Quantitative Evaluation of Clothing Assistance using Whole-Body Robotic Simulator of the Elderly

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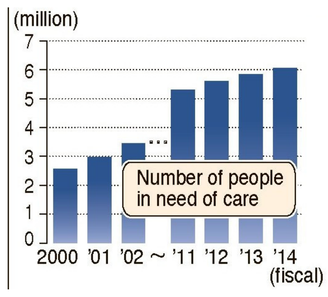
Background



Demand of caregivers in Japan

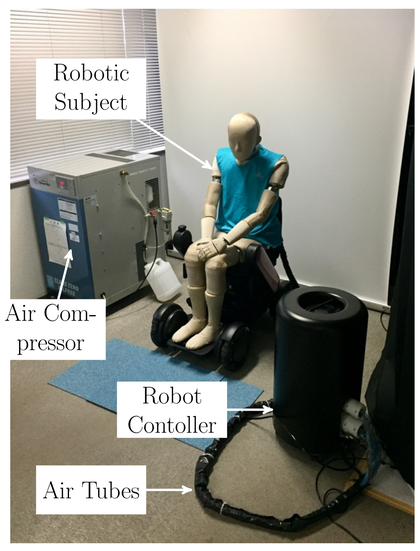
The robotic solutions to clothing assistance can significantly improve ADL for the elderly and disabled, because-

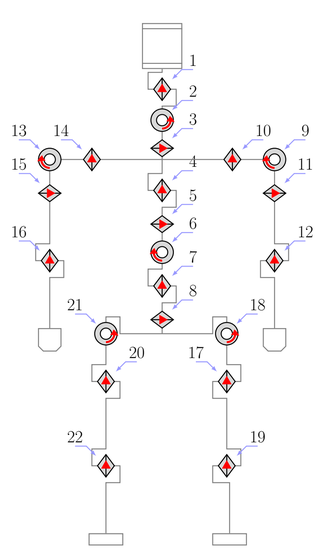
- Most of the developed countries, including Japan, are aging rapidly.
- Use of caregiver is predominant in dressing ADL.
- Japan is facing a severe shortage of caregivers.

Introduction

- We have developed a clothing assistance robot using dual arms.
- We could not systematically evaluate its performance because human arms are occluded.
- We propose to use another robot, Whole-Body Robotic Simulator of the Elderly.

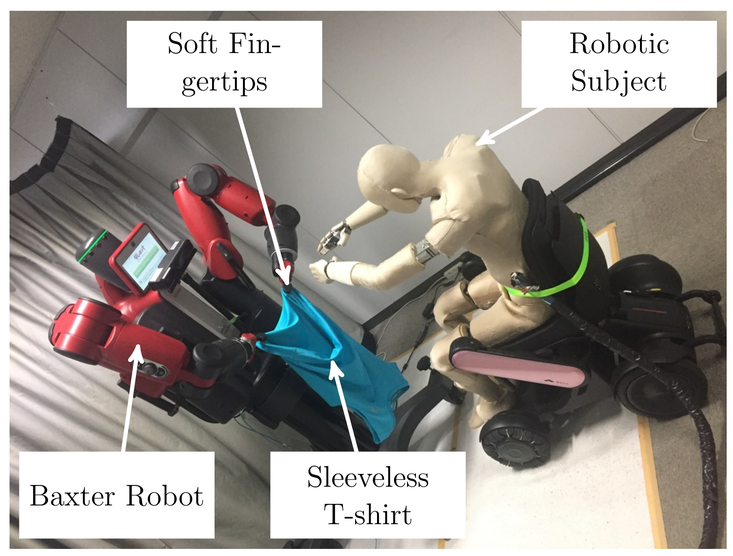
Robotic Simulator for Elderly





- It can mimic the posture and movement of the elderly person during the dressing task.
- It is covered with a skin-like soft material.
- It has 28 passive and 22 active joints that are position controlled.
- Each active joint is pneumatically controlled. The air pressure is about 8 atm.

Experimental Setup



DMP

It is used to learn the robot trajectory from demonstration. The policy is represented by a non-linear dynamical system as-

$$\tau\dot{v} = K(x_g - x) - Dv - K(x_g - x_0)s + Kf(s).$$

$f(s) = \frac{\Sigma_i w_i \psi_i(s)}{\Sigma_i \psi_i(s)} s$ and ψ_i is a Gaussian basis function.

