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SINGLE CAMERA BASED HAZARD AVOIDANCE AND AUTONOMOUS PRECISION LANDING SYSTEM FOR THE SMALL LUNAR LANDER

Abstract

Nowadays, landing techniques are based on an autonomous Guidance, Navigation and Control system are much studied. This makes it possible to send probes into places which can obtain more scientific results and is indispensable technology to future space development. And, it is planned many a few hundred kg scale lunar landers for advance.
In precision landing, there are two main systems including a terrain relative lunar positioning system and a hazard detection system. Both system are has LIDAR, stereo vision system, and a template matching system with image processing in use. However, in small landers, since the lander's weight is restricted, many pieces of equipment cannot be carried. Therefore, it is necessary to perform positions estimate and hazard detection for precision landing with a single camera.
At the autonomous landing with it, it has problems caused by low resolutions of the camera. With the objective of terrain relative navigation and resource of computing, it should be coordinated low resolution and wide field of view, but for hazard detection and fuel, it is needed to be high resolution. Thus, if hazards detection systems which are performed to detect hazards taken a few pixels in past studies can detect sub pixels level hazards too, it is important that safety areas are shown by single camera. And, the technique can give a huge contribution to terminal guidance.
To detect sub-pixel level hazards with a single camera, statistical method with several images are more advantageous than the techniques using single image. Therefore, the technique of having combined Variance Map and Co-occurrence Frequency Image is proposed. The former calculates the danger in individual pixels, and the latter can calculate thresholds of Variance. When several images in same the place are taken, the same images cannot be taken by gap error of minute camera positions. The differences of these taken images are caused by the sub pixel level objects which cannot be expressed by 1 pixel. Therefore, it is possible to detect sub pixel level hazards by acquiring a few same geographical feature images.
This paper will present the hazard detection method which can detect sub pixel level obstacles and show validity in CMOS sensors, various lunar textures and each sun elevations with synthetic lunar terrain maps and LRO images. And more, it will be also shown optimized simulations for single camera based terminal GNC systems with this hazard detection method.