ESA's Robot Technology Developments for Lunar and Planetary Exploration

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This presentation gives an overview of ESA's current technology developments in the area of Automation and Robotics for lunar and planetary exploration. The robot systems being targeted specifically are:

・Surface-mobile robots (rovers):

・Very small "nano-rovers" (less than 5 kg including payload) operating in the immediate vicinity of a lander spacecraft and providing images, carrying scientific instruments for multiple in-situ measurements, obtaining rock and soil samples (from the surface or by drilling down to 2 m), returning these samples to the lander and feeding them to lander-based analysis instruments. For this class of systems, a series of ESA R&D contracts has developed a space design and working prototypes of the tracked Nanokhod rover system which will be the subject of a separate presentation at ICEUM 4.

・Swarms of "pico-rovers" (10 - 50 identical rovers of less than 0.1 kg each) with single, narrowly specialised functions (typically measuring a single physical or chemical quantity) which exhibit substantial overall performance and robustness due to controlled collective behaviours and can be deployed by landers, rovers or aerobots.

・Other, larger classes of rovers (including pressurised and manned mobile field laboratories) are being studied in the context of human Mars exploration missions, but would be similarly applicable also for lunar bases.

・Underground mobile robots (penetrators or "moles"), deployed from landes or rovers, exploring the sub-surface regions in ranges from cm to ultimately km, vertically or horizontally. One such mole shall also be part of the Mars Express Beagle 2 lander, to be deployed by the robot arm.

・Flying robots (aerobots) for more global exploration of planets with an atmosphere. Studies on aerostats (robotic balloons or airhips / blimps) are still to be started, but one concept of an autonomous autogyro (similar to a helicopter) for Mars is already being treated as a technology carrier at pre-development level.

・Robotic deep drilling systems: ESA is developing a very small and compact package of a robotically-assembled drill which provides controlled drilling and coring at variable angles down to several m depth, sample acquisition from well-defined depths without cross-contamination, and storage of many such samples for repeated drill operations at different sites. This package can be accommodated either on landers or as the central payload of a Nanokhod-type rover.

・Arm-based manipulation systems: These are universal devices for inspection, deployment / pointing / burying of scientific instruments, collecting soil samples and feeding them to analysis instruments, but also for loading / unloading material for lunar / planetary bases and helping to unfold / erect / asssemble pieces of engineering infrastructure. One currently developed example is the instrument positioning arm of the Beagle 2 lander for the Mars Express mission.