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SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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NANOSAR – CASE STUDY OF SYNTHETIC APERTURE RADAR FOR NANO-SATELLITES

Abstract

Nano-satellites have a cost advantage due to their low mass and usage of commercial-off-the-shelf technologies. The low mass also restricts the functionality of a nano-satellite's payload. Typically, this would imply instruments with very low to low resolution and accuracy, essentially ruling out applications such as remote sensing. However, multiple nano-satellites can cooperate to improve the overall system performance, for example by increasing the frequency of the observations. The objective of this study is to design a radar that can be accommodated in a nano-satellite, and investigate the feasibility of using multiples of these nano-satellites to perform high temporal resolution remote sensing. In this paper therefore, the concept of a nano-satellite sized Synthetic Aperture Radar is investigated. Nano-satellites have very constrained power and volume budgets, and there are limits to how much surface area they can unfold for use in a radar. Given these constraints, a synthetic aperture radar system for use in a nano-satellite in a 350 km orbit was sized, and approaches to tackle the deficits in the radar link budget are proposed. When applying state-of-the-art technologies, both on the component level, as well as on an architectural level, one arrives at a closed link budget. The proposed radar system consists of a patch antenna array with a span of 1.14 m by 0.18 m, operating at a frequency of 5.8 or 18 GHz. Power amplification and phase shifting is performed on the panel, using digital RF integrated CMOS circuits. The system has a swath of 15 km and a range resolution of 8m. Given these performance values, coupled with the increased revisit times, it was obvious this radar, when flown in a larger swarm of nano-satellites, would allow faster now-casting for weather prediction. With significant investment in technology development, it could be possible to use this system for C- or K- band SAR interferometry, for near-real-time monitoring of fast ground deformation phenomena such as earthquakes and volcanoes. Other applications could lie in the field of near-real-time ship motion detection and oil spill spread detection. Many technical challenges need to be solved and platforms need to be designed, capable of supporting this payload, before this system would be ready for deployment. Preliminary design suggests the cost of such an instrument is substantially higher than what is common for nano-satellite components. However, the potential of such a system is extremely promising, and merits further investigation.