AOGS 2005
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Technology demonstration by the piggyback-style lunar pinpoint lander mission

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The ability of pinpoint soft landing to lunar or planetary surfaces broadens the range of scientific missions. For example if a spacecraft can perform direct landing to a crater central peak of the moon, some cutting-edge in si-tu measurements will be expected. The authors have started planning demonstration of the pinpoint landing technology using a small spacecraft, which is supposed to be launched with the piggyback-style.

The landing strategy consists of 'powered descent' with continuous burning of the main thrusters and 'vertical descent' below an altitude of about 3.5 km. In the powered descent, the spacecraft is navigated by the image-based geographical feature (e.g., crater) matching with the pre-acquired lunar surface's DEM (Digital Elevation Model). Delta-V adjustments for the navigation are carried out by the off- modulation operation of constant thrust. The key technologies in the vertical descent are the autonomous obstacle detection/avoidance system and the landing radar. The former system is also based on analysis of the lunar surface's images, where shadow information is expected to be a preferable cursor of the obstacle existence; global surface inclination is calculated by the motion stereo method. The C-band pulse radar provides not only altitude but also relative velocity against the surface with high accuracy, so that the spacecraft can achieve the soft landing. The primary purpose of this piggyback mission is end-to-end verification of all the above-mentioned technologies.

There seems to be a possibility that the lunar lander carries additional payloads for either engineering or scientific purposes: a variety of pico-rovers, a micro-manipulator for sampling, a reflector for laser measurement from the earth, and so on.

The trajectory design assumes piggybacking into Geostationary Transfer Orbit (GTO) on anonymous launch vehicles. The mass of this spacecraft under the conceptual design is roughly estimated as 200 kg or above. This value sounds reasonable for the existent piggyback programs. Since the propulsion subsystem will amount to 80 % of the total mass, a kind of innovative technologies, for example a single MMH/NTO blowdown tank, has to be investigated. At the same time, some smallsized components and COTS (Commercial Off The Shelf) devices should be employed in other subsystems. Furthermore we have the alternative plan to separate a part of components such as the transmitter and the data handling unit just before landing, aiming at securing the communication to the earth. Orbital demonstration of these novel techniques is another goal of this mission.