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GPS PSEUDO RANGE ERROR ANALYSIS WITH PRECISE ISS STRUCTURE MODELING BETWEEN HTV AND ISS NAVIGATION

Abstract

Japan Aerospace Exploration Agency (JAXA) had developed the H-II Transfer Vehicle (HTV). HTV is automated, unmanned logistic transporter to the International Space Station (ISS) and approaches to the ISS with relative navigation system utilizing both JEM-SIGI(Space Integrated GPS/INS) on JEM (Japanese Experiment Module) and HTV-SIGI on HTV to GPS (Global Positioning System).

HTV structure is relatively simple, whereas ISS structure is composed of 100m-order of structures, such as solar arrays and radiators. Then multipath influence due to this ISS structure has the possibility of serious impact on actual pseudo range and relative navigation accuracy. Since this peculiar multipath influence due to ISS structure is independent to that due to HTV, pseudo range error caused by this multipath cannot be removed by the relative navigation. Hence forecasting and understanding the influence by the multipath quantitatively becomes important.

The influence of the multipath is often treated as statistical approach or data assumption based on the measurement because its behavior is extremely complex. There are few papers that calculate the actual pseudo range errors quantitatively corresponding to the complicated structure as far as we know.

This paper describes the delay path analysis that considers the multipath with the ISS structure and a pseudo range error analysis with high fidelity ISS modeling and UTD(Uniform Theory of Diffraction) technique, which is synchronized with actual trajectory of ISS for accurate presumption.

First, the delay path is analyzed precisely with high fidelity ISS modeling consists of polyhedron and cylinder by using ray tracing that considers the multipath generated with the ISS structure. ISS solar arrays and radiators rotations are also considered in the analysis model.

Secondly, pseudo range error is analyzed using the delay path obtained from the ray tracing in accuracy. For pseudo range error calculation, the spread and modulated C/A code and Delay Lock Loop (DLL) for delay discriminator which assumes the receiver are adopt. Good correlations of the pseudo range error between analysis and measurement using GPS simulator has been obtained.

Lastly, variation of pseudo range due to ISS structure is analyzed in accordance with ISS and GPS trajectory. Prior to the launch of HTV-1, Pseudo range error had been analyzed between HTV-1 and ISS, and validation for navigation has been confirmed on orbit evaluation.