

# Tekin Alp Meriçli

**Thesis Supervisors: Prof. H. Levent Akın and Prof. Manuela Veloso**

## **Case-Based Mobile Manipulation**

### **Abstract**

The ability to manipulate the environment is one of the primary skills that autonomous mobile service robots are expected to have, considering that the daily lives of humans heavily rely on this skill. There are various ways for a mobile robot to perform manipulation, the exact form of which is determined by the requirements of the task and the constraints imposed by the physical properties of the environment, the object, and the robot itself. Anecdotal evidence suggests that humans mostly reuse their manipulation experiences, acquired through interaction and observation, especially in recurring everyday manipulation tasks, both in prehensile and non-prehensile manipulation contexts. With this motivation, this thesis contributes a case-based approach to achieving practical and efficient mobile manipulation through the utilization of past experience, stored as object-specific, distinct, and potentially probabilistic cases. In scenarios where prehensile manipulation is possible, this guidance combined with sampling-based generative planners helps reduce planning time by deliberately biasing the planning process towards the feasible cases while increasing the overall robustness and repeatability of the method. When non-prehensile manipulation techniques, such as push-manipulation, need to be utilized, these probabilistic cases can be used as building blocks for constructing safe and achievable push plans to navigate the object of interest to the desired goal pose as well as to potentially push the movable obstacles out of the way in cluttered task environments. Additionally, incremental acquisition and tuning of the probabilistic cases allows the robot to adapt to the changes in the environment, such as increased mass due to loading of the object of interest for transportation purposes. The purely interaction and observation driven nature of our method makes it robot, object, and environment (real or simulated) independent, as we demonstrate through extensive testing and experimentation. We also verify the validity of our push-manipulation method in preliminary real world tests.

### **PUBLICATIONS**

#### **Journals**

1. **Tekin Meriçli**, Manuela Veloso, and H. Levent Akın. Push-manipulation of complex passive mobile objects using experimentally acquired motion models. *Autonomous Robots*, pp. 1–13, Springer US, 2014. (SCI)
2. **Tekin Meriçli**, Manuela Veloso, and H. Levent Akın. Improving Prehensile Mobile Manipulation Performance through Experience Reuse. *International Journal of Advanced Robotic Systems*, 2014. (Accepted) (SCI-E)
3. **Tekin Meriçli**, Manuela Veloso, and H. Levent Akın. A Case-Based Approach to Mobile Push-Manipulation. *Journal of Intelligent and Robotic Systems*, 2014. (Under review after revision) (SCI-E)

## Conferences & Workshops

1. **Tekin Meriçli**, Manuela Veloso, and H. Levent Akin. Achievable Push-Manipulation for Complex Passive Mobile Objects using Past Experience. In *12th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2013)*, Saint Paul, Minnesota, USA, 2013.
2. **Tekin Meriçli**, Manuela Veloso, and H. Levent Akin. An Experience-Based Approach to Mobile Push-Manipulation. In *Computer Science Student Workshop*, Istanbul, Turkey, 2013. (**Best Paper Award**)
3. **Tekin Meriçli**, Manuela Veloso, and H. Levent Akin. Experience Guided Achievable Push Plan Generation for Passive Mobile Objects. In *Beyond Robot Grasping - Modern Approaches for Dynamic Manipulation, IROS'12*, Algarve, Portugal, 2012.
4. **Tekin Meriçli**, Manuela Veloso, and H. Levent Akin. Experience Guided Mobile Manipulation Planning. In *8th International Cognitive Robotics Workshop, AAAI'12*, Toronto, Canada, 2012.

## Defense Jury Members

- |                                   |                               |
|-----------------------------------|-------------------------------|
| 1. Prof. H. Levent Akin           | Boğaziçi University           |
| 2. Prof. Manuela Veloso           | Carnegie Mellon University    |
| 3. Prof. Ethem Alpaydın           | Boğaziçi University           |
| 4. Assist. Prof. Hatice Köse      | İstanbul Technical University |
| 5. Assoc. Prof. Olcay Kurşun      | İstanbul University           |
| 6. Assist. Prof. Albert Ali Salah | Boğaziçi University           |

**Defense Date:** 30.06.2014