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SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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ADVANCES IN THE HARDWARE/SOFTWARE CO-DESIGN FOR THE ABSOLUTE AND RELATIVE VISION BASED NAVIGATION SYSTEMS FOR THE LUNAR LANDING SCENARIO

Abstract

The Vision Based Navigation, including the Absolute and Relative visual navigation, is the key technology in order to achieve precise landing. The maturation of the technology is the essential issue required for acquiring confidence in this innovative and crucial navigation system. The fundamental step is to bring the initially developed and validated through simulation software to representative hardware where the Vision Based Navigation has to fulfil Real-Time performance maintaining the accuracy demonstrated in simulation. The Absolute Navigation (AbsNav) System is able to provide measurements directly related to known point on the surface terrain. The use of AbsNav prior the landing is fundamental in order to provide an accurate measurement of the spacecraft which will drive to a precision landing in the target landing site. The AbsNav technology uses image processing techniques in order to find craters in the image collected by the Navigation Camera. The craters are mapped and recognized against a Database present on board and previously generated. The mapping of multiple craters allows the Navigation Filter to derive accurate position estimation with respect to the Lunar Surface. Without the AbsNav technology the landing accuracy on the moon surface can be in the order of tens of kilometres, using the AbsNav technology during the landing phases the accuracy may be reduced to hundreds of meters. The Relative Navigation (RelNav) System is able to provide measurements relative of the displacement of specific points (also known as features) between consecutive images. The algorithm selects different features points and tracks these points up to when the point disappears in the image. Its fundamental task is to stop/limit the divergence of the Navigation solution with respect the classic inertial Navigation. The RelNav can be

activated once the AbsNav cannot provide measurements or in contemporary to the AbsNav. Without the RelNav technology, the Navigation filter should only rely on inertial and altimeter measurements, facing quick divergence of the Navigation Solution before the touchdown. In this paper, a brief recall of the GMV AbsNav and RelNav techniques are presented. Following, the target Hardware architecture is presented: the architecture includes a Hardware/Software co-design where the most demanding part of the algorithms are developed and executed in a Virtex-4 FPGA, the remaining part of the algorithms are instead executed in PowerPC 750FX. The paper will presents the results of the development, integration and validation campaigns of the breadboarding activities of the GMV AbsNav and RelNav algorithms