A Bionic Cognitive Based SLAM System

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Abstract In this study, BioSLAM, a bionic simultaneous localization and mapping system, is presented. BioSLAM models after human cognition for registering environment features and for recognizing whereabouts during navigation. When exploring a possibly unknown environment, BioSLAM incrementally updates a topological cognitive map (TCM) of the environment and achieves self-localization through scenery recognition without relying on external positional input. Computationally, BioSLAM is an adapted layered Hidden Markov Model, that mimics the Neocortex in creating cognitive memories of sensory information and in preserving the timing relation between memories. A TCM is composed of interconnecting Place Cells that contains sensory and positional information of a particular location. Links between Place Cells record dynamically updated probability of the visiting order between the two connecting Place Cells. In this model, the Place Cells function as the mechanisms to develop space cognition as in the Hippocampus. Simulation results show that when placed in an arbitrary complex environment, through self-learning and constant updating of Place Cells, BioSLAM can build an efficient TCM that provides descriptive information of locations. Furthermore, location recognition accuracy remains high as complexity of the environment increases. Simulation results also showed that BioSLAM provides useful predictive environmental change information.

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