Lunar Surface Simulation - Opening the Road to the Moon

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Exploration and utilisation of the moon, particularly by robotic systems, requires the development of piloting technologies for unmanned spacecraft that can guarantee a safe landing close to a predetermined target landing spot, in an area of rough terrain. This is not an easy task. Accurate navigation relative to the lunar surface is necessary, together with the detection of possible hazards like boulders, small craters or steep slopes. Previous manned and unmanned missions have landed in broad, relatively safe areas to minimise the risk of damage during landing. Manned missions with the capability of landing close to a required target landing spot, avoiding boulders and other hazards, have been limited by the need to minimise the risk to astronauts on-board the lander. Unmanned missions have not had sufficient computing capability to permit accurate surface relative navigation and obstacle avoidance. Advances in spacecraft on-board processing technology [1,2] have made autonomous or semi-autonomous vision-based lander guidance feasible. This means that unmanned missions to specific sites of scientific interest in potentially hazardous areas can be considered.

The ESA (European Space Agency) 3D Planetary Modelling study [3] and Integrated Vision and Navigation for Planetory Exploration study [4] have demonstrated the feasibility of using vision for the guidance of planetary landers. Extensive testing of these intelligent vision guidance algorithms is essential if they are to be able to cope with the full range of possible surface conditions that could be experienced during a landing.

The problem is that only relatively poor information about the detailed surface morphology of other planets is available. The moon, for example, has been extensively mapped to a resolution of some 200m by NASA's Clementine mission [5]. This is inadequate for a vision based lander which must detect and avoid boulders and craters as small as 0.5m across. Some form of simulation or mock-up of the planet's surface is necessary to support the development of the vision based guidance algorithms. This must be based on known information about the surface morphology and must be convincingly realistic.

The LunarSim project at the University of Dundee has developed a system for producing computer models of lunar like surfaces intended for use in testing and validating the use of computer vision for autonomous, semi-autonomous and operator-guided planetary landing systems. The output from the LunarSim system is a 3D model of a lunar like surface together with images of the surface taken at various positions and orientations above the simulated surface. This simulates a camera on a lander taking a sequence of images as it heads towards the surface. Ray tracing or a similar 3D visualisation technique is used to produce the image from the simulated surface and to model Sun and Earth illumination.

The full paper will describe the LunarSim system and present some of the resulting images. The images appear realistic (see figure 1) but assistance is being sought from planetary scientists to validate the crater models and other surface feature models used in the simulation.

Acknowledgements:
The LunarSim study was carried out by the University of Dundee with support from ESA (ESTEC contract no. 12821/98/NL/MV).

References:

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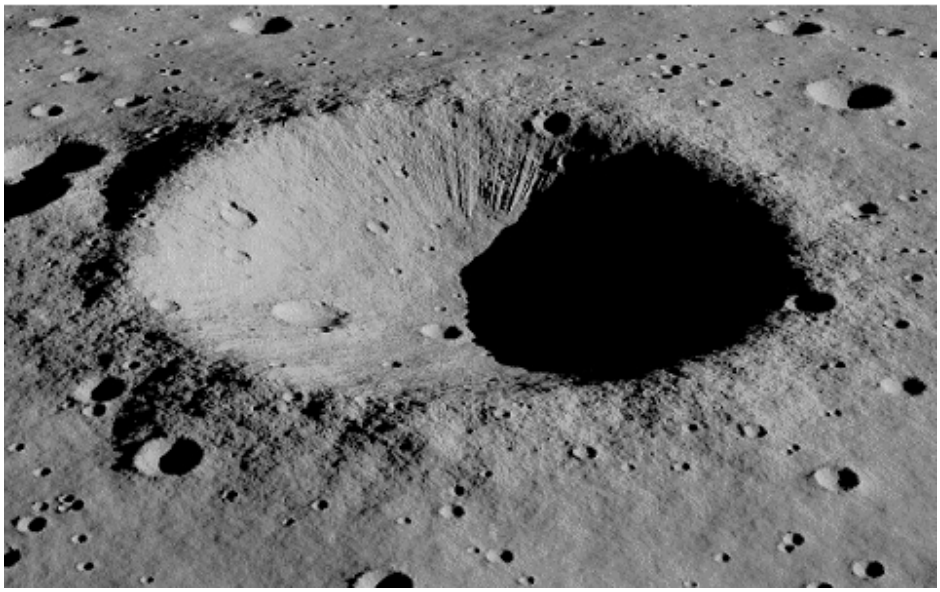

Figure 1: Simulated Image of Lunar Surface Produced by LunarSim