CogRob Report

Your Name

Abstract—Write your abstract here.

Index Terms—Write up to three keywords about your work.

I. Introduction

This is a template for MAS R&D projects, based on IEEETran. Here are some preliminaries about some common things you need to do to use the template:

- Add your references to the file references.bib and cite them as Mustermann and Smith [1] (if there are more than three authors, cite as Mustermann et al. [1]).
- Refer to sections as Sec. I.
- You can include figures as follows (note that the figure caption is below the figure). Refer to figures as Fig. 1.

Fig. 1: My caption

1.

- You can add tables as follows (note that the table caption is above the table). Refer to tables as Tab. I.

TABLE I: My caption

Header 1	Header 2
Cell 1	Cell 2
Cell 3	Cell 4

- You can add equations as follows.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \tag{1}$$

Refer to equations as Eq. 1.

A. Motivation

Describe the context of your work and the motivation for it.

B. Problem Statement

Describe the problem you are addressing in the work.

*Submitted to the Department of Computer Science at Hochschule Bonn-Rhein-Sieg in partial fulfilment of the requirements for the degree of Master of Science in Autonomous Systems

†Supervised by Supervisor 1 (Affiliation) and Supervisor 2 (Affiliation)

‡Submitted in Month 20XX

C. Proposed Approach

Write a short summary of your proposed approach.

II. Related Work

Summarise the relevant related work in this section and position your work with respect to the related work.

III. Background

This is an optional section in which you can introduce concepts, terms, or methods that are important for understanding your approach and that would not directly fit in Sec. IV. If you do not need this section, comment out the respective line in report.tex.

IV. Methodology

A. Simulation

The agent and its environment were simulated using the PyBullet physics engine. As PyBullet is a Python module, it's functionality can be directly integrated in any python script. This allows precise control over the simulation and its interaction with external tool calls. PyBullet also comes with methods to create custom objects as well as a fully implemented robotic arm, the KUKA iiwa model. These methods and the KUKA iiwa robotic arm where used to create the agents embodiment and the environment it can act in.

The agent's body is modeled as a mobile manipulator, consisting of a square omnidirectional base and a 7-DoF robotic arm derived from the KUKA iiwa model. To increase maneuverability, the rotational joint limits of the arms joint connecting the base to the arm were disabled, enabling full 360° reach around the base. A fully articulated gripper was not implemented. Instead, grasping and placing were simplified by attaching objects directly to the end-effector when within a predefined proximity threshold, and detaching them at the desired placement location, as illustrated in Fig. 2.

The environment was designed as a simplified two-room household, comprising a kitchen and a living room. The kitchen contains a three-layer shelf and a table, both capable of supporting objects. The living room contains a television placed on a table. The two rooms are connected by a hallway, as shown in Fig. 3.

To interact with the environment and its objects, the agent was equipped with several tool functions, each exposed through a tool-calling interface with text-based status responses. The implemented tools are summarized below:

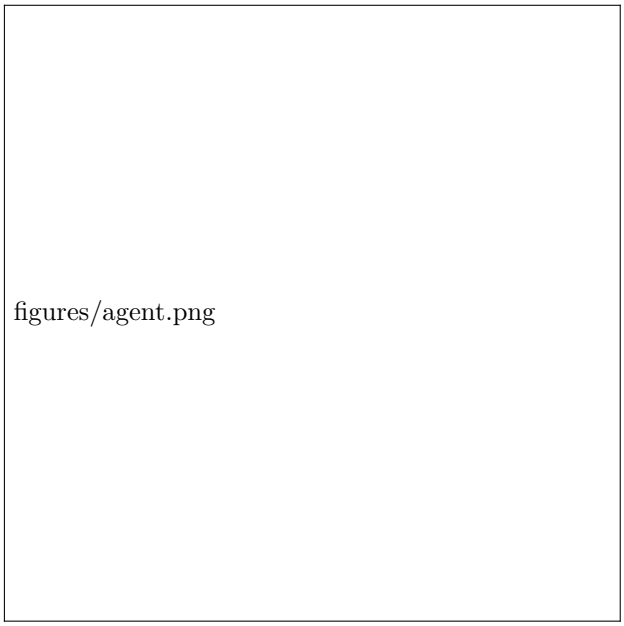

Fig. 2: The simulated mobile manipulator consisting of a square omnidirectional base and a 7-DoF arm.

