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Perspective

Orbit Determination of Satellite in Space Travel

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DESCRIPTION

The topic of Orbit Determination (OD) of celestial bodies has been of interest to many astronomers for centuries. OD involves the determination of position and velocity of the orbiting celestial body. The motion of celestial bodies in the space is influenced by many external forces including Earth's gravity, attraction forces from other celestial bodies, outer space environment and solar activities, making OD a challenging problem to address. This has attracted the attention of many mathematicians and physicists towards the problem of OD. Initially the satellite OD used visual observations which were accurate up to kilometre (km) level, whereas, subsequently the optical tracking systems using telescopes, radio tracking systems, Doppler systems, Laser tracking systems etc. were evolved for satellite OD.

Artificial satellites are being used for various civilian and defence purposes that include communication, navigation, interplanetary missions, earth observation and environment studies. The need of precise positioning was fulfilled for the first time with the realization of satellite navigation system known as Transit in 1960's. The theories developed for Transit were proved to be important and useful for the subsequent design and development of the Global Positioning Satellite System (GPS). Satellite navigation system was also planned by Russia and launched navigation satellites forming the GLONASS system, which achieved its fully operational capability in early 1996. Navigation satellite systems posed a need for satellite orbit determination as it is one of the key elements to obtain the Positioning, Velocity and Time (PVT) solution using the Global Navigation Satellite Systems (GNSS) receiver. GNSS receivers track the signal as a radio frequency transmitted from the GNSS satellite and compute the user position using the navigation data sent by the satellite and decoded after tracking. Observation data obtained from a GNSS receiver contains information about pseudo ranges, carrier phase cycles and doppler measurements. The ephemeris data transmitted by a navigation satellite and decoded by GNSS receiver.

Tracking of the radio signals becomes difficult in challenging environments such as, inside the building, areas with dense plantation etc. Hence the GNSS receivers find it difficult to acquire the broadcast ephemeris from satellites in challenging environments. This is achieved by statistical orbit determination techniques locally at the receiver. Satellite Orbit Determination (SOD) is the process of estimating the state of a satellite whose initial state is unknown based on the observations that are influenced by random and systematic errors. The statistical orbit determination algorithms become an essential part of the generating ephemeris locally at the receiver. Kinematic approach is purely a geometric approach that considers the range and carrier phase measurements of the satellite. Dynamic approach on the other hand is based on the numerical integration of the equation of motion of the satellite. Kinematic approach, being a geometric approach is less precise as compared to the dynamic approach of the orbit determination. Statistical orbit determination is the modern approach of orbit determination which not only uses the information about the motion of the satellite but also the observation vector of the satellite from ground. Various statistical orbit determination algorithms have been reported in the literature for different navigation constellations.

CONCLUSION

Global Positioning System (GPS) based orbit determination of highly elliptical orbit using data collected from a Trimble Advanced Navigation Sensor (TANS) vector receiver with an accuracy of kilometer (km) level. This study did not address the prediction errors in radial direction of satellites for longer durations. Ephemeris extension algorithm for BeiDou Navigation Satellite System (BDS) orbits using LS technique. They use the precise ephemeris orbit products for the calibration of satellite orbits. Every particle attracts every other particle in the universe with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

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