20th SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Distributed Space Missions (7B)

Author: Mr. ge zhu
Xi'an Institute of Space Radio Technology, China

Dr. Jian Guo
Delft University of Technology (TU Delft), The Netherlands
Prof. Eberhard Gill
Delft University of Technology, The Netherlands

A NEW SIDE-TONE-BASED INTER-SATELLITE RADIO LINK FOR SMALL SATELLITE FORMATION FLYING

Abstract

An inter-satellite radio link combining the functions of communication with ranging is preferred by formation flying mission using small satellites due to power and mass limitations. This paper addresses a new side-tone-based inter-satellite radio link for small satellite formation flying.

Typically, the inter-satellite radio link based on pseudo-random code technology for data transmission and the measurement of relative distance. However, this technology requires a more complex architecture resulting in high hardware cost. A side-tone ranging and communication system offers a less complex architecture compared to pseudo-random code systems. Thus reduces the load for the onboard processor. However, traditional side-tone systems, such as in satellite Tacking Telemetry and Command (TTC)systems, use several separated subcarriers for both ranging tone and data transmission. The data and ranging tone modulated on subcarriers are then modulated by an analog phase-modulated on a main carrier. By means of this modulation, the residual carrier occupies most of the power while only part of the power is used for data transmission. Therefore, the power efficiency of those systems is lower than for pseudo-random code ranging systems using a digital modulation method. There is a clear need to design more power-efficient system to improve traditional side-tone ranging systems.

This paper presents a modified side-tone based ranging and communication system in which the side-tone is first phase-modulated on a main carrier, and then this "alienation" main carrier works as BPSK digital modulated carrier. Since a digital modulation method is applied, the system improves the power efficiency of data transmission.

The performance of demodulation of ranging side-tones and data is investigated. This paper also presents a method for ambiguity of phase resolution. Under varies signal-to-noise ratio, the ranging accuracy and calibration error is analyzed. The analysis shows that the modified side-tone ranging system for inter-satellite communication and ranging link presented in the paper achieves a good performance. A ranging side-tone and communication function integrated in one device with a efficient utilization of radio channels is promising for small satellite formation flying missions.