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OPTIMIZATION OF SATELLITE COMMUNICATION LINK BY DIGITAL BEAMFORMING IN GROUND STATIONS

Abstract

Satellite ground stations for LEO and GEO satellites are installed with antennas of size of several meters' parabolic dishes. Due to advances in the field of space communication, certain deficiencies of these antennas are becoming significant which are not important previously regarding their mechanical complexity, network efficiency, flexibility and high setup and maintenance cost. In the context of these, it is the need of hour to research alternative technologies to cope with these challenges. This paper explores the concept of intelligent ground stations, various adaptive array processing algorithms for antennas and discusses the feasibility of utilizing digital beam-forming techniques to improve the performance of ground stations for satellite communication link. Parabolic dishes e.g. in case of LEO satellite perform tracking through mechanical steering. Despite having high gain, their large weight and wind load of structure give rise to the technical challenge of precise narrow beam pointing in the satellite direction. Moreover, the ground station antenna gain is not optimized in case of LEO satellite because range loss is maximum at the lowest elevation angle due to larger distance of spacecraft-to-ground station as compared to larger elevation angel. Consequently, this requirement enforces large antenna size that provide high gain for the larger range loss at lower elevation angles. However, with this size of the aperture there are then unnecessary margins at higher elevation angles. Therefore, to resolve aforementioned issues, instead of installing a single large size antenna, an innovative idea is to employ an adaptive array composed of small size relatively low cost antenna elements. The outputs of these elements are processed at the base-band level using the adaptive beam-forming algorithms. These adaptive algorithms adapt the response of each antenna element of array according to varying environment to produce its corresponding optimized radiation pattern. So this digital beam forming in antenna arrays is a substitute of mechanical steering at satellite ground stations. Along with this electronic tracking other benefits are achieved in terms of interference suppression, anti-jamming capability, SINR enhancement, multi beam capability to track multiple satellites at a time and digitally up-gradation of system. This research presents the antenna arrays combined with adaptive beam-forming and DOA estimation techniques to make the ground stations intelligent and low cost. Such low cost ground stations can be spatially located that result in increased satellite visibility. There larger amount of data can be downloaded due to this increase in contact time.