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DESIGN AND IMPLEMENTATION OF RADIO OPEN-LOOP SIGNAL EXTRACTING (ROSE) SOFTWARE FOR MARS EXPLORATION

Abstract

In order to meet the requirement of high accuracy velocity measurement of the Mars probe precise orbit, Radio Open-loop Signal Extracting (ROSE) software is designed and implemented based on the open-loop measurement method. This software architecture includes: baseband digital signal format analysis unit, parameter configuration unit, signal processing unit, and measurement generation unit. The crucial part is the signal processing unit with open-loop processing model. The signal processing unit of ROSE software is introduced in detail in this paper.

Deploying ROSE software on the general hardware computing platform, it can realize the format analysis, preprocessing, processing and measurement conversion generation of the deep probe's downlink signal obtained by the deep space station. ROSE software can be utilized to precisely extracting the features from the deep space probe's downlink signal, including Doppler frequency, SNR and carrier phase. The most important output of ROSE is the high accuracy open-loop Doppler frequency extracting result, thus the high accuracy velocity measurement of the deep space probe could be obtained by ROSE software.

The high accuracy velocity measurement of the probe could be effectively obtained by ROSE software. ROSE software has been successfully and effectively applied for high accuracy orbit measurement in

Chinese Tianwen-1 Mars probe mission and the ESA Mars Express (MEX) joint experiment. The open-loop velocity measurement accuracy of Tianwen-1 is better than 0.1mm/s in 1s integration, which is better than the velocity measurement accuracy of the deep space station's baseband. The open-loop velocity measurement accuracy of MEX is at the level of 0.05mm/s in 1s integration. The high accuracy Doppler observations by ROSE software have effectively support the precise orbit determination of Mars probes.

At the same time, ROSE software was effectively utilized for radio science experiment of Mars and the other planet. ROSE software was utilized to process and analyze the downlink signals of Mars radio occultation experiment based on Tianwen-1. The obvious radio occultation features of Mars were effectively extracted by ROSE software. The retrieval of Martian ionospheric electron-density profiles and neutral atmospheric density were effectively obtained by ROSE's measurement results. Thus, it can be believed that ROSE software can be popularized and applied to more deep space navigation missions and planetary radio scientific research.