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EXPLORING ALTERNATIVE SPACE-BASED NAVIGATION SYSTEMS FOR UAVS OTHER THAN GNSS

Abstract

Navigating unmanned aerial vehicles (UAVs) in space without GNSS (Global Navigation Satellite System) presents a significant challenge. GNSS, including GPS, GLONASS, and Galileo, can experience signal blockages from natural or artificial objects, and the signals can be jammed or disrupted by electromagnetic interference. Thus, it is essential to develop alternative navigation systems for UAVs that can function without GNSS.

One alternative system is the Inertial Navigation System (INS), which relies on accelerometers and gyroscopes to measure the vehicle's motion and calculate its position, velocity, and attitude. However, INS has some limitations, such as drift errors that can accumulate over time, causing the system to lose accuracy. To overcome this, INS can be integrated with other navigation systems, such as the Doppler Velocity and Positioning System (DVPS) and the Celestial Navigation System (CNS).

The DVPS measures the UAV's velocity and position based on the Doppler effect of signals emitted from satellites, while the CNS uses astronomical observations to calculate the UAV's position and orientation. These systems can be used together with INS to provide more accurate and reliable navigation information for UAVs.

The Magnetic Anomaly Navigation (MAGNAV) system is another alternative navigation system that uses the Earth's magnetic field to navigate the UAV. The system works by measuring the magnetic field's intensity and direction and comparing it with the known magnetic field map. The difference between the measured and known magnetic fields provides the UAV's position and orientation.

The Vision-Based Navigation (VBN) system is also a navigation system that can be used to navigate UAVs in space without GNSS. VBN relies on cameras and computer vision algorithms to recognize and track visual features, such as landmarks, roads, and buildings, to calculate the UAV's position and orientation. However, the VBN system is sensitive to lighting conditions and weather, and its performance can be affected by changes in the environment.

In conclusion, navigating UAVs in space without GNSS is a challenging task, but alternative navigation systems, such as INS, DVPS, CNS, MAGNAV, and VBN, can be used to provide accurate and reliable navigation information for UAVs. The appropriate system to use depends on various factors, such as the mission requirements, environment, and available resources.