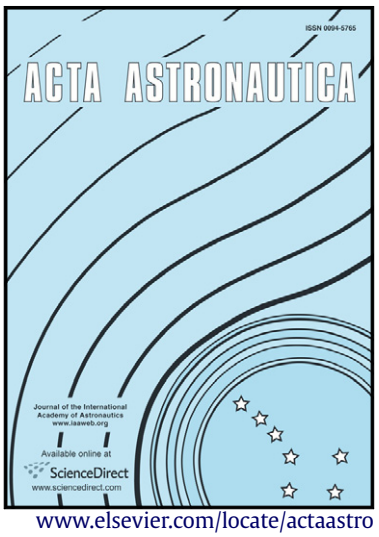

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An innovative high accuracy autonomous navigation method for the Mars rovers

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Abstract：Autonomous navigation is an important function for a Mars rover to fulfill missions successfully. It is a critical technique to overcome the limitations of ground tracking and control traditionally used. This paper proposes an innovative method based on SINS (Strapdown Inertial Navigation System) with the aid of star sensors to accurately determine the rover's position and attitude. This method consists of two parts: the initial alignment and navigation. The alignment consists of a coarse position and attitude initial alignment approach and fine initial alignment approach. The coarse one is used to determine approximate position and attitude for the rover. This is followed by fine alignment to tune the approximate solution to accurate one. Upon the completion of initial alignment, the system can be used to provide real-time navigation solutions for the rover. An autonomous navigation algorithm is proposed to estimate and compensate the accumulated errors of SINS in real time. High accuracy attitude information from star sensor is used to correct errors in SINS. Simulation results demonstrate that the proposed methods can achieve a high precision autonomous navigation for Mars rovers.

Key words：Mars rover, Autonomous navigation, SINS, Star sensor

1 Introduction

The Mars rover is an extremely important tool for the Mars exploration [1]. Some scientific missions, such as the collection of the environment materials, rock and soil samples, can be accomplished by the rover's exploration [2]. Usually, the rover is controlled by radio signals from the stations on the Earth. However, the control signals may be blocked by the two planets (Earth and Mars) due to the relative motion (including rotation) of the two. Consequently, the rover cannot be controlled all the time by earth stations [3]. Even during the period the control signals can reach the rover, there is still delay in the communication resulting latency in the response of rover. Therefore, it is very crucial to develop autonomous for Mars rover including autonomous navigation. The rover's autonomous navigation includes two steps, the initial alignment and navigation.

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