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3D SCENE RECONSTRUCTION AND MOTION PLANNING FOR AN AUTONOMOUS MOBILE ROBOT IN COMPLEX OUTDOOR SCENES

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Abstract. *3D environment modeling and motion planning are two essential tasks for an autonomous mobile robot's outdoor navigation. In order to implement mobile robot large-scale motion planning, an edge-feature-based ICP algorithm is presented to complete 3D scene registration and reconstruction. According to the respective advantages of geometric features and terrain features, a novel motion planning approach is proposed based on the reconstructed scene. This method integrates the planar features and elevation information in one map to build the 3D roadmap, and then search a safe path with multiple constraints. A series of experiment results show the method's validity and practicability.*
Keywords: 3D scene reconstruction, Motion planning, 3D laser scanning, Mobile robot

1. **Introduction.** The effective recognition and perception of 3D environment are the most fundamental problems that have to be solved before the mobile robot can navigate and explore autonomously in complex outdoor environment. Compared with the indoor environment, the outdoor environment with completely unstructured characteristics has put forward higher requirements for the robot system's self-awareness, motion planning and dynamic decision making. There are several successful application cases in mobile robot 3D scene reconstruction and autonomous motion planning in structured environment, however, it is still hard to accomplish these tasks in completely unknown outdoor scenes.

A mobile robot working in typical unstructured outdoor scenes must have two fundamental abilities, 3D scene reconstruction and autonomous motion planning. The former enables a robot to complete 3D environment cognition and modeling. The latter helps a robot generate a feasible motion trajectory which can guarantee mobile robot's moving safely and optimally in outdoor scenes. There are two main technologies for mobile robot's spatial information acquisition, stereo vision and laser scanning. In our research, we only use 3D laser scanner to gather enough spatial information from outdoor scenes. Compared with stereo vision, laser range finder has not only much higher resolution, but also faster sampling rate with limited measurement noises. More importantly, laser range finder shows better adaptability in the dark environment.

Several groups are devoted to the research of 3D scene reconstruction and motion planning in 3D unstructured environment. The AVENUE project developed a robot for urban environments modeling [1], using a CYRAX laser scanner and a feature-based scan matching approach to register 3D scans. Thrun et al. [2] used two orthogonal 2D laser range finders to get the horizontal and vertical laser data respectively. Surmann's group [3, 4] developed an AIS 3D laser range finder and used it to complete 3D exploration and 3D