SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Space-Based Navigation Systems and Services (3)

Author: Dr. Dun Wang
Beijing Institute of Satellite Information Engineering, China, dawun04@163.com

Mr. Qijia Dong
Beijing Institute of Satellite Information Engineering, China, dong_qijia@163.com
Mr. Meng Wang
Beijing Institute of Satellite Information Engineering, China, wang_meling@163.com
Mr. Ye Li
Beijing Institute of Satellite Information Engineering, China, liyea1@sina.com
Ms. Lei Li
Beijing Institute of Satellite Information Engineering, China, 604534588@qq.com
Dr. Rui Li
Beijing Institute of Control Engineering, China Academy of Space Technology (CAST), China, rliz9805@hotmail.com

RESULTS FROM THE GNSS FLIGHT EXPERIMENT ON THE CIRCUMLUNAR FREE RETURN TRAJECTORY OF CHINA CE-5T1 SPACECRAFT

Abstract

Performance of GNSS applications in space service volume (SSV) has been attracting high concerns from space scientists and engineers since GPS began to provide its full operational capability. In October 2014, China lunched her fourth spacecraft of lunar exploration program, CE-5T1, to examine the technologies of returning from the Moon. A multi-GNSS receiver of GPS and GLONASS was loaded on CE-5T1 and reported the results of real-time on-board PVT calculation and raw measurements during the flight heights of 50,000 to 5,000 km. With these experiment data, this paper revealed signal characteristics of both GPS and GLONASS satellites observed within SSV, analyzed contributions of signals from antenna side lobe and then evaluated the performance of CE-5T1's autonomous navigation based on GNSS signals. In this paper, the components, functions and designed performance of the multi-GNSS receiver were introduced and followed by a brief explanation of the algorithm of real-time on-board PVT calculation. After then the methods for analyzing the raw measurements to obtain GNSS signal characteristics like number of visible satellites, carrier-to-noise power density ratio and dilution of position (DOP) and so on were represented and the method for assessing the accuracy of calculated PVT on-board were expressed in comparison with the results of orbit determination by using VLBI. Offline evaluation results showed that the multi-GNSS receiver provided stable and continuous navigation outputs with positioning and velocity accuracies of better than 100 m and 0.1 m/s respectively during the flight heights of 50,000 to 5,000 km. Preliminary analysis results exhibited that total number of visible GPS and GLONASS satellites increased gradually for 4 to 12 and the DOP of combined GPS and GLONASS satellites decreased slowly from 17 to 2 while the spacecraft flied over the heights from 50,000 km to 5,000 km. Results from flight experiment on circumlunar free return trajectory of CE-5T1 proved that multi-GNSS receivers can provide stable and continuous autonomous navigation capability for spacecrafts up to the height of 50,000 km.