Learning Accurate Three-Dimensional Models from Range Data using Global Constraints

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Abstract: Recently, the acquisition of three-dimensional maps from range scans acquired with mobile robots has become more and more popular. This is motivated by the fact that robots act in the three-dimensional world and several tasks such as path planning or localizing objects can be carried out more reliably using three-dimensional representations. Key questions in this context are how to reduce the complexity of the data and how to efficiently match scans. Man-made structures such as buildings typically contain many structures such as planes and corners that are parallel. In this presentation we describe recently developed techniques that take into account such constraints to better approximate the data by planes to compute more accurate registrations. For plane extraction we use a hierarchical version of the expectation maximization (EM) algorithm to simultaneously cluster the data points into planes and the planes into their corresponding main directions. The information about the main directions is incorporated in the maximization step to calculate the parameters of the individual planes. We present experimental results obtained with real data and in simulation which demonstrate that our algorithm can accurately extract planes and their orientation from range data. Further results illustrate that our approach yields more accurate planes than the standard EM technique. Additionally, we present an approach that improves the registration process of three-dimensional range scans by introducing global constraints between the poses from which the scans were taken. Our approach minimizes not only the distance between scans, but also the distance of edges extracted from the scans to planes that are supported by the edges. This seriously decreases the required overlap between scans and in this way allows to reduce the number of data points in the model. We present experimental results illustrating that the global constraints allow to learn more accurate models even when there only is a small overlap between the scans.

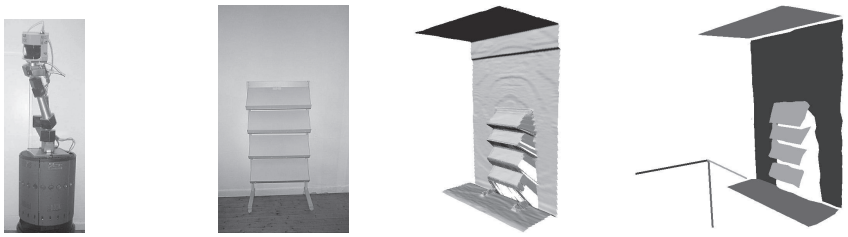

Abbildung 1: Mobile robotic Zora (left image), scene scanned by the robot (second image), resulting data (third image), and final model (right image).