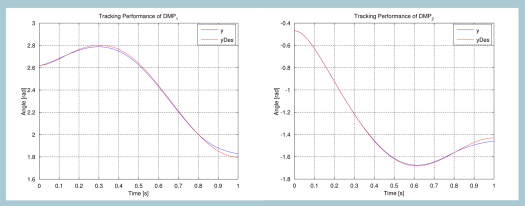
Vertical Line

Simulator

2 DoF planar robot arm with High level DMP trajectory inputs, and low level PID control

Simulation Results

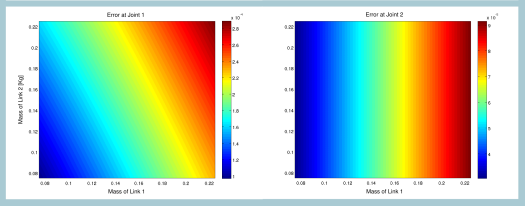
DMP learning performance
Similar to state of the art results



RMSE of controlled robot vs. DMP output

Joint 1: greater influence due to mass of link 1

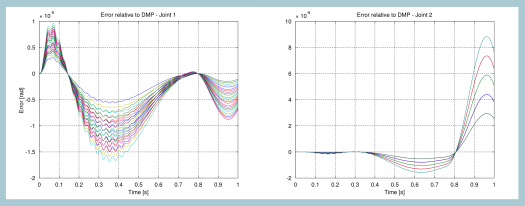
Joint 2: variation of mass of link 2 has a negligible effect



Error against time for all masses

Performance drops with increase in mass

“Zero Crossover” region independent of mass



Error qualitatively shaped by trajectory, quantitatively affected by robot mass

Conclusion

An “Intelligently Learned” DMP (i.e. which takes into account body dynamics) might allow performance independent of the robot dynamics. This might be necessary for a compliant robot.

MARIE CURIE ACTIONS

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