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Author: Mr. Viduranga Landers
Sri Lanka

Mr. Samitha Ranasinghe
Sri Lanka
Mr. Oshadha Pathirana
Sri Lanka
Mr. Jude Thidushan Peiris
Sri Lanka

A SELF ADAPTING WHEEL SYSTEM FOR SPACE EXPLORATION ROVERS

Abstract

The soil parameters of cohesion, angle of friction and soil density vary with the territory on extraterrestrial surfaces resulting in changes of the values of sinkage, slippage and rolling resistance on the wheel system. Self Adapting Wheel System (SAWS), initially designed for a fully autonomous exploratory lunar rover, is a continuous adjusting system of special grousers giving it an advantage in unfamiliar or unoptimized territory. Grousers with different heights and shapes are commonly used in rovers to optimize the wheel system for the mission location. SAWS uses an old mechanical concept called expanding pulley with a motor to actively adjust the heights of the grousers, changing the dimensions of the wheel and affecting the parameters of terra mechanical equations. Adjusting the height of the grousers to produce optimal values of slippage, sinkage and rolling resistance gives the rover high control and maneuverability in a wide range of territory. Linear potentiometers, force torque sensors, and LIDAR can be used to continuously monitor parameters as sinkage, forces and torques generated by the motion of the wheel and determine the adjustments of the grousers. A mathematical analysis shows an increase in performance when SAWS was integrated which was confirmed in Discrete Element Method simulations. The ability of SAWS to handle forces much larger than forces from normal rover operations was validated using Finite Element Method analysis. The use of the suggested wheel system in space exploration rovers improves the range of traversable terrain properties and inclinations while minimizing risk of entrapment in deformable terrains making it a viable solution for current slip and sinkage problems.