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IN-ORBIT AUTONOMOUS NAVIGATION SYSTEM BASED ON ATTITUDE SENSORS

Abstract

Exact positioning in orbit is the key issue for the successful exploration of lunar or other planets. Since the GPS information is not available in lunar or planetary orbits, the earth-based satellite tracking system is currently used for the purpose of the navigation of other planet satellites. However, this system not only requires heavy cost, but also suffers from communication problems due to far distance from earth to satellite. In the study, an autonomous navigation method for satellites using the dual-conical scan sensors and star trackers, which are typical on-board attitude sensors, is addressed. The autonomous navigation system to be studied in this project is based on the principle of the ancient celestial navigation in which the position of an object on the earth surface can be determined by using the different direction angles of a star to the zenith. Solving the problem of where satellite is can be achieved by observation of three stars because there is only one point where all three circles of equal zenith intersect. The satellite can find its position by plotting the circles of equal zenith on a globe. According to this principle, we need to know the direction of the zenith and the altitude of the satellite. The local horizontal level can be provided by a dual-conical scan sensor. Especially in case of an altitude, it can be calculated by an angle which is formed by two lines, a straight line from satellite toward the planet-centered and a tangent line of the planet-surface from a satellite. This angle can be estimated by a dual-conical scan sensor. And the directions of stars to the zenith can be determined by star trackers. Those sensors are standard equipment for precision attitude determination of satellites. Two tools, MATLAB and OpenGL, are used for this method. MATLAB provides basic calculations and OpenGL control after linking up between two tools. Integrated simulation tool of autonomous navigation system can be also developed by MATLAB simulink. OpenGL performs mainly 3-D processing, i.e. the planet modeling. The proposed autonomous navigation system for earth and moon satellite is very cost effective because the typical on-board satellite attitude sensors are only required.