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THE SNR AUXILIARY CARRIER SYNCHRONIZATION METHOD WITH MINIMAL RESOURCE COST FOR MARS EXPLORATION

Abstract

Mars is the key milestone in human exploration of the solar system. Due to the long distance between earth and Mars, the one-way light travel time is about20 minutes, and the ground cannot control the Mars probes in real time. Therefore, higher requirements are placed on the efficient autonomous communication ability between Mars probes. In order to maximize the transmission of valuable data information within the visible arc, Mars probes need to quickly and accurately estimate signal frequency offset for rapid signal locking, while accurately estimating SNR for real-time adjustment of bidirectional code rate, almost to maximize the transmission of data within the Shannon limit of the channel. The traditional SNR estimation algorithms and carrier frequency offset estimation algorithms are designed independently of each other, resulting in high resource costs and inability to meet the requirements of Mars exploration missions for product miniaturization and low power consumption. In this paper, the SNR auxiliary carrier synchronization method with minimal resource cost for Mars exploration is presented, which could take advantage of the characteristics of Manchester code in PM modulation defined by CCSDS proximity-1, and integrates the SNR estimation algorithm and carrier frequency offset estimation algorithm under the condition of significant resource conservation. The SNR estimation accuracy is better than 0.02dB and the carrier frequency offset estimation is better than 1Hz. The method will be used in next Chinese Mars exploration mission. By using the conception product with limited FPGA resource, real tests shows that the presented method performs well in any possible communication arc.