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AUTONOMOUS MULTI-ROBOT TOPOLOGICAL SPATIAL COGNITION

Abstract

This thesis is concerned with topological spatial cognition in multi-robot systems. With topological reasoning, continuous space is discretized into a set of places that are spatially related. Thus, topological spatial cognition is associated with the acquisition, organization, utilization and revision of knowledge of places and their spatial relations. In turn, this can occur either through the direct experience of the robot or indirectly based on the knowledge of other robots. In this perspective, the problem is handled in three stages. First, efficient sensory data representation is studied and a model based on previously developed bubble space is presented. Next, the full range of spatial processing associated with direct experience is considered via introducing a topological spatial cognition (TSC) model. This model enables each robot to detect places, recognize them or learn them as necessary in a completely unsupervised, incremental and organized manner. The robot continually builds and utilizes its long-term spatial memory where knowledge of places and their spatial relations are retained in separate, but related parts. Finally, the problem of expanding each robot's spatial cognition based on other robots' knowledge is addressed and a model that enables each robot to merge its spatial memory with those of other robots is proposed. All of the proposed approaches are evaluated on benchmark data sets as well as on real robots. The experimental results demonstrate that robots are able to autonomously become cognizant of their surrounding through either their individual experience or that of other robots.

PUBLICATIONS

Journals

- **Karaoguz** H. and H.I. Bozma, "An Integrated Model of Autonomous Topological Spatial Cognition", *Autonomous Robots*, (in press), 2015
- **Karaoguz** H., O. ErKent and H.I. Bozma, "RGB-D based place representation in topological maps", *Machine Vision and Applications*, 25(8), pp 1913-1927, 2014

Conferences

- **Karaoguz** H., H.I. Bozma, "Topological Place Recognition Based on Long-Term Memory Retrieval", *In Proc. Int. Conf. Adv. Robot. (ICAR)*, 2015 (Won Best Student Paper Award)
- **Karaoguz** H., H.I. Bozma, "Reliable Topological Place Detection in Bubble Space", *In Proc. Int. Conf. Robot. Autom. (ICRA)*, pp 697-702, 2014
- **Karaoguz** H., H. Bayram and H.I. Bozma, "Communication Integrated Control Architecture in Multi-Robot Systems", *ICRA 2013 Workshop on Towards Fully Dec. Multi-Robot Systems*, 2013

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