ESA's Lunar Robotics Challenge

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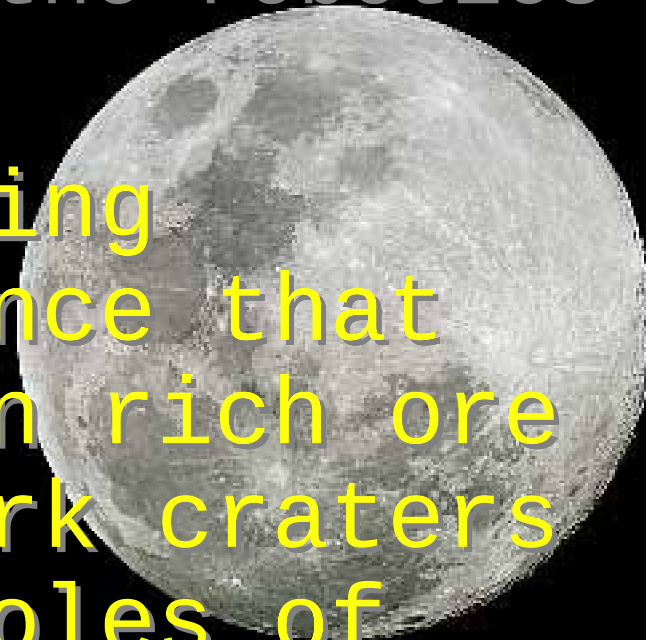
Solving the Problem of Water… the robotics way



- There is compelling scientific evidence that there is hydrogen rich ore into the cold dark craters located at the poles of the Moon.
- The question whether this ore contains water or not, still waits for a more

Solving the Problem of Water… the robotics way

- To this purpose, engineers have postulated the use of a wide variety of robotics means (e.g. walking/hopping/rolling rovers, cable ways, tethered tumbleweeds, harpoons) which despite their basic different working principles have in common one characteristic: <u>lack of experimental proof of the concept</u>

The objectives of ESA’s general studies programme are:

- Contribute to the formulation of the overall ESA strategy;
- Study feasibility for selection of new mission concepts;
- Prepare/demonstrate the case for approval and funding of new optional projects/programmes;
- Support the evolution of ESA by analysing and testing new working methodologies.

From 2005 the GSP includes (among others)

Technical Objectives

The main technical goals of the challenge are :

- to conceptually define a number of sufficiently diverse robotics means to accomplish a hypothetical mission to acquire samples in a lunar crater
- to design, manufacture, integrate and ready for test such robotics means against realistic resource requirements (i.e. mass, volume, power) and crater characteristics

Educational Objectives

For what regards outreach, the challenge has 2 goals

- Motivational: Establishing an high visibility event to which the "community" of space engineering students can associate with and be proud of
- Inspirational: Establish an example of "cool stuff" being done by elder students that can inspire younger

Hypotetical Mission

The challenge assumed the following hypo

A Lunar lander touches down in proximity of the rim of the target Lunar crater. The Lunar Lander is equipped with:

- Some sort of robotics means that allows collection of soil samples from the crater bottom
- A Lunar ascent vehicle that allows return to Earth of

2. The robotics means
   - deploy out of the lander,
   - overcome the crater rim,
   - reach the bottom of the crater
   - search for and collect soil samples
   - return the samples to the lunar lander

3. Some sort of lander automated means collect the

The challenge focussed only

esa

LRC Venue

The selection of a venue was performed following the main criteria:

1. Similarity to a lunar crater
2. Size and trafficability of crater compatible with the capabilities of robotics system that can be realised and demonstrated in the challenge
3. Proximity to transportation means and ease of logistics
4. Affordable accessibility from Europe
5. Ease to achieve administrative clearance
6. Scenery suitable for PR event

LRC Venue

Simulated water-rich - soil patch
Possible testing areas for trials
Robot trajectory
Moon Lander Mock-up
Image © 2007 GRAFCAN
© 2007 Tele Atlas
Google
Pointer 28°15'55.57" N 16°35'22.80" W elev 2298 m
Streaming 100%
Eye alt 2.58 km

Participants

- University of Bremen (Germany)
- 1 robot “CESAR” equipped with 2 wheel-legs (front), a paddlewheel (back), a sampling device and a releasable communication beacon

Winner

Participants

ETH Zurich (Zwitzerland)

- a 6-wheels robot “CRABLY” to provide communication relay
- a 4-legs tethered walking robot “WALKY”
- A tether management box “SPAGHETTI BOX” to release the

This team did not manage to conclude the challenge. CRABLY stopped working after it reached the crater rim, due to insufficient charging of the batteries.

