

The Nanokhod Micro-Rover - A Versatile Platform for Surface Exploration of Celestial Bodies

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In the last years, the use of robotic surface landers has become a standard tool for scientific exploration of celestial bodies. Although some missions proved to be very successful, it is recognized today that in-situ measurements based on a static lander only lead to a rather strong restriction of scientific operations: Interesting scientific samples might be just out of reach of those instruments, even when being mounted on a manipulator system, which can provide in general some degree of mobility in the range of only some meters. Fully autonomous rovers can overcome this restriction, however, these systems tend to add an enormous system overhead, which, in general, represents a factor of ten more than the actual payload instrument mass. On the other hand, full autonomy is not required by most scientific users. In many cases, an operational reach in the range of 20 to 30 m around a surface lander is largely enough to address the specific surface features for a given landing site. When tailored to these mobility requirements, a micro-rover can transport and operate scientific instruments for in-situ measurements with a system overhead in the range of the one of a robotic arm, allowing for payload instrument mass fraction as high as 40 to 50 % and a very high degree of operational flexibility.

The Nanokhod micro-rover follows this design approach. It has been conceived to accommodate a miniaturized suite of instruments and to transport them to sites of scientific interest within a radius of some tens of meters around a stationary lander in order to deploy and operate the instruments directly on the samples. The mechanical configuration is optimized to orient four payload instruments subsequently to the same sample without the need for displacing the rover. Driven by tracks, it provides efficient and reliable locomotion in a large variety of terrains, ranging from fluffy/sandy to crusty/rocky and pebbly surface morphology. It receives power and telecommunication through a tiny tether from the lander. The tether is deployed on the rover side as the vehicle moves forward. Consequently, the sub-system overhead on the rover can be significantly reduced, allowing the vehicle to accommodate more than 1100 g of payload with a total rover mass of 2.55 kg (including payloads).

This paper presents the micro-rover concept of the Nanokhod. It points out the potential for scientific explorations and addresses in particular possible applications on Moon, Mars, or other celestial bodies like Mercury.