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ORBIT AND CLOCK ESTIMATION OF IRNSS USING INDIAN NAVIC RECEIVER

Abstract

The aim of this paper is to precisely estimate the satellite orbit and clock errors using Indian NavIC receiver's data. ISRO's Satellite Application Centre (SAC) installed NavIC receiver in the department of Electronics and Communication, Dayananda Sagar College of Engineering (DSCE), Bengaluru, India for estimating precise orbit and clock errors of IRNSS as a funded project. The range measurements received by the ground receivers have multiple errors added due to ionospheric delay, tropospheric delay, multipath delays, satellite clock errors and some unmodeled effects. But, the major factor accounting to errors is the satellite clock error. Due to non-availability of data from other NavIC receivers at present, simulated data is used for the study.

The process of satellite's orbit estimation mainly includes trajectory generation, measurement modelling and finally estimation of the satellite orbit and clock error. Numerical integration method is used which is based on implicit Runge-Kutta methods (RADAU IIA) with variable order and step size control for the trajectory generation. Measurements are generated for a network of tracking stations at every instant of time using satellite ephemeris and station coordinates.

Most commonly used estimation techniques are batch and sequential. Extended Kalman Filter (EKF) is a sequential estimation technique which estimates the state parameters at each epoch using range measurements. A software has been developed based on EKF and it has been applied to two different cases, with and without clock bias for widely separated ground station. The estimated position and velocity is compared with the true satellite ephemeris to verify the satellite position estimated by the algorithm. The EKF algorithm is explained in section II and the trajectory generation, measurement modelling, the ground stations considered, initial conditions and the process involved in the estimation are discussed under methodology in section III of the paper. The results observed are tabulated and discussed in section IV.

The state parameters and the clock bias are estimated with actual and well disturbed initial conditions. It is observed from the results obtained that estimated satellite position and clock errors are about 11 cm and 0.01 ns respectively, even with well disturbed initial state parameters. Having precise orbit positions of all IRNSS satellites, the end user position can be determined precisely.