

Slip-Based Traction Control of a Planetary Rover

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Extended Abstract

This paper investigates motion dynamics of a planetary rover with attention to wheel traction mechanics and vehicle dynamics. Case studies are made for a rover that negotiates with natural rough terrain, or slips and sticks on a slippery slope. Experiments are carried out with a rover test bed to observe the physical phenomena and extract essential parameters, and the dynamic simulations are developed to be compared with the experimental observation. The tire traction force is modeled as a function of slip ratio, which is commonly used in road vehicles and relatively easier to measure in practical situations. Illustrative simulations show that the motion of the vehicle, including the adaptive response of an articulated suspension to rough terrain, is successfully modeled and simulated with an in-house software dynamics simulator. Finally a slip-based traction control method is developed to improve the locomotion capability. In the control, tire slip is estimated on-line by a simplified method, then the wheel driving force is regulated to meet the estimated slip with a desired value. The proposed control method has been validated by both the simulations and experiments.

Figure 1 shows pictures of the test bed used in this paper.

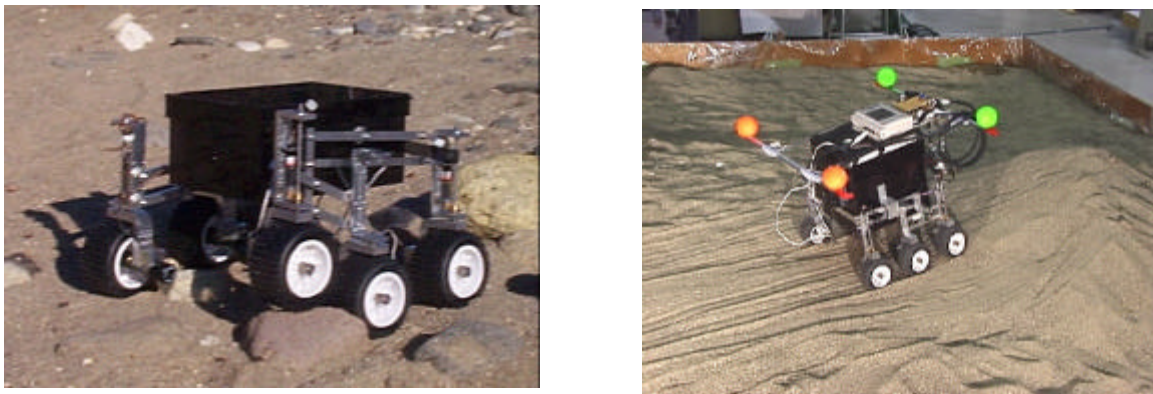


Figure 1 Rover test bed at Tohoku University (left: initial configuration, right: negotiation with a sandy slope: both are clickable to get a movie)

Figure 2 shows the simulations that account the traction mechanics and vehicle dynamics.

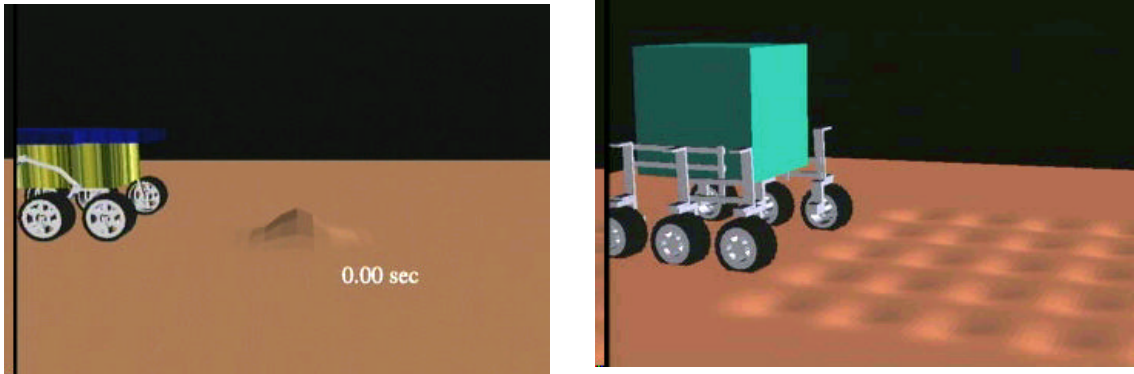


Figure 2 Graphical simulations developed at Tohoku University (Clickable to get movies)

Figure 3 depicts a control block diagram for the slip-based traction control developed in this paper.

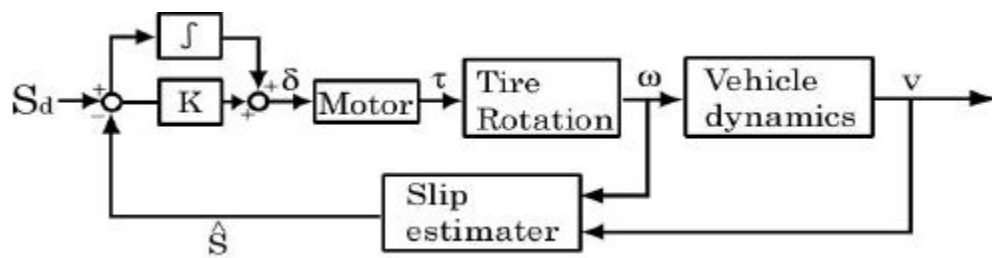


Figure 4 compares unsuccessful negotiation without the proposed control and successful negotiation with the proposed control.

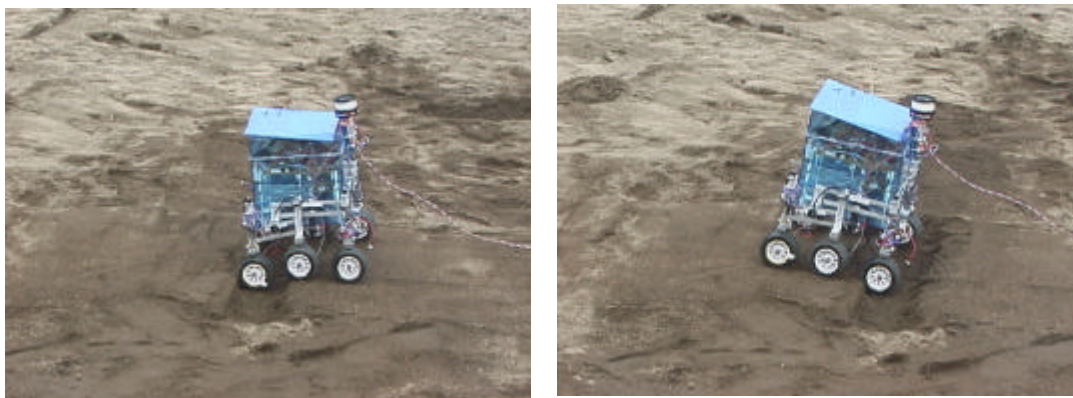


Figure 4 Unsuccessful negotiation (left) v.s. successful negotiation (right) (Clickable to get movies)