Robotic Cloth Manipulation for Clothing Assistance Task using Dynamic Movement Primitives

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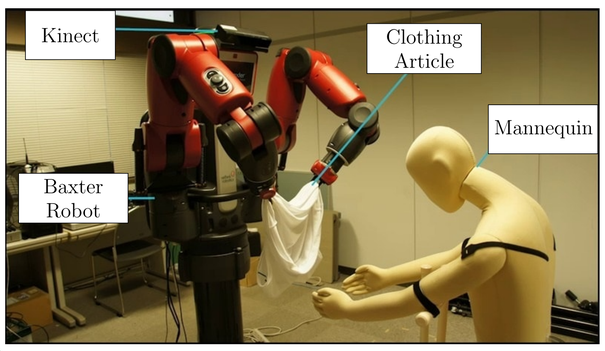
Introduction

The need of Robotic Clothing Assistance in the field of assistive robotics is growing, as it is one of the most basic and essential assistance activities in the daily life of elderly and disabled people. Robotic Cloth Manipulation task deals with putting a clothing article on both the arms.
In this research, we are investigating the applicability of using Dynamic Movement Primitives (DMP) as a task parameterization model for performing clothing assistance task. We have performed experiments on soft mannequin instead of human.

Experimental System



- Baxter Robot
- Clothing Article
- Kinect v2
- Mannequin

Experiments

1. Dynamic Movement Primitives (DMP)
2. Robotic Cloth Manipulation using DMP
3. Estimation of Hand location in 3D space

Dynamic Movement Primitives (DMP)

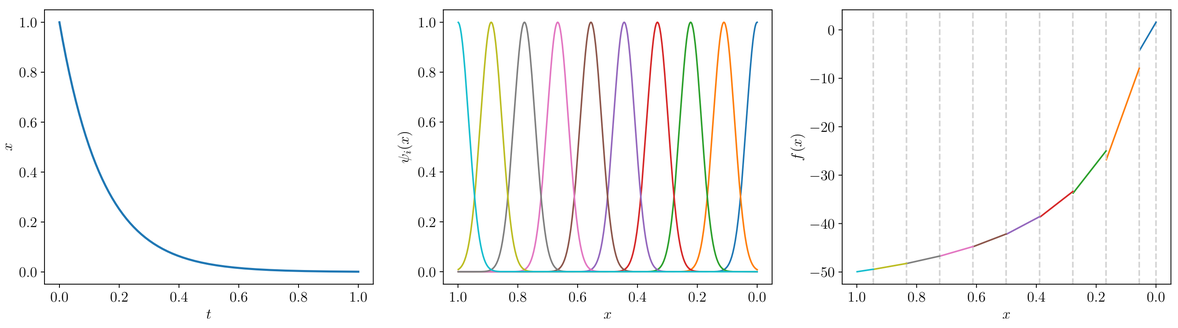
Used for generating control signal to guide real system

1. Represent policy as a non-linear dynamical system

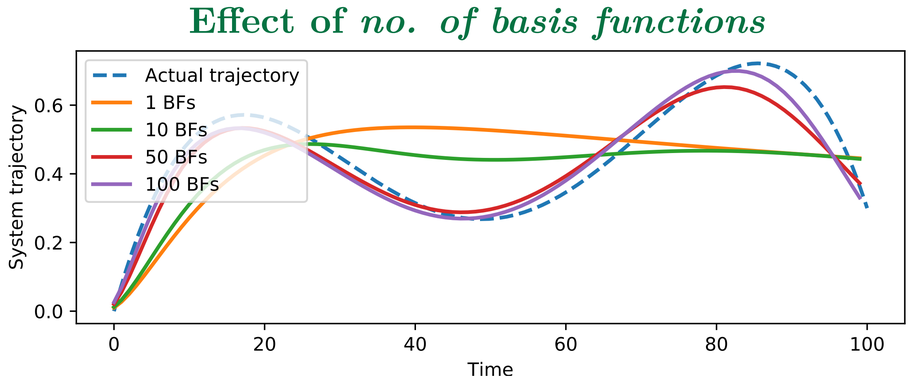
$$\ddot{y} = \alpha_y(\beta_y(g - y) - \dot{y}) + f$$

$$f(x, g) = \frac{\Sigma_{i=1}^{N} \psi_i w_i}{\Sigma_{i=1}^{N} \psi_i} x(g - y_0) \text{ where } \dot{x} = -\alpha_x x$$

