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Author: Ms. Yun-young Kim
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, yykim@fdcl.kaist.ac.kr

Mr. Min-guk Seo
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, mgseo@fdcl.kaist.ac.kr
Prof. Min-jea Tahk
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, mjtahk317@gmail.com

VISION-BASED LUNAR VIRTUAL SURFACE GENERATION USING SHAPE-FROM-SHADING METHOD

Abstract

For lunar exploratory development, Autonomous precision landing and hazard detection and avoidance technology (ALHAT) is essential. Unlike satellites, the moon landing has limitations on ground support and real-time topography images, caused by the dark side of the moon and communicational delay. To overcome the limitations, vision-based images and surface altimeter data are significantly used in ALHAT procedure. NASA and ESA have been studied vision-based relative navigation technologies for guidance. They achieved pin-point planetary landings within 10 to 100 meters. For more stabilized landing, it is also required to research on vision- based image processing to derive a 3D scene description from one or more 2D images.

To recover and improve reliability of vision-based data images, many techniques have been provided. In the early 1970s, the recovery technique using a gradual variation of shading in the image called Shape from Shading (SFS) technique was developed. The SFS problem computes the 3-dimensional shape of a surface from the brightness of one black and white image. In SFS, the gray level at a pixel in the image depends on the light source direction and the surface. Using Lambertian model, given a gray level image, the objective is to recover the light source and the surface shape at each pixel. SFS techniques can be divided into 4 groups: minimization approaches, propagation approaches, local approaches, and linear approaches. Among them, minimization approaches are known to be more robust and studied in more papers then other approaches. In minimization approaches, to overcome the deficiency of equations in solving the problem, two additional constraints are proposed: the brightness constraint and the smoothness constraint. Images are generated by minimizing an energy function consists of two constraints.

In this paper, SFS technique using minimization approach is applied to the solve shape recovery problem in vision-based lunar surface generation. Using DEM (Digital Elevation Model) based on NASA LRO (Lunar Reconnaissance Orbiter) which is survey data from LOLA (Lunar Orbiter Laser Altimeter), SFS is applied and simulated.