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DESIGN, MODELING AND EXPERIMENTAL VALIDATION OF THE MOBILITY SYSTEM FOR A PLANETARY EXPLORATION ROVER

Abstract

This work presents the design, modeling and experimental validation of the mobility system for the planetary rover prototype being developed by students of IIT Bombay for participating in the University Rover Challenge-2014. The long term goal of this endeavor is to develop technological expertise in building planetary rovers to contribute to India's future planetary exploration missions. Various designs for suspension systems were studied and certain performance metrics were considered to compare their performance viz. power consumption, effective ground pressure and geometric traffic-ability. After a preliminary analysis, the six-wheel rocker bogie suspension system is determined to be the most suitable amongst the other evaluated configurations. The design parameters of rocker bogie system are obtained by optimizing the objective function consisting of the weighted combination of the performance metrics. A novel mechanical differential mechanism is developed for pitch averaging. This system provides four support points to the chassis while maintaining it at an average angle of the gradients on either side of the rover. The chassis houses electronics bay, camera, payload rack and a robotic arm. The mobility system is designed to enable the rover to climb slopes of up to 60 degrees and traverse over obstacles of height equal to the wheel diameter in the fully loaded condition. The locomotion is enabled by 6 wheel independent drive and 4 wheel individual steer, with the add-on capability of zero turn radius steering. Since the rover is expected to run at a moderate speed (0.5 m/s), polyurethane wheels were selected to absorb the dynamic loads and allow motion over loose soil. Tire tread patterns were developed to increase traction and skid resistance. A dynamic simulation model is being developed for studying the mobility of rover and testing traction control technique. This model takes into account the tyre - soil interaction, driving motor characteristics and body dynamics of the suspension system. Also the mobility system is being manufactured and the simulation results will be validated against the actual rover's motion on different terrains. Vibration based techniques are also being explored for generating terrain profile using readings from accelerometer mounted on rover structure.