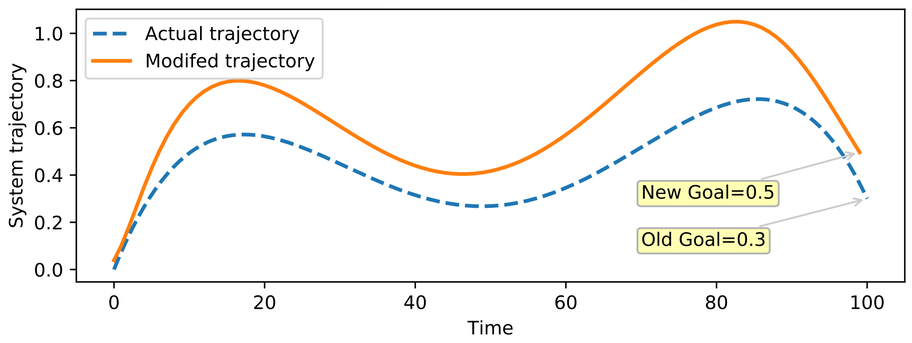
2. Policy parameters: Weight parameters w_i used in Locally Weighted Regression



Effect of *no. of basis functions*



DMP adaptation to new goal



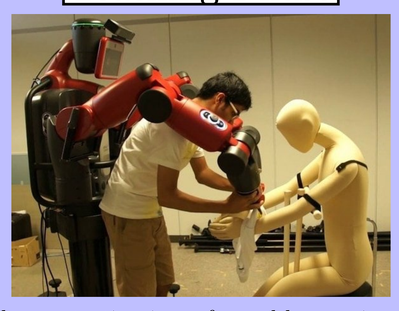
Publications

[1] Ravi P. Joshi, Nishanth Koganti, and Tomohiro Shibata. Robotic cloth manipulation for clothing assistance task using Dynamic Movement Primitives. In *Proceedings of Conference on Advances In Robotics*, 6 pages. ACM, 2017.

[2] Ravi Joshi, Rithul Perathara, Rolyn Labuguen, Nishanth Koganti, and Tomohiro Shibata. Estimating 3D Hand Location for Clothing Assistance Initialization Using Dynamic Movement Primitives. Submitted to *Robotics Society of Japan*, 2017.

Robotic Cloth Manipulation using DMP

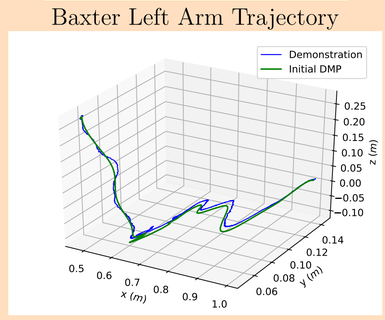
Teaching Phase



A demonstration is performed by moving the Baxter arms in the appropriate trajectory

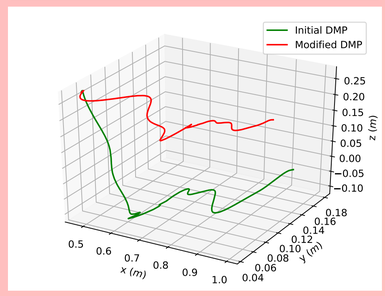
Learn Trajectory

Baxter Left Arm Trajectory



Recorded trajectory is parameterized by DMP

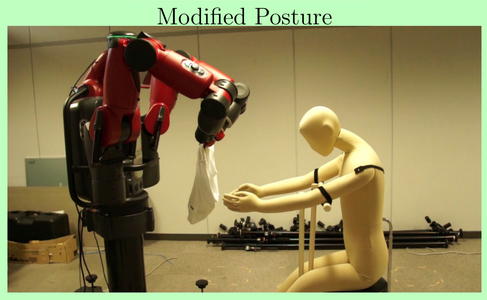
DMP Generalization



Arms posture of the mannequin is changed. Accordingly goal parameter of DMP is modified

