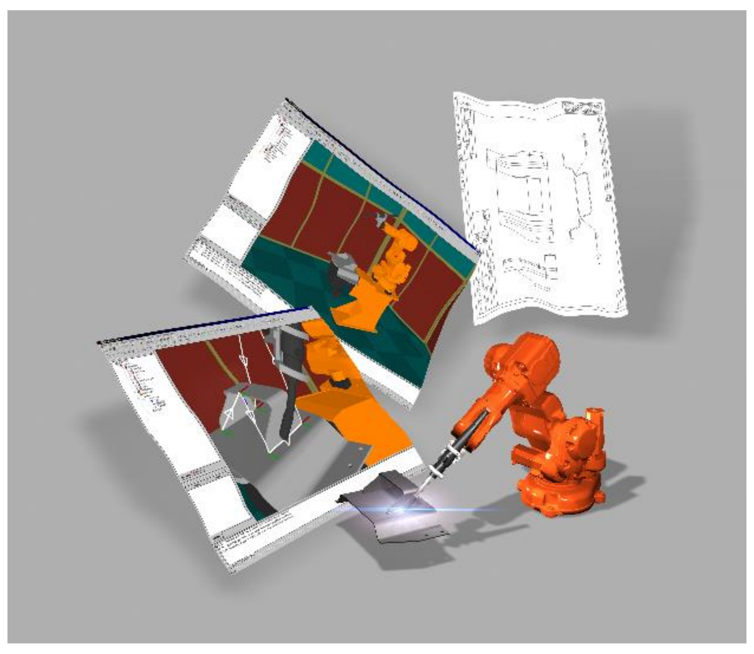
Skill Acquisition for Industrial Robots

Shahbaz A. Khader, KTH, ABB

Description:

In this project we look at how industrial robots can acquire “skills” which can then be employed in a production scenario such as an automobile assembly line. A human worker develops such a skill after receiving formal instructions followed by some practice. Nobody tells the human how to move his hands exactly. Robots, on the other hand, have to be meticulously programmed to produce the exact motion which would result in the job getting done. This programming phase is expensive and time consuming. So we ask the question: Can a robot, provided with high-level instructions and/or shown a demonstration, practice on its own and acquire an optimal skill?

Background & Motivation



Parts assembly tasks in industrial production is the most difficult class of robot applications due to the presence of interaction forces and requirement of high precision. The cost and availability of specialized robot programmers is often a serious limiting factor in successful deployment of such tasks. An autonomous skill learning robot can go a long way in solving this problem.

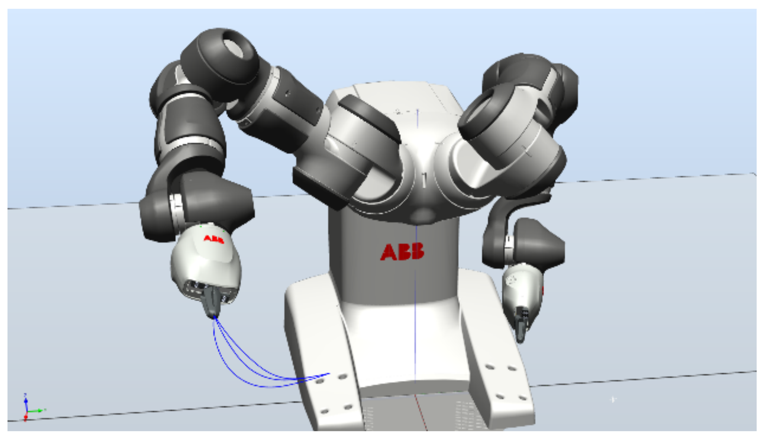
Research Goal & Questions

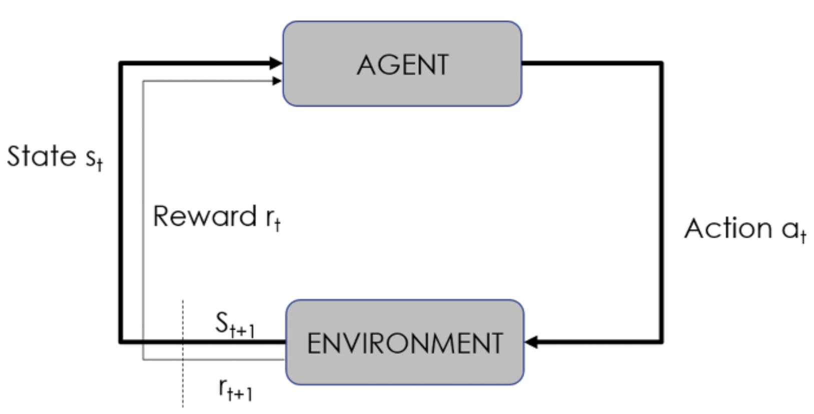
In industrial robotics application, the manipulated objects are know and a human supervised teaching phase for each task is acceptable.

This opens up some research questions:

1) How should the supervisor interact during teaching?
2) How to generate good nominal control policies?
3) How to semi-autonomously refine policies for optimal performance?

Methods





Teaching (one of three):
- Policy learning from demo
- Inverse reinforcement learning
- Trajectory optimization from via point specification

Nominal policy:
- Motion/Impedance primitives
- ANN or Gaussian Process for policy representation

Refinement of policies:
- Reinforcement learning for policy improvement
- Iterative trajectory optimization

Roadmap & Milestones

Main tasks:
- Literature review and evaluation of prior work
- A model-based trajectory optimization for common assembly tasks
- A control policy representation and learning in a reinforcement learning framework which utilizes the trajectory optimization result
- A solution involving model free trajectory optimization

Additional tasks:
- Combine learning from demonstration (kinesthetic teaching) with trajectory optimization?
- Extend result to bimanual skill
- Online learning for robust execution
- Stable and/or safe learning for continuous control

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