31st IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Earth Observation Missions (4)

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FUCHENG-1: THE FIRST SMALL SAR SATELLITE TO ROUTINELY MONITOR GROUND DISPLACEMENT TO MILLIMETER LEVEL

Abstract

In recent years, miniaturized synthetic aperture radar (SAR) satellites have become an important and irreplaceable part of Earth Observation missions. With their all-weather, day-and-night imaging capability, SAR satellites are able to provide continuous and high-resolution imageries over any given areas of interest (AoI). For SAR missions, one of the most desired and important features is SAR interferometry (InSAR), which is possible not only to derive ground elevation information but, more importantly, to measure surface deformation up to millimeter-level accuracy by investigating the SAR phase information.

However, achieving InSAR capability consistently with SAR satellites is not a trivial task. It requires not only lower noise equivalent sigma zero (NESZ) but also precisely maintaining the orbit, preferably within an orbit of the 250-meter-radius tube. Both requirements are even more challenging for miniaturized SAR satellites due to their lightweight characteristic. So far, none of the existing small SAR satellite missions could provide InSAR services routinely.

Here, we present a miniaturized C-band SAR satellite named FuCheng-1 (FC-1), which was launched in June 2023 and has a weight of only 285 kg. FC-1 is the first small SAR satellite capable of routinely providing InSAR and multi-temporal InSAR (MTInSAR) service. Flying a relatively low orbit, the NESZ of around -20 dB can be achieved, comparable to larger satellites such as Sentinel-1 and TerraSAR-X. What's more, by using electric propulsion for orbit maneuvers, the orbit of FC-1 can be precisely maintained within an orbit tube of 150 m radius, also comparable to Sentinel-1 and TerraSAR-X. We conducted the InSAR process over a number of testing sites. For all current testing sites and all acquisitions, we are able to produce highly coherent interferograms. All interferograms have been compared with the Sentinel-1 product, showing very consistent signals on interferograms but with a much higher resolution and coherence. In addition, for the first time, an MTInSAR technique is applied to a half-a-year data stack, giving very promising results.

High-accuracy ground displacement monitoring has long been the privilege of large SAR satellites. With our breakthrough, we anticipate this work to be a turning point for the field of InSAR. With much lower cost and more frequent revisits, we would dramatically improve the quality, detail, and accessibility

of InSAR applications to the next level. It's also good to know that another twin satellite is ready for launch in mid-2024, forming a constellation with FC-1.