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AUTONOMOUS POSITIONING AND ORIENTATING FOR LUNAR LAUNCH

Abstract

Lunar ascent is one of the most important steps to return a crew or samples to the earth. Similarly to launch on the earth, the initial position and attitude of the ascend module (AM) should be known firstly, and then the ascent trajectory with control parameters could be designed, according to which, the AM could be guided.

On the earth, the initial position of a rocket is already known when the launch site is selected. The initial attitude of a rocket can also be determined easily using a self-alignment method of Inertial Navigation System (INS) or with the help of some external direct aiming equipment. But when doing these on the moon, those available conditions do not exist, which makes the work more difficult. Furthermore, since the earth-moon distance is great, the operators on the earth cannot give more assistance and most of the operations of positioning and orientating should be performed autonomously.

Although those general methods and instruments on the earth cannot be carried to the moon, star trackers and Inertial Measurement Units (IMU) composed of gyros and accelerators are usually equipped on board, which makes the autonomous positioning and attitude alignment of INS on the moon practicable. The algorithm can be divided into three steps. At first, the inertial attitude of the AM will be determined by star trackers and gyros, and the constant flow of gyros can also be calibrated using the Kalman filter technique. Secondly, according to the specific force measured by accelerators and the inertial attitude obtained in the first step, the position of the AM in the inertial frame can be obtained. And with the knowledge of ephemeris of the moon, the geography position of the AM can also be calculated. Finally, based on the information obtained above, the attitude relatively to the geography coordinate can be solved easily.

In this paper, this method above will be discussed in detail and a simulation will be used to verify the performance of the algorithm.