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Theoretical Investigations on Open Source Algorithms for Laser Scanning based SLAM and Software Implementation on a Robot

The investigation demonstrates the state of the art algorithms which are nowadays being used as a solution of the 2D and 3D SLAM (Simultaneous Localization and Mapping) problem. SLAM is how a robot can map an unknown environment and localize itself on it at the same time. So it seeks to recover the navigation state vector (x,y,θ) from either fixed landmarks or by estimating it from the scan registrations. The investigation focuses on the laser scan based solutions and shows the advantages and disadvantages of the different Bayesian approaches i.e. Kalman Filter, Extended Kalman Filter (EKF), Extended Information Filter (EIF), Sparse Extended Information Filter (SEIF) and the FastSLAM which is based on the particle Filter.

Figure 1: Equipped Robot for performing SLAM

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The investigation shows also the model-free approaches which do not depend on forming neither motion nor observation models but relies directly on the scan matching for estimating the navigation state vector of the Robot. An Implementation of a chosen algorithm (2D Hector SLAM, **He**terogeneous **C**ooperating **T**eam **o**f **R**obots) which is written by Hector Team in University of Darmstadt 2008. The algorithm is tested with a Volksbot and a Velodyne laser scanner Fig. (1). A navigable occupancy grid 2D map is generated Fig. (2) with less than 1 cm accuracy.

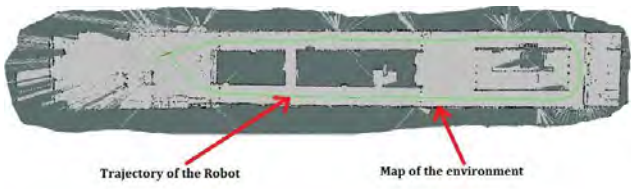

Figure 2: Map of 2nd floor, B-Building, HSKA Campus.

ROS (Robot Operating System) which is an Open-Source Meta operating system is used for controlling the Robot and the laser scanner.

Finally, the obtained map with the trajectory of the Volksbot show a high reliability of the chosen algorithm, because of its ability of closing the loops and dealing with high rate frequencies. The Algorithm is also used in handheld mapping systems and UAVs.