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SURFACE ERROR MEASUREMENT AND CORRECTION OF A SPACE ANTENNA BASED ON ANTENNA GAIN ANALYSES

Abstract

High performance space antennas are required for future communications and observations to obtain high gain and to be operated in high frequency. To realize such requirements, antennas need to be large and precise. Because of capacities of launch vehicles, large space antennas are required to be light and deployable. Consequently, these structures are usually very flexible and they are easily deformed due to disturbances. Reconfigurable antenna systems are expected for high performance space antennas; because they can change their surface shapes of reflectors and beam shapes arbitrarily. For such reconfigurable antenna system, antenna surface deformations are required to be measured and corrected to achieve a high precision antenna surface. Some measurement methods, such as radio holography and photogrammetry, are employed for ground based antennas. However it is difficult to adopt these methods for space antennas, because they require special equipments and procedures. In this study, a novel measurement and correction method of antenna surface deformations is proposed. Surface adjustment mechanisms, which are necessary for a reconfigurable antenna system, are used to measure and correct surface errors. Relations between antenna surface errors and changes in antenna gains caused by intentional deformations are derived from the Ruze equation. In this method, an antenna surface is deformed additionally using the surface adjustment mechanisms and changes of the gains caused by the intentional deformations are measured. From the information of the intentional deformations and changes in the antenna gains, an original deformation of the antenna surface is estimated using the relations and the deformation is corrected using the surface adjustment mechanisms. Control inputs for the antenna surface correction are directly determined from the information using relations between antenna surface errors and changes of the gains caused by shape adjustments. Some numerical simulations are carried out to investigate the feasibility of this method. In these simulations, a cable-network antenna system is employed and cable stiffness errors corresponding to degradations of cables caused by the space environment are assumed. The antenna surface is deformed additionally using the surface adjustment mechanisms and changes of the gains are measured. The nominal deformation is estimated and corrected using the proposed method. From the results of these simulations, it is shown that the antenna deformations are estimated and corrected adequately by using this method.