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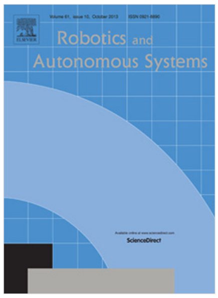

Special Issue on Localization and Mapping in Challenging Environments

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Special Issue on Localization and Mapping in Challenging Environments

Reliable localization and mapping are competencies essential to realize many different robot applications. A broad range of techniques, ranging from statistical approaches such as Kalman filters and particle filters, to optimization based methods, have been developed in the last two decades for solving these problems. Significant contributions have been made in improving the efficiency and robustness of robot localization and mapping in both 2D and 3D scenarios using different sensors such as laser scanners, monocular cameras, RGB-D sensors and many others. However, it is still a significant challenge to achieve robust localization and mapping in environments populated with dynamic or deformable objects, underground with uneven terrain, underwater in turbid conditions, and in environments with changing lighting conditions. This special issue aims to consolidate some recent developments in localization and mapping in challenging environments, providing state-of-the art approaches and algorithms that are able to facilitate the use of mobile robots in a range of application domains.

Twenty-nine papers were received out of which eighteen were accepted after a few rounds of reviews and revisions. Accepted papers cover a large range of topics including localization, tracking and mapping in dynamic environments with laser sensors, localization using acoustic sensors, Simultaneous Localization and Mapping (SLAM) in underwater environments, 3D point cloud registration and 3D reconstruction, RGB-D SLAM in dynamic environments, global localization, loop closure detection, and industry applications of robot localization and mapping.

Four papers discuss robust vehicle navigation in outdoor environments with a laser scanner as the primary sensor**.** Wei et al. propose a strategy to detect moving/dynamic vehicles by using the difference between two consecutive scans and a likelihood-field-based vehicle measurement model. Registration is achieved by the combination of coarse motion estimation and fine batch adjustment. Wang et al. study the pedestrian recognition and tracking problem for autonomous vehicles using a 3D LiDAR. A classifier trained by a support vector machine is used to recognize pedestrians, so that a timely prediction of pedestrian motions can be provided to the autonomous vehicle platform. In the paper by Li et al., a Gaussian Mixture Model (GMM) is proposed to represent a point cloud acquired from a 3D sensor. A hierarchical structure is employed to deal with the problem of the density variations at different ranges thereby increasing the robustness of the scan registration. Furthermore, when the platform is moving while scanning, a probabilistic graph is constructed by assigning each Gaussian component with a pose. Droeschel et al. propose a SLAM method where laser-range measurements are aggregated by registering sparse 3D scans with a local multi-resolution surfel map that has high resolution in the vicinity of the robot and coarser resolutions with increasing distance. A globally consistent dense 3D map of the environment is built through graph optimization and registration of incrementally built local dense 3D maps of nearby key poses. The drivability of the terrain is assessed by analyzing the height differences in an allocentric height map. The system has been successfully used in the DARPA Robotics Challenge and the DLR SpaceBot Camp.

Laser scanners are widely used for mapping in many applications. However, glass, mirrors, shiny or translucent surfaces cause erroneous measurements depending on the incident angle of the laser beam. Two papers in this special issue have addressed this challenge**.** Wang and Wang propose a simple and effective solution to identify glass panels by detecting the reflected light intensity profile around the normal incident angle to the glass panel. The glass detection method is integrated with SLAM algorithm and is shown to be able to detect and localise glass obstacles in real-time with around 95% accuracy. Koch et al. deal with the problem of mapping transparent and specular reflective objects with an extended version of the Mirror Detector Approach, named Reflection Classifier Approach. The characteristics identified in the measurements of different materials such as shiny metals, mirrors, and glasses, from different distances and angles are investigated. Experiments show that discrimination of transparent and reflective materials based on the reflected intensity is