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Author: Prof. Hirobumi Saito
Nihon University, Japan

Mr. Mitsuteru Kaneoka
CSP Japan, Inc., Japan
Mr. Kazuyuki Nakamura
Japan
Prof. Yasuyuki Miyazaki
Nihon University, Japan

SMALL X/L BAND SAR SATELLITES FOR MEGA CONSTELLATION AT VLEO/LEO

Abstract

We have developed small X band SAR (synthetic Aperture Radar) satellites of 1-m ground resolution with a novel deployable slot array antenna. This antenna is cost-effective since it is passive and plain antenna. Three of the small SAR satellites have been already launched since 2021 by a start-up company in Japan. The satellite body is in size of 0.4m x 0.7m x 0.7m and the deployed SAR antenna is in size of 5m x 0.7m.

We can make easily a disk-shaped satellite body with 1m diameter x 0.2m height and attach this deployable slot array antenna to the disk body. This quasi-two-dimensional SAR satellite configuration, SAR DiskSat is suitable for stacking in a rocket faring for mega-constellation launching. Another advantage of the SAR-DiskSat is the possibility of vLEO (very low Earth orbit) operation. A thin edge cross-section makes atmospheric drag small. A small electrical propulsion for CubeSats can compensate the atmospheric drag of the SAR DiskSat at 350-400km altitude. At such vLEO there is an advantage of short-range SAR operation in terms of signal-to-noise ratio. This advantage of RF power makes it easier to improve its ground resolution. The final goal of this SAR-DiskSat would be a mega constellation of 0.25-m ground resolution in VLEO. This slot array antenna is equipped with feed waveguides and can be embedded a delay line in the antenna segment. It is possible to widen the SAR swath with a technique of elevation frequency scan at expense of a ground resolution.

L band wave can penetrate below the top of forest, while X band SAR are suitable for monitoring of urban areas. L band SAR monitoring becomes more important for carbon credit markets. A simple scaling on signal-to-noise ratio of SAR image indicates that L band SAR requires larger antenna area or average RF power than X band. Our SAR DiskSats utilize deployable panel antennas, which are not suitable for significant increase on antenna area unlike deployable parabola antennas. However, L band SAR observations from vLEO can compensate its disadvantage. It is shown that L band DiskSat with a similar size to X band becomes feasible at vLEO. Our SAR antenna type, deployable slot array panel-antennas can only enjoy the advantage of vLEO unlike other types. Our presentation will describe the feasibility of L band SAR DiskSat.