Doctoral thesis/dissertation Digest Form

Thesis/dissertation Title:
Disentangled Dynamics Learning through Randomized-to-Canonical Visual Translation for Sim-to-Real Robotic Manipulation

Student’s Name:
Tomoya Yamanokuchi

Approved Digest:

Sim-to-Real transfer of visual dynamics using domain randomization has been studied in recent years, but the model can only learn the dynamics of a limited number of patterns due to the model's capacity, which currently only allows the model to be transferred to test environments with small visual reality gaps. Accordingly, the dynamics reality gap cannot be taken into account due to the constraints of the dynamics patterns to be learned. In this study, we propose a learning framework that enables Sim-to-Real transfer of visual dynamics for test environments with large visual reality gaps and a dynamics reality gap. While conventional model learns state transitions of images, we first extract task-relevant features of images and then learn their dynamics. This allows us to learn shared dynamics independent of visual properties and to capture environmental variations on top of them. To confirm the effectiveness, we conducted two extended case studies. In the first case, Sim-to-Real transfer was verified for test environments with large visual reality gaps in a valve rotation task, and it was confirmed that our model can be transferred to a wide range of test environments. In the second case, Sim-to-Real transfer was validated for test environments that included both visual and dynamics reality gaps. Here, we used an object-pushing task in which object size varied as a dynamics reality gap in the test phase. Results showed that the proposed model can capture dynamical variations, enabling flexible manipulation based on object size.