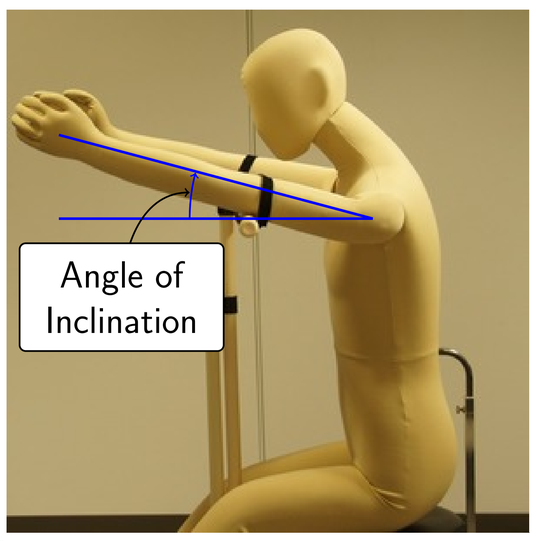
Testing Phase

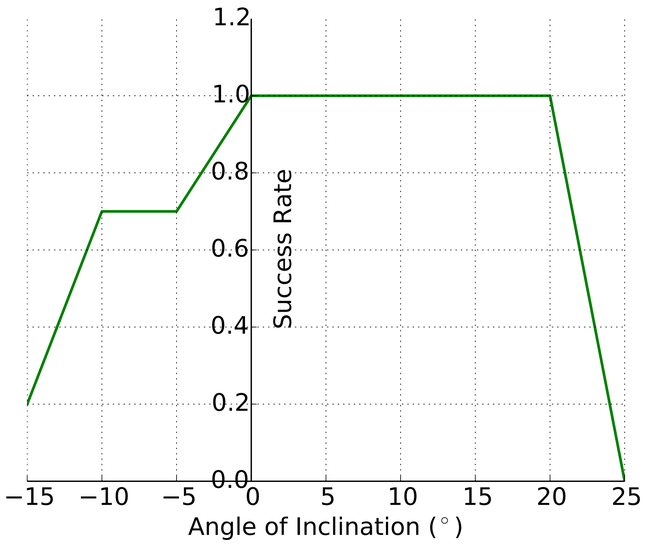
Modified Posture



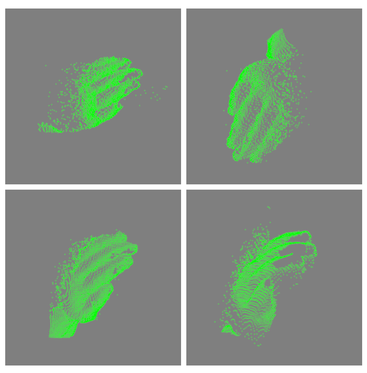
DMP can accomodate any posture by changing goal parameter

Accuracy measurement

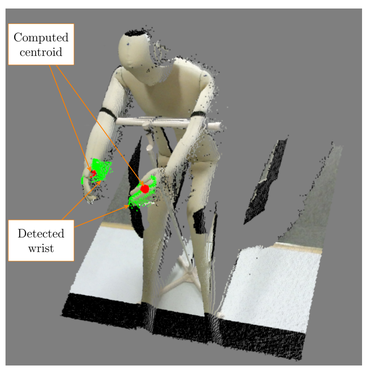




Estimation of Hand location in 3D space



Template Matching



Conclusion

1. Robotic clothing assistance is challenging since it requires cooperative manipulation
2. Clothing article inherits non-rigid and highly deformable properties
3. Real-time tracking of mannequin for making approach more robust
4. Result shows that DMPs are able to generalize the movement trajectory

Acknowledgments

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