Teaching and Reinforcement Learning of Robotic View-Based Manipulation

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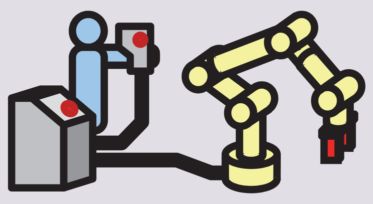
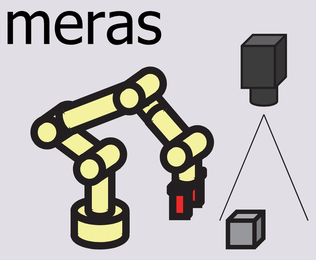
Background

- Conventional Teaching/Playback
  - still widely used
  - versatile
  - for constant task conditions
    - e.g.) initial pose of object does not change



- Typical object localization with cameras
  - Model-based image processing
  - Object-specific: versatility is limited
  - Calibration is necessary



Motivation

- To develop a **versatile** robot programming method that can cope with change of task conditions

"View-based teaching/playback": robot programming with **view-based** (or appearance-based) image processing

[Maeda 2010 ICAM] [Maeda 2011 ICRA]

- To minimize required human teachings in view-based teaching/playback

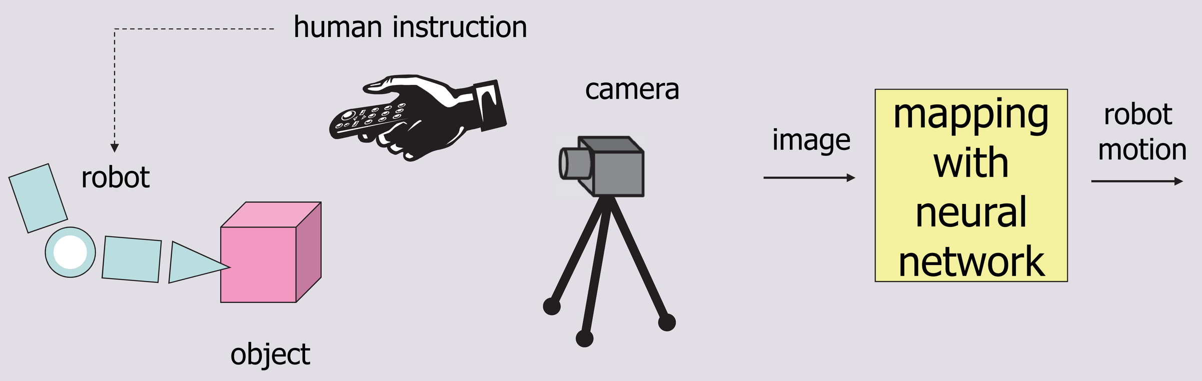
Reinforcement Learning (RL) should be integrated

[Maeda 2011 ISAM]

View-Based Robot Programming with Reinforcement Learning

Overview [Maeda 2011 ISAM]

