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SMART ANTENNA CONTROL SYSTEM FOR GROUND STATION PRECISE TRACKING OF UITMSAT-1 NANOSATELLITE

Abstract

Nowadays, the lean satellite concept nowadays has been implemented widely in the development of small satellites. Fascinating approaches towards low-cost development/technology and fast-delivery duration attract space builders, researchers and players all around the world. The UiTMSAT-1 is a Malaysian nanosatellite, which is one of the three identical 1U nanosatellites constellation of the Joint Global Multi-Nation BIRDS-2 Project. It is the first nanosatellite ever built primarily by Universiti Teknologi MARA (UiTM) postgraduate students, together with other BIRDS-2 Project members from some developing countries, Bhutan and Philippines. After completing the development process, the hand-over to JAXA, the launching into space in June 2018 and the deployment from ISS into space in August 2018, the BIRDS ground station network started to track and monitor BIRDS-2 nanosatellites, actively. As the number of small satellites constellation keep increasing over the years, there is a demand for higher capacity and capability of a ground station's tracking system in order to mitigate the performance's degradation experienced in a conventional ground station system, which are mainly due to signal interference, inter-satellite interference and multi-path fading. This paper describes a promising solution to mitigate the above-mentioned problems by presenting a smart antenna tracking control system that implements an optimization scheme of Least Mean Square (LMS) algorithm into the Adaptive Antenna Array (AAA) control system. The algorithm computes the set of weighting factors until the optimum weights are adapted and converged. The MATLAB simulation results show the ability of the optimized LMS algorithm to steer radiation pattern electronically towards desired satellite (UiTMSAT-1) and suppress other interferences from interferer satellites (other BIRDS-2, Planet Labs and Spire Global Inc. satellites). Orbital simulation in Simulation Tool Kit (STK) software is performed to analyze the inter-satellite interference either in the same/different orbital plane. The performance of the LMS algorithm optimization scheme is verified by analyzing the Signal-to-Noise ratio of the main beam pattern towards its side lobes and Mean Square Error minimization. Analysis of UiTMSAT-1 precise tracking is also discussed in this paper based on the calculated and simulated results of main beam narrow beam-width radiation pattern. The capability of the optimized LMS algorithm to do automatic steering and precise targeting towards UiTMSAT-1 while nulling out other interference signals from other satellites proves its reliability to implement the control system in the future ground station tracking system and finally gives benefits to satellite operators.