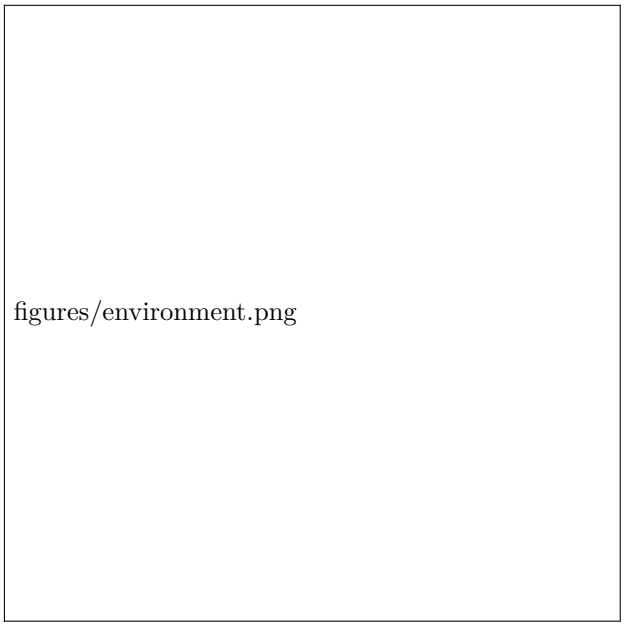

Fig. 3: The simulated household environment consisting of a kitchen, a living room, and a connecting hallway.

- Perceive: Returns the agent's location on a semantic map of the environment, as well as a list of objects detected in the current location.
- Move To: Executes navigation to a goal location on the semantic map. Path planning is performed using the A* algorithm; if a valid path is found, the agent follows it until the goal is reached. If no path is available, the tool reports failure.
- Grab: Moves the robot arm toward a specified target object. If the end-effector reaches within a proximity threshold, the object is attached to the arm, and the tool reports success. Failure is reported if the target object does not exist, is out of reach, or if the agent is already holding an object.
- Place: Allows the agent to release the currently held object at a specified location. Placement succeeds if the end-effector reaches the designated location, the location is unoccupied, and the agent is holding an object. Otherwise, the tool reports failure, specifying the violated condition.

V. Evaluation

If your work involved experiments, describe the experimental setup and the results in this section.

VI. Conclusions

A. Summary

B. Contributions

C. Future Work

References

[1] M. Mustermann and J. Smith, "Some Title," in Some Conference, 2023, pp. 1–8.

ACKNOWLEDGMENT

Write your acknowledgments here.

STATEMENT OF ORIGINALITY

[If AI assistants have not been used, use this sentence] I, the undersigned below, declare that this work has not previously been submitted to this or any other university and that it is, unless otherwise stated, entirely my own work.

[If an AI assistant has been used, use this sentence] I, the undersigned below, declare that this work has not previously been submitted to this or any other university and that it is, unless otherwise stated, entirely my own work. The report was, in part, written with the help of the AI assistant [AI assistant name] as described in the appendix. I am aware that content generated by AI systems is no substitute for careful scientific work, which is why all AI-generated content has been critically reviewed by me, and I take full responsibility for it.

Date Signature

Appendix

Please limit the main part of the report to 20 pages (not including the references, the statement of originality, and the appendix).

In your appendix, you can add any additional details about your work, such as:

- extra results that do not necessarily belong in Sec. V
- more detailed justifications of certain algorithm design decisions

- algorithm proofs

Additionally, in the case of using AI assistants, describe in detail what content was generated using an AI assistant. In particular, name the AI assistant(s) that you used and how they were used (e.g. which prompts were used, and for which parts of the project).