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ATTITUDE AND ORBIT CONTROL OF A GEOSTATIONARY SATELLITE DURING NORTH-SOUTH STATION KEEPING

Abstract

Geostationary satellites are placed in a specific orbit that allows them to remain in a fixed position over the Earth's equator. This orbit is known as the Geostationary Earth Orbit (GEO) and is approximately 36,000 kilometers above the Earth's surface. Maintaining the satellite's position in this orbit is crucial for ensuring consistent communication and data transmission services. However, orbital perturbations can impact the satellite's position in the GEO. These perturbations can come from various sources, including gravitational forces from the Earth and other celestial bodies, solar radiation pressure, and atmospheric drag. East-West station keeping (EWSK) and North-South station keeping (NSSK) are used to control the satellite's position in the Geostationary orbit. NSSK is performed to correct the inclination drift in latitude due to luni-solar perturbations, while EWSK is performed to correct the semimajor axis/eccentricity drift in longitude due to earth gravitational force and solar radiation pressure perturbations. The inclination of a geostationary satellite is the angle between the plane of the satellite's orbit and the equatorial plane of the Earth. Due to the luni-solar perturbations, this inclination changes over time, causing the satellite's latitude to drift. NSSK corrects for this drift by adjusting the satellite's attitude and orbit using thrusters. This process is more complex than EWSK, as the inclination angle changes at a faster rate than other orbital parameters, requiring more propellant. Thrusters are commonly used as actuators to control the satellite's attitude and orbit simultaneously during station keeping. To manage the thruster pulses, modulation techniques are employed. These techniques modulate the pulse duration, frequency and timing of the thruster pulses to achieve the desired control effect. There are several modulation techniques used in orbit control and station keeping, including bang-bang, dead-band, pulse-width modulation (PWM), pulse-frequency modulation (PFM), pulse-rate modulation (PRM), and others. Bang-bang modulation is a simple but effective technique that involves turning the thrusters on and off to achieve the desired result. It is particularly useful for small, precise adjustments to the satellite's orbit or attitude, as it provides a quick and accurate response. Dead-band modulation is another common technique that involves setting a range of acceptable values for the thruster pulses. If the thruster pulse falls within the acceptable range, it is left unchanged. However, if it falls outside the range, the pulse is adjusted to bring it back within the acceptable range.