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INTER-SATELLITE RELATIVE POSITION MEASUREMENT MODULE FOR FORMATION FLYING OF MICROSATELLITES

Abstract

Microsatellite formation flying are playing an increasingly important role in global real-time observation, wide-range stereo imaging, scientific exploration and other space missions. The real-time and accurate relative position measurement is a key issue in formation flying. It is a fundamental prerequisite for maintaining and reconfiguring formation configurations, collision avoidance and safety assurance. For microsatellites, baseline measurements also need to meet the requirements of low cost and low power consumption. In this paper, a GPS/BDS receiver-based inter-satellite relative position measurement module for microsatellite formation flying is proposed. The module includes a receiver, a digital transmission device and an embedded computer. Based on two modules, the GPS or BDS data obtained from the receivers are exchanged through the digital transmission device, and then get the relative position through a novel single-calendar element baseline solving algorithm by the embedded device. The relative position solving algorithm consists of the following 5 steps. 1) Reduce the effect of low precision observations by the height angle sine weighting function. 2) Eliminate the clock difference between the navigation satellite and the receiver by differencing the observation equation twice for the same moment of observation. 3) Construct long-wave observation equations to compress the search space of full-period ambiguity. 4) Based on the pseudo-distance double difference equation, obtain the approximate solution of the whole-period ambiguity, and combine with the channel noise model to give the long-wave whole-period ambiguity to be checked region 5) Determine the accuracy of the whole-week ambiguity by the quadratic ratio test and the channel residual test. The GPS/BDS receiver in the module has been successfully validated for on-orbit flight on Q-Sat, a microsatellite for measuring the gravity field and the density of the upper atmosphere. On-orbit tests show that it can simultaneously receive high-quality GPS data (L1, L2 and L3 bands) and BDS data (B1, B2 and B3 bands) with a low power consumption of only 2W. Based on GPS or BDS data, it can meet the needs of Q-Sat for precision orbiting at the decimeter level. Baseline measurement ground tests shows that through two modules, the real-time relative positions with centimeter-level accuracy can be obtained within 10 km. It will provide a low-cost, high-precision, real-time relative position measurement technology for formation flying of microsatellites.