International Journal of Innovative Computing, Information and Control
Volume **7**, Number **9**, September **2011**

ICIC International ©2011 ISSN 1349-4198
pp. 5571–5582

MARS ROVER LOCALIZATION AND PATH-PLANNING BASED ON LIDAR AND ANT COLONY OPTIMIZATION

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Received June 2010; revised January 2011

Abstract. *This paper presents a novel method for Mars Exploration Rover (MER) localization and path-planning by means of the terrain data from the light radio detecting and radar (LIDAR) in the final descent phase. Firstly, the real 3D terrain data of landing area from LIDAR in probe body coordinate system is transformed into a topographic map of roving area in landing site coordinate system. The map is further quantized and processed to generate a hazard map corresponding with real craters and rocks, which will be downloaded to the MER navigation database. Then, a novel path-planning algorithm based on ant colony optimization (ACO) is presented. Goal-oriented behavior, inertial behavior and obstacle-following behavior are appended to every ant individual of ACO by means of the fusion of behavior weights. Moreover, the shortest path from landing point to the exploration site is optimized by the tight-rope algorithm on the base of the path-planning result of ACO. The method and software developed are tested by using simulating data and the validity of the path planning algorithm is testified by simulation.*
Keywords: Mars rover, Path-planning, Rover localization, ACO

1. **Introduction.** The Mars exploration architecture often consists of an orbiter, lander and rover. The NASA's Mars Exploration Program successfully conducted a lander-rover mission – Mars Pathfinder in 1997 [1]. The rover Sojourner provided powerful close-range tools for microscale rock investigation, soil research and other scientific objectives within a landing area of about 10m×10m. Future MSP (Mars Surveyor Program) exploration missions will extend the rover exploration range from the landing center region to an area of 10km×10km. This calls for high precision navigation and localization to guarantee the rover to safely traverse the Martian surface. Research was carried out on rover localization using several different methods. Volpe et al. [2] used a colored cylinder to provide reasonably accurate position and heading information for the rover within a 10 meter range at an accuracy of typically 5^0 for heading and 5% for distance. Another approach tested maximum likelihood estimation techniques for performing rover self-localization in natural terrain by matching range maps [3,4]. This technique can find the best position in some discretization of the pose space and does not require an initial estimate of the rover position. Li et al. [5] developed a bundle adjustment software to localize the Mars rover using descent and rover images by an extended bundle adjustment method, in which ground control points, tie points, camera calibration parameters and various distortion parameters were taken into account. The results of the rover localization experiments using the descent and rover imagery demonstrated that the rover positions were located within an accuracy of 1 to 4.5 meters of location error for a distance of 1km from the landing center.