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IMPLEMENTATION OF LOW-POWER, WIDEBAND SYNTHETIC APERTURE RADAR FOR PRIMITIVE BODY RECONNAISSANCE APPLICATIONS

Abstract

High-resolution imaging of surface morphology and spectral properties of primitive bodies has been identified by the NASA Planetary Science Decadal Survey as a technological need for future Discovery missions. Its implementation depends on development of state-of-the-art radar instruments, especially for tumbling objects like asteroids where inverse synthetic-aperture radar is preferable to optical imaging. Surface characterization through radars is limited by finest achievable range resolution, which itself is limited by the widest achievable radar signal bandwidth. Due to power constraints, existing spaceborne radar architectures have relatively narrow bandwidths. These bandwidths, typically on the order of 10 MHz or smaller, correspond to range resolutions on the order of 10 meters or larger. We have developed a prototype wideband synthetic aperture radar system which operates at X-band with a low power consumption more typical of a narrowband radar. It supports linear frequency modulated (LFM) waveforms of up to 200 MHz bandwidth, corresponding to sub-meter range resolution. Because the instantaneous bandwidth of the LFM waveform is greater than the sampling rate of the analog-to-digital converter and the swath is sufficiently small, stretch processing is used to reduce the required signal processor bandwidth to within tolerable limits. The prototype was adapted from space-qualified hardware with heritage in both near-Earth and deep space missions, so at a TRL of 4 its development is at the maturity targeted by the decadal survey.