AI-MAS Group

Computer Science & Engineering Department

Long-Term 3D Mapping Of Unknown Environments for Social Robotics

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1. Introduction/Context

In the two past decades we have witness an ever increasing presence of robots in our daily lives, where, according to the International Federation of Robotics [1], by 2008 the usage of service robots had already outgrown the number of industrial robots. In this sense, social robots that can assist elderly or disabled people are of special interest from the current research perspective as they can significantly improve the quality of life, promoting increased independence for people with special needs. Moreover, robots that are able to interact with people can offer an interesting and personalized experience when visiting museums, fun parks or even assist customers during shopping. One of the critical components that enables the autonomy of such robots is the ability to perceive and build a representation of the environment. This research problem is commonly referred to as the Simultaneous Localization and Mapping problem and in robotics it is considered to be a fundamental problem of perception that is integral for the realization of robust panning and safe navigation under motion and sensor information uncertainties [3]. Nowadays, for certain simplifying assumptions about the robot, environment and performance the problem is essentially considered to be solved [2]. However, Long-Term 3D Mapping for prolonged operation of social robotics has yet to find an answer, especially when considering the dynamics, clutter and size of the environment in which these robots operate. In this sense, this research topic aims to develop robust 3D Mapping frameworks for social robotics that enable both Long-Term operation and robust motion planning [4, 5].

2. Objective

The main objective of this research is to develop a robust 3D Mapping application for social robotics using the Pepper Humanoid robot in conjunction with RGB-D or 3D LiDAR sensors (e.g. Kinnect). Specifically, the developed application has to create 3D map of the environment that can be continuously updated in order to support Long-Term operation for a venue assistant humanoid robot.

The main milestones are as follows:

- Getting to know Pepper and supporting tools/libraries (e.g. kninect, ROS)

- State of the art SLAM techniques investigation (e.g. octo-maps, RTAB, iSAM)

- Modeling the application architecture by considering associated constraints (e.g. loop-closure, memory management, re-mapping)
- Application modules implementation
- Integration with light-weight motion planning algorithms
- Application testing / optimization and re-works
- Creating a 3D Map of the entire PRECIS building 3'rd floor

3. Required and Learned Skills

Requirements:

- Adequate programming experience in Java, Python and/or C++
- Knowledge about probabilistic reasoning under uncertainties is a plus

Skills learned:

- Experience working with robots, sensors and ROS
- Experience working with large data streams
- Experience in building autonomous robot applications
- A deep understanding of probabilistic robot models

4. References

[1] International Federation of Robotics. (2008). World robotics survey (Tech. Rep.). Statistical Department – International Federation of Robotics.

[2] Frese, Udo. "Interview: Is slam solved?." *KI-Künstliche Intelligenz* 24.3 (2010): 255-257.

[3] Cadena, Cesar, et al. "Past, present, and future of simultaneous localization and mapping: Toward the robust-perception age." *IEEE Transactions on Robotics* 32.6 (2016): 1309-1332.

[4] Sun, Li, et al. "Recurrent-OctoMap: Learning State-Based Map Refinement for Long-Term Semantic Mapping With 3-D-Lidar Data." *IEEE Robotics and Automation Letters* 3.4 (2018): 3749-3756.

[5] Labbé, Mathieu, and François Michaud. "Long-term online multi-session graph-based SPLAM with memory management." *Autonomous Robots* 42.6 (2018): 1133-1150.