Post-Doc. Position: Mission planning for a fleet of autonomous robots

Location: Laboratoire d'Infomratique de Grenoble (LIG) – Marvin team, Grenoble, France (with some periods at ONERA, Toulouse, France)

Duration/Dates: 24 months

Student profile: Computer Science

Supervisors:

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Post-Doc Description

One of the primary challenges in developing autonomous systems is defining decision-making functions, such as the task scheduler or planner. This challenge is particularly pronounced in complex underwater missions, where robotic systems (UAVs) comprise a diverse fleet of autonomous and/or teleoperated vehicles tasked with performing intricate operations. Each UAV possesses the capability to execute tasks and fulfill roles with its unique performance characteristics. These tasks encompass activities like deploying or retrieving vehicles, reaching designated areas, mapping terrain, inspecting objects, relaying information, and more.

These missions demand sophisticated and automated fleet planning and replanning. This involves considering the overarching objective while optimizing the allocation of roles and tasks to the available robotic systems. This optimization process takes into account multiple objectives related to time, quality, and the quantity of resources mobilized, each assigned varying degrees of importance.

To address this problem, the proposed Post-Doc subject aims to utilize AI Planning approaches[1], particularly hierarchical approaches (HTN) [1]. These approaches enable the definition of complex environments and provide the flexibility to describe mission planning problems at various levels of granularity. However, it's worth noting that the representation used in general HTN planning does not explicitly incorporate time, and there is no commonly accepted standard language for hierarchical planning with temporal constraints within the community.

Nonetheless, a recent development in this area is the introduction of a syntax and semantic formulation for describing Temporal HTN problems in HDDL2.1 [2]. The primary objective of this post-doc is to build upon this work and develop a hierarchical temporal planner capable of generating complex missions. As our needs for expressivity evolve, the planner will adapt accordingly. The development of such a planner will significantly advance the state of the art, as there are currently very few planners that operate under this paradigm.

In addition to evaluating the proposed planners, an industrial case study will assess the effectiveness of the approach and its integration into robotic platforms. This evaluation will utilize simulation tools and sea trials to ensure practical applicability.

Expected Results

We wish to develop three contributions during this post-doc:

[1] To get acquainted with AI Planning, we highly recommend installing and testing the PDDL4J library, which can be found at this address: `http://pddl4j.imag.fr/`.

- To develop an HTN Temporal planner
- To propose an approach (based on the planning algorithm) to specify recovery strategies (actions to be taken in case of failure in the plan execution)
- To integrate the approach on a robotic platform, real or simulated, and assess the effectiveness of the approach.

References

[1] M. Ghallab, D. Nau, and P. Traverso. *Automated Planning: Theory and Practice*. The Morgan Kaufmann Series in Artificial Intelligence. Morgan Kaufmann, Amsterdam, 2004.

[2] D. Pellier, A. Albore, H. Firino, and R. Bailon-Ruiz. HDDL 2.1: Towards Defining an HTN Formalism and Semantics with Time. In *ICAPS workshop on HTN Planning*, 2023.