Step 1. View-based supervised learning with human demonstration



Step 2. View-based reinforcement learning

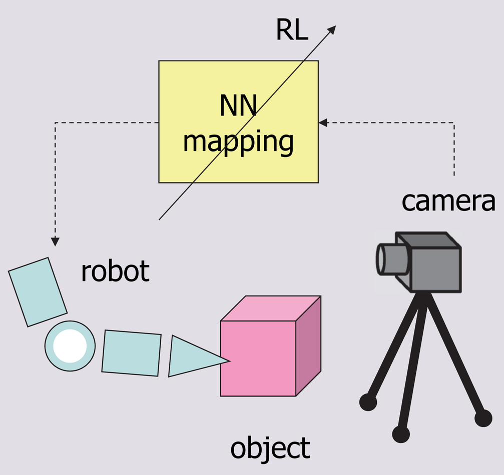
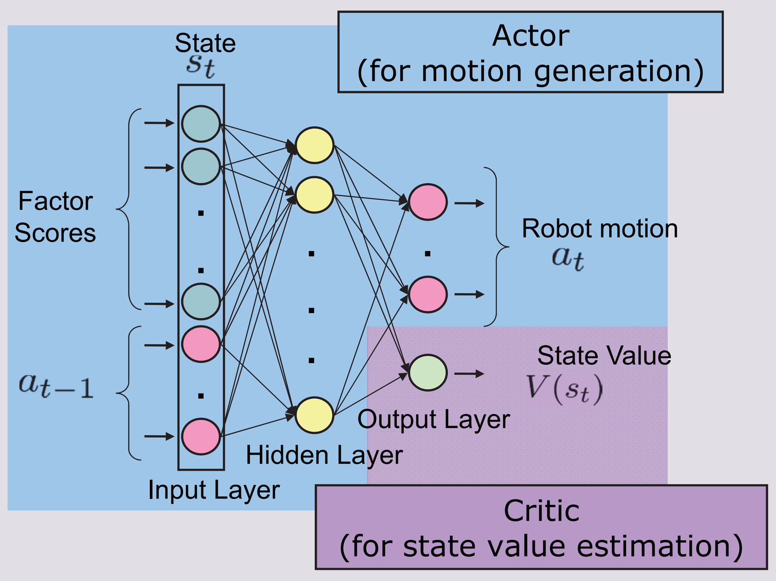
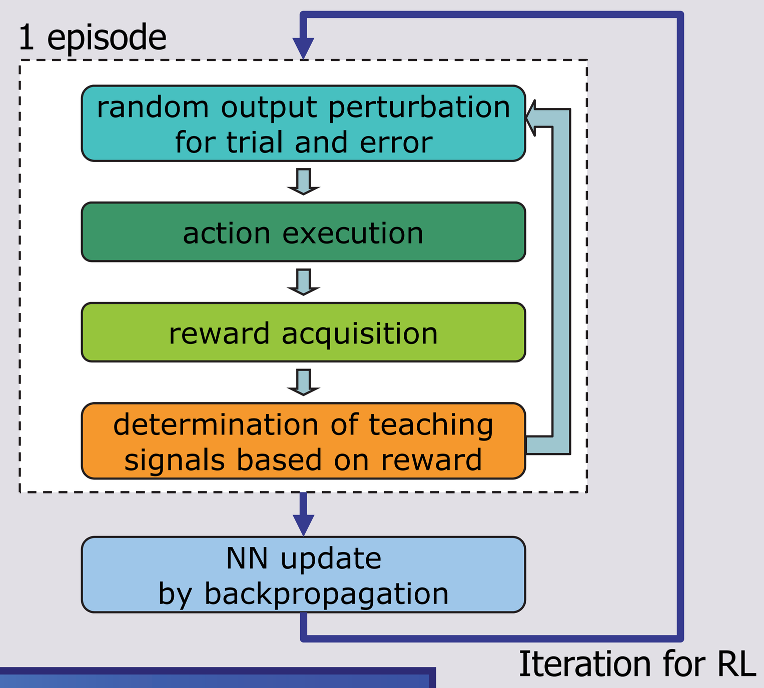


Image-to-motion Mapping

- 3-layered neural network (NN)
- Factor scores computed by PCA (Principal Component Analysis) are used for NN input instead of raw pixel data



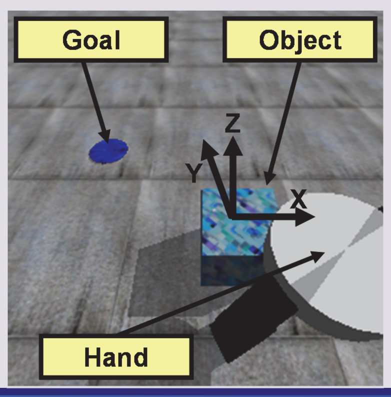
Actor-critic-based RL



Results

- Successfully applied to pushing and pick-and-place tasks in a virtual environment
- RL requires huge computation (typically ~6000 [s])

Acceleration is required



Computation Acceleration

On PCA (computing factor scores)

