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THE FLL BASED BIT SYNCHRONIZATION AND FREQUENCY REFINEMENT METHOD FOR SMALL LUNAR MISSION

Abstract

Nowadays, GPS has widely served a large number of ground and low earth orbit users, providing them with accurate location information and time benchmarks. Due to the strict weight and power consumption limitations of small lunar mission probes, if GPS signals could be used for their own positioning and timing, it will bring great benefits. However, there are some reasons which restrict the GPS application of the small lunar mission, one of them is the bit synchronization and frequency refinement problem. In lunar orbit, the spacecraft is far from the GPS constellation and it could only receive the side lobe signals in most of time, which means that the received signal power is very low and the accuracy of the acquisition result is insufficient, making it impossible for the tracking loop to successfully lock the signal. To solve this problem, the normal method is to use the modernized GPS signals (e.g.L5), which have pilot channel. But the drawbacks are obvious: 1) the number of GPS satellites transmitting L5 signal is limited, which means that it is difficult to ensure the continuity of lunar navigation missions; 2) to improve ranging accuracy, dual frequency signals are essential. In this paper, the FLL based bit synchronization and frequency refinement method for small lunar mission is presented, which will be used in Chinese next lunar mission. The algorithm could accurately calculate the Doppler shift, Doppler rate and the edge of the information data of GPS L1 in high sensitivity situation (-159dBm). The real simulation experiment (Spirent 8000) shows that this method can work well in the lunar navigation mission with very few resources: (ALTERA EP3SE260F: 6 percent ALMs, 8 percent DSP and 8 percent RAM).