SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 2 (3B)

Author: Mr. Olaf Krömer
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, olaf.kroemer@dlr.de

Dr. Tim van Zoest
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, tim.zoest@dlr.de
Ms. Caroline Lange
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, Caroline.Lange@dlr.de
Dr. Marco Scharringhausen
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, marco.scharringhausen@dlr.de

ADAPTIVE FLEXIBLE WHEEL FOR PLANETARY EXPLORATION

Abstract

The exploration of planetary surfaces is a major focus of international space research. Mobility of exploration platforms is key to examine a wide area, focus on interesting sites and thereby maximise output of scientific data. The compromise of a reliable, compact, lightweight system with maximal mobility in rough terrain, leads to very specialized vehicle designs and a high degree of optimization in each individual subsystem of the overall locomotion system. All robotic planetary rovers have been designed with rigid wheels. This kind of wheels is reliable and has a big heritage from terrestrial applications; in addition to that, their design is very simple and fail safe. Their main disadvantage is the higher ground pressure, soil sinkage and compaction resistance. As a result of that, the trafficability is reduced and areas with loose soil need to be avoided. An alternative way to overcome the disadvantages of traditional rover wheels was already chosen with the introduction of flexible wheels in the ESA ExoMars rover design. Flexibility of wheels lead to flattened footprints. Thus lower ground pressure and sinkage into the soil appears. The tractive performance increases with flexible wheels, so smaller wheel diameter can be chosen. In the final design, this leads to lower volume and power requirements at a higher degree of mobility due to better trafficability in loose soil.

The next step in wheel optimization shall provide the optimal wheel for each individual underground. This can be realized by developing a flexible wheel with adjustable stiffness. An adaptive, flexible wheel is currently under development at DLR Bremen in the department of Exploration Systems and is related to the German RIMRES robotics project. At this project, a flexible metallic wheel for extraterrestrial use is re-designed with a stiffening system. This mechanism allows to vary the spoke stiffness from soft to hard and to reduce the sinkage in loose soil, as well as to reduce the hysteresis losses on hard ground. The sensor system and control circuit of the wheel stiffness is part of this investigation as well. First tests with breadboard models have shown the feasibility of the chosen concepts and a prototype is in the process of hardware realization.