

## Robotic Task and Motion Planning for Long-Horizon Problems

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### Opis teme

The project focuses on planning methods for robots that must solve complex, multi-step tasks in structured or semi-structured environments, potentially under visual and language-based task specifications.

Long-horizon robotic problems require reasoning across multiple levels of abstraction, including task sequencing, symbolic consistency, geometric feasibility, and execution-aware replanning. Task and motion planning provides a principled framework for addressing these challenges by combining high-level symbolic reasoning with low-level motion generation and feasibility checking.

This internship emphasizes AI planning methods, including search algorithms, PDDL-based modeling, and related approaches to sequential decision-making in robotics. Depending on the project scope, vision-language models (VLMs) may also be incorporated for semantic grounding, subgoal proposal, perception, or search guidance.

### Zadaci i ciljevi

The internship may involve one or more of the following directions:

- Task and motion planning for long-horizon manipulation or mobile manipulation problems
- Symbolic task specification and domain modeling using PDDL or related planning languages
- Heuristic search, plan generation, replanning, and plan repair in robotic settings
- Incorporation of vision-language models for object grounding, semantic abstraction, or planner guidance
- Comparative study of planning-based and learning-based methods for long-horizon robotic tasks

### Responsibilities

- Develop and implement task and motion planning algorithms for robotic task execution
- Formulate planning problems using symbolic representations such as PDDL
- Investigate the use of search algorithms and heuristic planning methods in long-horizon robotics

- Integrate perception, motion feasibility, and execution feedback into planning pipelines
- Evaluate planning performance in simulation and, where applicable, on robotic platforms
- Analyze failure cases, search efficiency, and robustness under execution uncertainty
- Document experiments and contribute to research reports or publications

### **Lista referenci**

- [1] S. Azirar, Z. Ajanovic, and H. Blum, “SYMBOLIZER: Symbolic Model-free Task Planning with VLMs,” Apr. 20, 2026, arXiv: arXiv:2604.17830. doi: 10.48550/arXiv.2604.17830.
- [2] Z. Ajanović, E. Regolin, B. Shyrokau, H. Čatić, M. Horn, and A. Ferrara, “Search-based task and motion planning for hybrid systems: Agile autonomous vehicles,” Engineering Applications of Artificial Intelligence, vol. 121, p. 105893, 2023, doi: 10.1016/j.engappai.2023.105893.

### **Tražene vještine od studenata**

- Strong programming skills in Python
- Background in AI planning, search algorithms, or robotics
- Familiarity with one or more of the following: PDDL or related symbolic planning formalisms; classical planning, heuristic search, or automated planning; motion planning; robot manipulation; vision-language models)
- Interest in long-horizon decision-making for embodied systems

### **Link za grafički element**

<https://arxiv.org/abs/2604.17830>