HUMANITY CENTERED ROBOTICS INITIATIVE

BROWN

Matt Klingensmith
Carnegie Mellon University

Tech Talk: "Articulated SLAM"

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Uncertainty is a central problem in robotics. In order to understand and interact with the world, robots need to interpret signals from noisy sensors to reconstruct clear models not only of the world around them, but also their own internal state. For example, a mobile robot navigating an unknown space must simultaneously reconstruct a model of the world around it, and localize itself against that model using noisy sensor data from wheel odometry, lasers, cameras, or other sensors. This problem (called the SLAM problem) is very well-studied in the domain of mobile robots. Less well-studied is the equivalent problem for robot manipulators. That is, given a multi-jointed robot arm with a noisy hand-mounted sensor, how can the robot simultaneously estimate its state and generate a coherent 3D model of the world? We call this the articulated SLAM problem.

Given actuator uncertainty and sensor uncertainty, what is the correct way of simultaneously constructing a model of the world and estimating the robot's state? In this work, we show that certain contemporary visual SLAM techniques can be mapped to the articulated SLAM problem by using the robot's joint configuration space as the state space for localization, rather than the typical SE(3). We map one kind of visual SLAMt technique, Kinect Fusion, to the robot's configuration space, and show how the robot's joint encoders can be used appropriately to inform the pose of the camera. The idea that the configuration of the robot is not merely a sensor which informs the pose of the camera, but rather it is the underlying latent state of the system is critical to our analysis. Tracking the configuration of the robot directly allows us to build algorithms on top of the SLAM system which depend on knowledge of the joint angles (such as motion planners and control systems).

Matt Klingensmith is a final-year PhD candidate at the Robotics Institute at Carnegie Mellon. He is co-advised by Sidd Sirinivasa and Michael Kaess. Matt previously earned his BS in Computer Science, and MS in Robotics at Carnegie Mellon. Matt was a core member of CMU's DARPA Autonomous Robotic Manipulation Software team at the National Robotics Engineering Center. He has also interned at Willow Garage, RE2, and Google Tango. As part of CMU's Personal Robotics Lab, Matt's current research involves state estimation and SLAM for robotic manipulation, and the intersection of 3D sensing and robot manipulators.