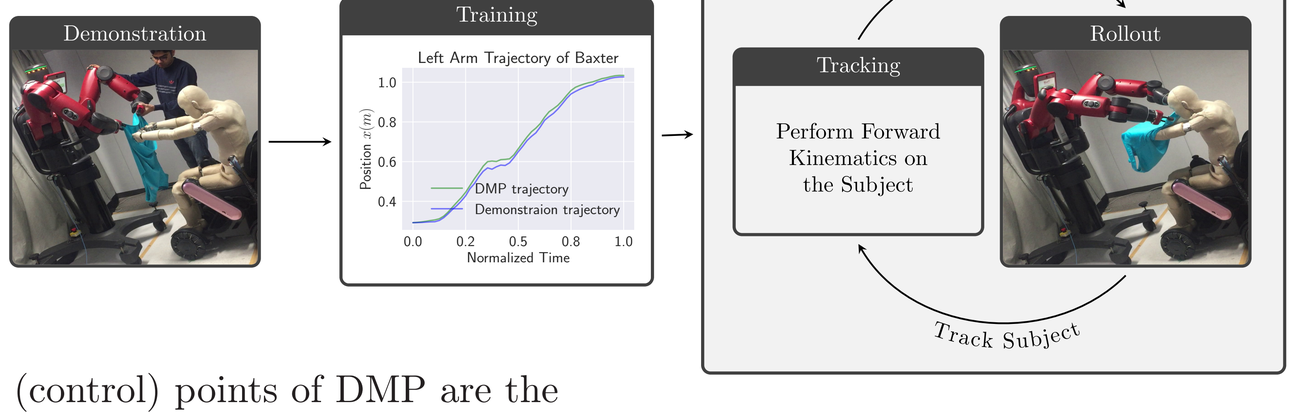
We redefine $f(s)$ so that it allows to modify the start and goal state, i.e., x_0 and x_g respectively.

$$f_{target}(s) = \frac{Dv + \tau\dot{v}}{K} - (x_g - x) + (x_g - x_0)s$$

Method

Our method contains three stages-

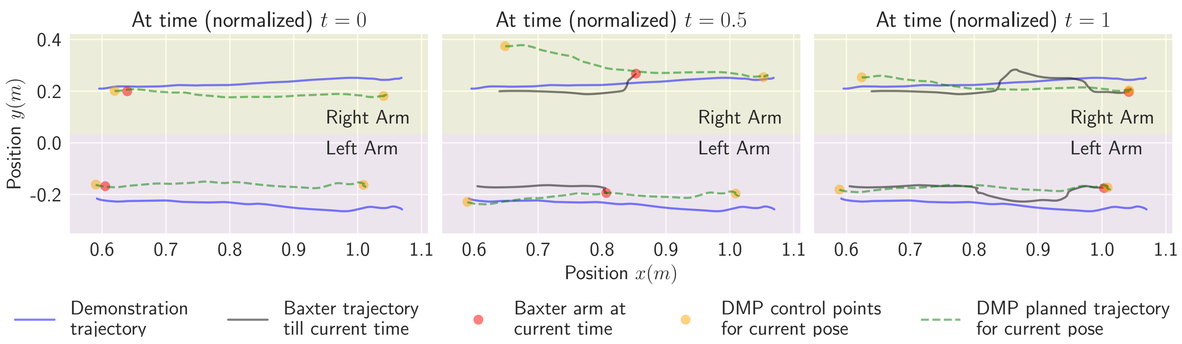
1. Demonstration
2. Training
3. Testing

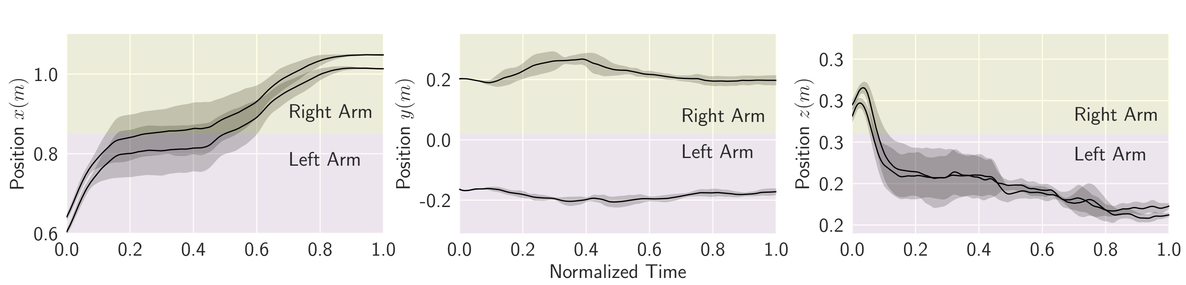


The start and goal (control) points of DMP are the fingertips and elbows of the robotic subject, respectively.

Results

We empirically defined two types of arm movements of the robotic subject. These movements belong to day-to-day arm stretching movements.





- The Baxter robot is commanded at each timestamp while setting the control points on the fly.
- At $t = 0.5$, both the arms of the Baxter robot are adopting the change and moving away from each other.
- We ran the arm dressing task ten times and visualized the robot trajectory.
- The y and z-axis of Baxter confirm that the arms of the robotic subject are not in symmetry.

Conclusion

- Systematic evaluation is necessary to make such devices accessible in the elderly care facilities.
- We have shown the plausibility of our approach by performing the dressing task on defined arm movements.

Future Work

- Incorporating 3-dimensional arm movements, head, and torso movements.
- Perform complete dressing, i.e., right from fingertip through the head till waist.
- Experimentation with the elderly and understand their psychological behavior too.

References

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[2] R. P. Joshi, N. Koganti, and T. Shibata. A Framework for Robotic Clothing Assistance by Imitation Learning. In *Advanced Robotics'19*.