Paper ID: 47409
student

21st IAA SYMPOSIUM ON HUMAN EXPLORATION OF THE SOLAR SYSTEM (A5)
Interactive Presentations - 21st IAA SYMPOSIUM ON HUMAN EXPLORATION OF THE SOLAR SYSTEM (IP)

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A NOVEL APPROACH TO VISUAL NAVIGATION BASED ON FEATURE LINE CORRESPONDENCES FOR MARS LANDING

Abstract

In order to meet the requirement of precise pin-point landing mission in Mars exploration, this paper presents an algorithm based on feature line extraction and matching to estimate the attitude and position of a lander during descent phase. Due to the errors accumulation of relative navigation and the lacking of prior knowledge about feature lines on the surface of Mars, the relative navigation is combined with the absolute navigation to overcome their shortcomings in our method. Firstly, the relative navigation algorithm is applied to compute the lander's pose. The constraint equations about lander's motion parameters are given by using at least four feature lines on the 2D projections of planetary surface. And, by taking advantage of nonlinear least squares, the solution of the Mars lander's attitude and position are solved. Then, the absolute navigation algorithm is used to correct the pose errors of the relative navigation. Constraint equations of the method between $n(n >= 3)$ feature lines on the surface of Mars and their 2D projections are deduced. Lastly, the precise motion parameters of absolute navigation algorithm are estimated via the Singular Value Decomposition (SVD) and least squares. The extensive experiments over simulated images and parameters demonstrate the robustness, accuracy and effectiveness of our method. In our experiments, the attitude errors are within 0.5 and the position errors are within 1m at altitude of 247.9m.