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RELATIVE NAVIGATION FOR SPACE SYNCHRONIZATION BASED ON GNSS CARRIER PHASE SMOOTHING

Abstract

The servicing spacecrafts (chasers) should be able to rendezvous, approach and even synchronize the serviced spacecrafts (targets) autonomously in the future. Synchronizing flight means that the chaser should be in the same relative position to the target whether the target is changing orbit. The precise relative information of position and velocity is needed during synchronizing flight.

Different for the common methods, using radars and cameras, to get the relative kinematics parameters, the relative Global Navigation Satellites System (GNSS) based on carrier phase smoothing is discussed to work for close range flying here.

Why is the carrier phase smoothing selected? The GNSS for the space relative navigation has four working modes: position/velocity, pusedorang, carrier phase and carrier phase smoothing. Since the distance between target and chaser is supposed to be short, the relative GNSS precision should be sure to distinguish the two spacecrafts. Then carrier phase smoothing is chosen as it has the best precision in ideal.

The target maybe moves suddenly and could not supply the very precise kinematics information, a new relative navigation method, using the information of chaser orbit and relative GNSS, is proposed. It means that chaser has no necessities to know the precise target absolute kinematics information.

The relative position and velocity from target to chaser are chosen as the Relative Navigation Filter (RNF) states. The RNF state equation is constructed in chaser orbit coordinate system and taken the orbit angle velocity and the corresponding angular acceleration into account. The linear accelerations of target and chaser are neglected because the acceleration amplitudes are considered to be few commonly.

Relative measurements are constructed by expansion the relative GNSS based on the chaser while the common method is base on the targets.

The simulation is accomplished base on the relative navigation soft developed with the Matlab/Simulink. The GNSS is designed to contain three constellations: GPS, GLONASS and COMPASS. The system is derived by the real navigation satellites ephemeris downloaded from the website. To compare performance with the conventional method, the relative RNF based on the target is also constructed.

The simulation results show that the new method has the potential to supply the better precision of relative information between chaser and target. The further simulations are carrying out and the new results are expected.

Keywords: Relative Navigation, chaser orbit information, Global Navigation Satellites System (GNSS), indirect measurements, carrier phase smoothing