A Wheeled Mobile Device for Deployment of Surface and Subsurface Instruments and for Subsurface Sampling on Planets

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As a result of the ESA TRP activity MIDD (Mobile Instrument Deployment Device), a Breadboard Model of a wheeled mobile device for use on planetary surfaces has recently been completed and functionally tested, and is now available for demonstration at the ASTRA 2000 Workshop.
The vehicle is based on previous mechanical component development work for small wheeled devices performed since 1995 and serves to demonstrate the scientific potential of a 4 kg-class system for supporting surface and subsurface science on a planetary landing mission. Moreover, the device is being extensively used to study general problems of locomotion on regolith-like surface materials and of obstacle negotiation.
As payload elements, two spectrometers for mineralogical and elemental studies on surface materials - including rocks - have been foreseen, as well as an acoustic subsurface sounder, a close-up imager and a self-penetrating "Mole" for subsurface measurements and sampling. In addition, a dust removal device was accommodated for preparing rock surfaces for measurements. The mass of the payload, excluding their electronics, amounts to 1.5 kg.
Following an accommodation study for the instruments, the vehicle chassis was sized by taking into account planetary surface rock distributions with ground clearance as well as mean straight path constraints, while restricting the number of wheels to four for reasons of simplicity and mass. The two front wheels are mounted on folding levers which allow to contact the soil with the cab and to place the spectrometers and the close-up imager against their targets. Also for operations of the Mole sampling system - reaching depths of more than 1 m - , the front wheels are preferably rotated upwards to achieve a larger vehicle base. In order to minimize the stowage volume, a dual wheel configuration was chosen which allows the front wheels to be folded back with overlapping the rear wheels. The folding lever feature also provides a re-righting capability by shifting the center-of-mass, should the vehicle fall on its side.
All wheels and the two folding levers are individually driven by brushless DC motors located inside a thermal enclosure in the vehicle cab. Except for the actuators and drive mechanisms, the enclosure houses a central electronics unit which also provides pre-processing of payload data. For the power supply and communications, a tether link to the lander is used, allowing a maximum range of some 20 m. As to the tether type, a flexible circuit was chosen which allows efficient packaging of the tether on board the vehicle. The wheel design was based on theoretical and experimental studies on tractive performance of small wheels on planetary soils being one of the subjects of the MIDD activity, involving a dedicated soil channel at DLR. As a result, the vehicle wheels were chosen to be rigid while featuring a wire mesh running surface and chevron-shaped grousers.