Jacobs University of Bremen (Germany)

- 2 almost identical robots "Lunatics 1" and "Lunatics 2" equipped with tracks
- Lunatics 1 worked as a relay system
- Lunatics 2 which had a sampling device went into the crater

Lunatics 2 went into the crater and did manage to find the sample, however it could not move closer

Participants

University of Oulu (Finland)

- 1 Robot con tracks and an arm like sampling device

The Oulu robot went very rapidly into the crater. Unfortunately as it did not have a communication relay on the rim it lost communication with the “ground station” while climbing

Participants

University of Pisa (Italy)

- One wheeled robot "DAVID"with 6 wheels (not articulated)
- DAVID was equipped with a sling launching a sampling device (SD)
- The SD once landed into the sampling zone would be drawn scraping away some soil out of the surface and into a sampling room

DAVID entered succesfully the crater, found the sample, sampled an unmeasured amount of

Participants

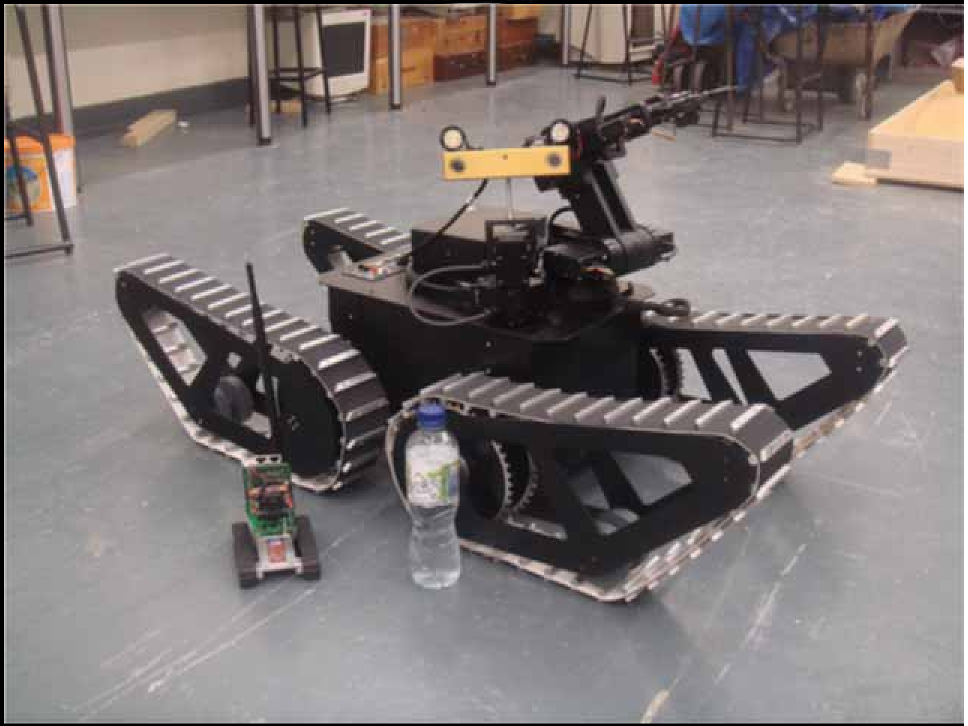
Scuola di Studi Superiori Santa Anna (Italy)

- 1 Robot “pESApod”with 6 legs each with 3 degrees of freedom
- One leg has in its foot a sampling device

pESApod was the most complex of all robots presented at the LRC. Its fairly slow speed made it unlikely to win. However its good chances to fetch the sample were spoiled

University of Surrey (UK)

- 1 Rover “SELENE” moving on 4 articulated tracks
- SELENE had a 5 degrees of freedom robot arm for sampling



SELENE did not manage to compete. Its locomotion drives turned out to be undersized for the task and broke down

Participants

Universidad Politécnica de Madrid (Spain)

- 1 Rover "MoonHound" equipped with 4 big cylindrical wheels and a sampling arm
- The 2 axis on which the weels are mounted have a passive articulation joint between them allowing the rover to "twist"

MoonHound managed easily to deploy a telecom relay on the rim and reach the bottom of the crater. However once there it experienced software

Conclusions

- The LRC was a total success in all fronts
- From the technical point of view: we have found promising solutions for a difficult technical problem
- From the educational point of view: over 70 European students have had the chance to realise sophisticated robots and test them in a tough but exciting event
- From the inspiration point of