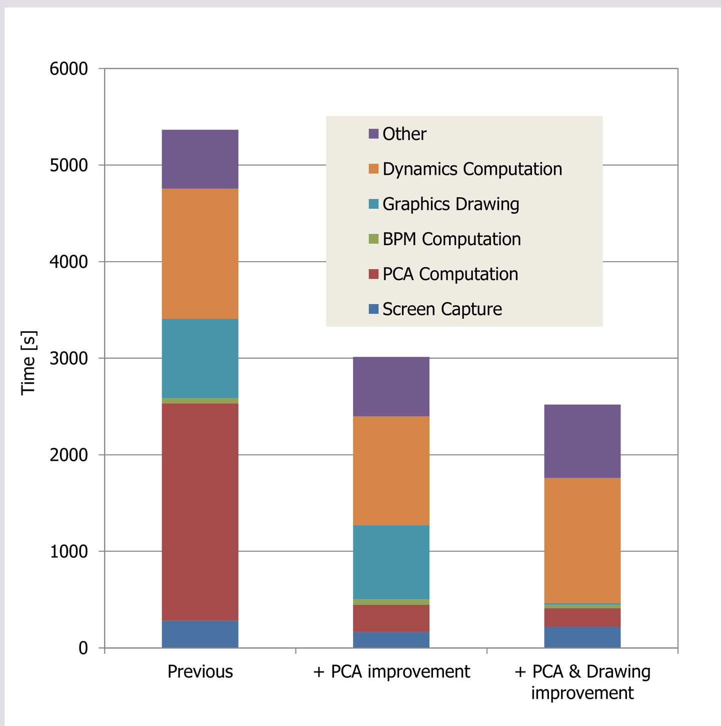
- SIMD (Single Instruction, Multiple Data) Operations
  - Intel AVX instructions
- Multi-Thread

On Graphics Drawing

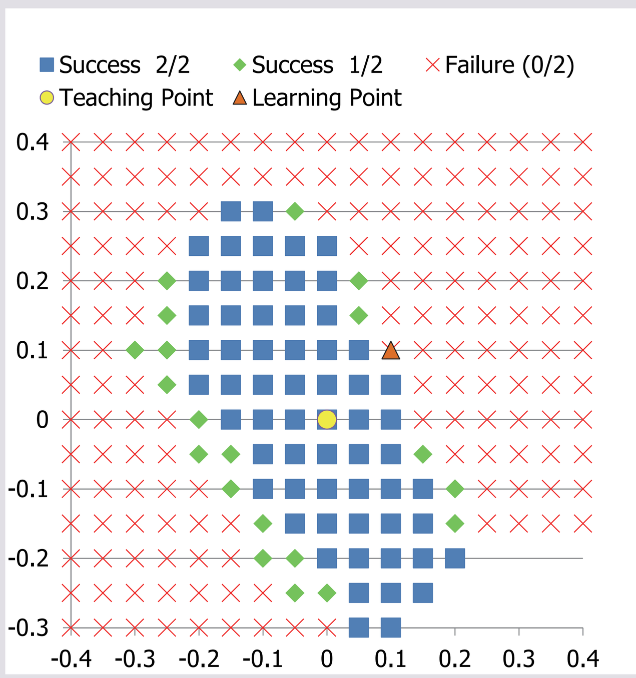
- Skipping Unnecessary Drawing
  - Simulation scenes are drawn only when taking screenshots for view-based control

Results

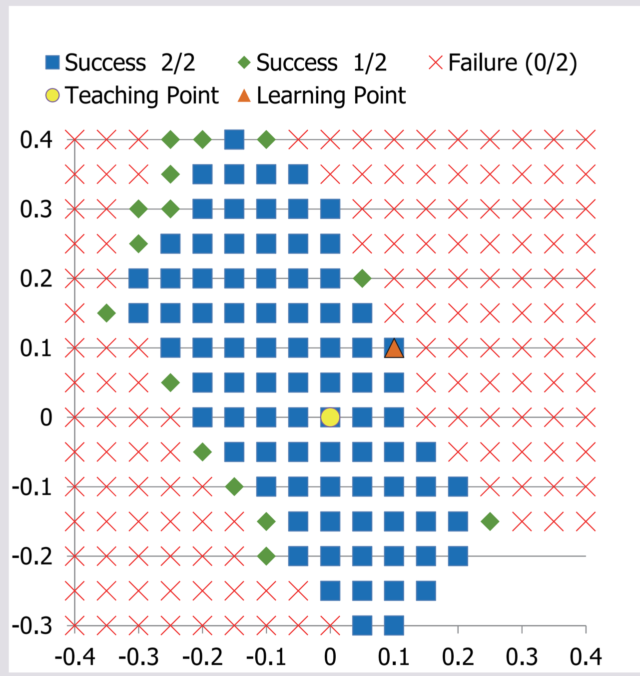
- 50% faster than our previous implementation



- Example) Allowable initial object positions before/after RL



Before RL



After RL

Conclusion

Summary

- Our view-based robot programming with reinforcement learning can deal with changes in task conditions with minimal human demonstrations
- Computational efficiency: improved 50%
- Learning success rate: improved 30% (not explained in this poster)

Future work

- Acceleration of learning of neural networks
  - Required for fast computation with better learning success rate
- Application of various tasks in virtual/real environments

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