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DESIGN AND TESTING OF ACTIVE SUSPENSIONS FOR WHEELED PLANETARY ROVERS

Abstract

Robotic planetary rovers and human rated rovers used since the beginning of space exploration and planned for the future missions are mostly based on wheels. The wheels are connected with the rover's body through a suspension system having different tasks, like correctly distributing the load among the various wheels, granting the required terrainability and mobility to the rover and reducing the accelerations the rover's body is subjected to due to the motion on uneven ground. The last requirement is much dependent on the speed of the rover and on whether it carries only instruments or also humans. Robotic rovers used up to now, and in particular those operating on Mars, are very slow and the third requirement is only marginal. Due to this reason, suspension not including elastic and damping elements like the rocker bogie mechanism were used. The only human-carrying rover used up to now, the LRV of the Apollo missions, used a double wishbone suspension of automotive derivation. The use of active suspensions is very beneficial for all the above mentioned three tasks of the suspension mechanism. The present work deals with the development, design and testing on a demonstration model of a small robotic rover of an innovative type of simple active suspension. The innovative layout allows to maintain the rover body level even in case of travelling on strongly uneven ground, while using the suspensions as 'legs' to cross obstacles whose height would make then not manageable by a conventional passive suspension. Moreover, by controlling the suspensions' actuators it is possible to adapt the suspension stiffness to the working conditions. The suspension is innovative also from the viewpoint of the control strategy, based on a feedback loop using the data from accelerometers to maintain the rover's body level, and on a feedforward branch based on CCD cameras to identify the terrain irregularities and to make the system ready to react to them even before they are physically encountered. The system is tested on a Mars and Lunar stimulant terrain, provided with a load reliever to simulate reduced gravity. The results here obtained are applicable also to the automotive field, for off road and military vehicles having to manage at high speed an irregular terrain.