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INNOVATIVE METHOD OF CONSTELLATION DESIGN TO ENABLE NEW ARISING APPLICATIONS BASED ON SPACE-AIRBORNE BISTATIC SAR

Abstract

Classical methods developed to design satellite constellations foresee that each satellite instantaneous coverage area is obtained by intersection between the Earth sphere and a cone with vertex in the satellite positions and axis constantly aligned with the local vertical. For applications such navigation and telecommunications, the assumed circle coverage area is not a limitation because it adequately models payload capabilities. On the contrary, the circle coverage area assumption completely fails when synthetic aperture radars (SARs) are considered. Furthermore, for the future developments, such as bistatic SAR (BSAR) additional requirements on coverage area must be included due the relative transmitter/receiver geometry. Recently important experimentations are carried out on the use of space-airborne bistatic SAR. Identification and tracking of moving obstacles, GPS-less navigation, autonomous landing and remote piloting are innovative applications based forward-looking (FL) receiver, while side-looking (SL) receivers can achieve very high image resolution useful in remote sensing and surveillance applications. The analysis has considered both receiver observation geometries and two main advantages have been identified: (1) bistatic geometry allows the system to overcome the main limitation of monostatic forward-looking SAR due to range-Doppler ambiguity; (2) passive side-looking receivers can take advantage of reduced requirements. The geometric analysis has been performed (Moccia et al., 2011) to define image resolutions for space-airborne bistatic SAR and to individuate best/worst illumination conditions in terms of position, velocity and look angle of the transmitting satellite. The identified requirements on transmitter/receiver geometry to guarantee a suitable image pixel angle can be translated in requirements on transmitter coverage area, which shape and size will depend on receiver observation geometry. In this frame, the paper aims at development of a novel methodology to design radar satellite constellations based on unusual coverage area. The previous constellation design methods not based on the circular coverage area concept were performed by Rider, who considers the possibility to have a nadir-hole, and by Hanson and Linden, that improved low altitude constellation design method for one-fold continuous global coverage. Starting from these two formulations, a new method for constellation design based on unusual coverage area has been developed, in which the number of satellites per plane is defined to guarantee the required level of coverage whereas the number of planes assures the 360deg-azimuth coverage of any target on the Earth surface. The mathematical formulation will be shown for both receiver observation geometries and the validation model will verify the coverage requirements.