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DECOUPLING GROSS MOTION AND VIBRATION OF FREE-FLOATING SPACE ROBOTS IN FREQUENCY AND TIME DOMAIN

Abstract

In future, free-floating space robots (FFSR) with multi-flexible arms will play an important role in space servicing. Compared with the traditional robotic arms like Canadarm2 which is very heavy about 1641kg and moves slowly about 2-15 cm/sec when loaded to suppress vibration, the flexible arms are much lighter which saves the cost and finishes the missions more quickly. However, due to structural property, the motion of the arm would produce vibration which would do harm to itself and the payloads. So it is essential to analyze the dynamics of the system to suppress vibration. For FFSR with multi-flexible arms, the structural vibration, gross motion and the motion of each arm are coupled together, which would make the dynamics more difficult to analyze. For dynamic modelling, the different ways will have different results for the same system. Absolute Nodal Coordinate Formulation (ANCF) is widely used in recent years due to its high precision but gross motion and vibration are added together in the result. Assumed Modal Method (AMM) decouples gross motion and vibration but it is only for small deformation with lower precision. This paper will decouple the gross motion and vibration in frequency and time domain of the dynamics based on ANCF for analyzing. First, the dynamics will be gotten based on AMM and ANCF separately. Then motion of each arm will be planned according to the missions, different loads will be added to the system and the results are gotten via numerical integration. Later, the results of numerical simulation will be analyzed in frequency domain via Fast Fourier Transform (FFT) first and then in time domain via Extended Time Domain Collocation (ETDC). Finally, the vibration from the dynamics based on ANCF will be analyzed by comparing with them from AMM in frequency and time domain together to validate the model.