INTERACTION DYNAMICS OF ON-ORBIT CONSTRUCTION

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Deployment and assembly of large structures in orbit is a critical technology to the overall problem of orbital construction. The attendant large configuration changes of structures will cause significant changes in the dynamic characteristics of the entire system, and perturbation to the orbital dynamics of the spacecraft from which the structures are deployed and/or assembled. To better design structures for deployment and assembly, and to better design controlled deployment/assembly processes, accurate modeling techniques are absolutely essential.

In the first part of this study, the problem of modeling the dynamics of deploying and retrieving beam-like structures from a rotating base has been addressed. A methodology for discrete modeling, and a computational procedure have been developed. These results give us the capability of understanding and predicting the effects on the overall satellite motion of deploying flexible appendages. This is an initial step towards a general capability of treating axially moving three-dimensional beams.

The second part of the study investigates the interaction dynamics of the orbiter, its flexible manipulator and the structures to be assembled/deployed, as a prerequisite in order to simulate incremental in-space structural construction processes. Preliminary results so obtained indicate that, as the inertia properties of the flexible large space structure under construction change during the space assembly/construction process, the interaction dynamics undergo significant changes in their characteristics, thus revealing the need for a variety of control strategies throughout construction.

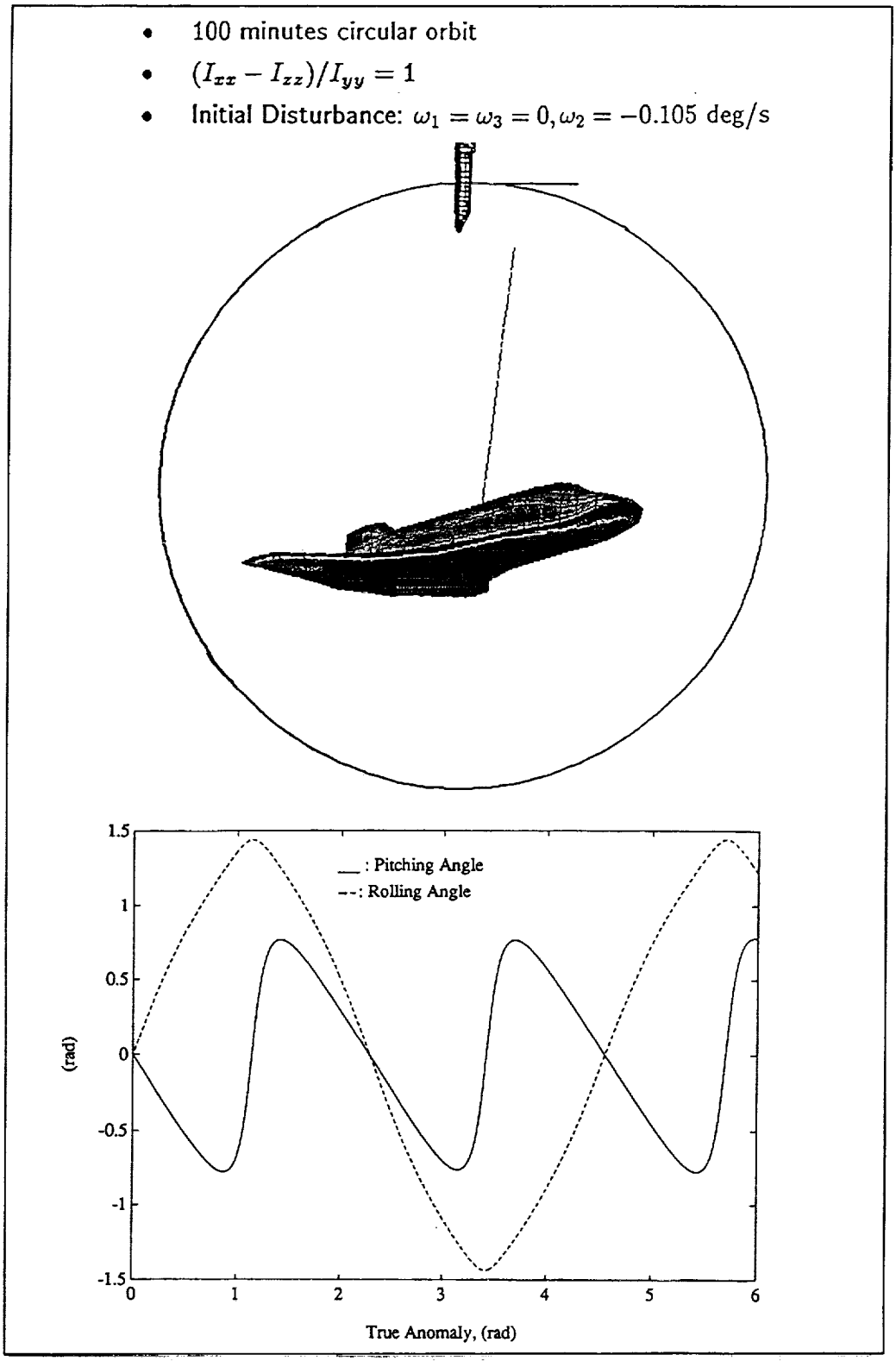

Fig 1.1 Librational motion of a space shuttle: (a) Orbiting space shuttle with MRMS; (b) three-dimensional librational response

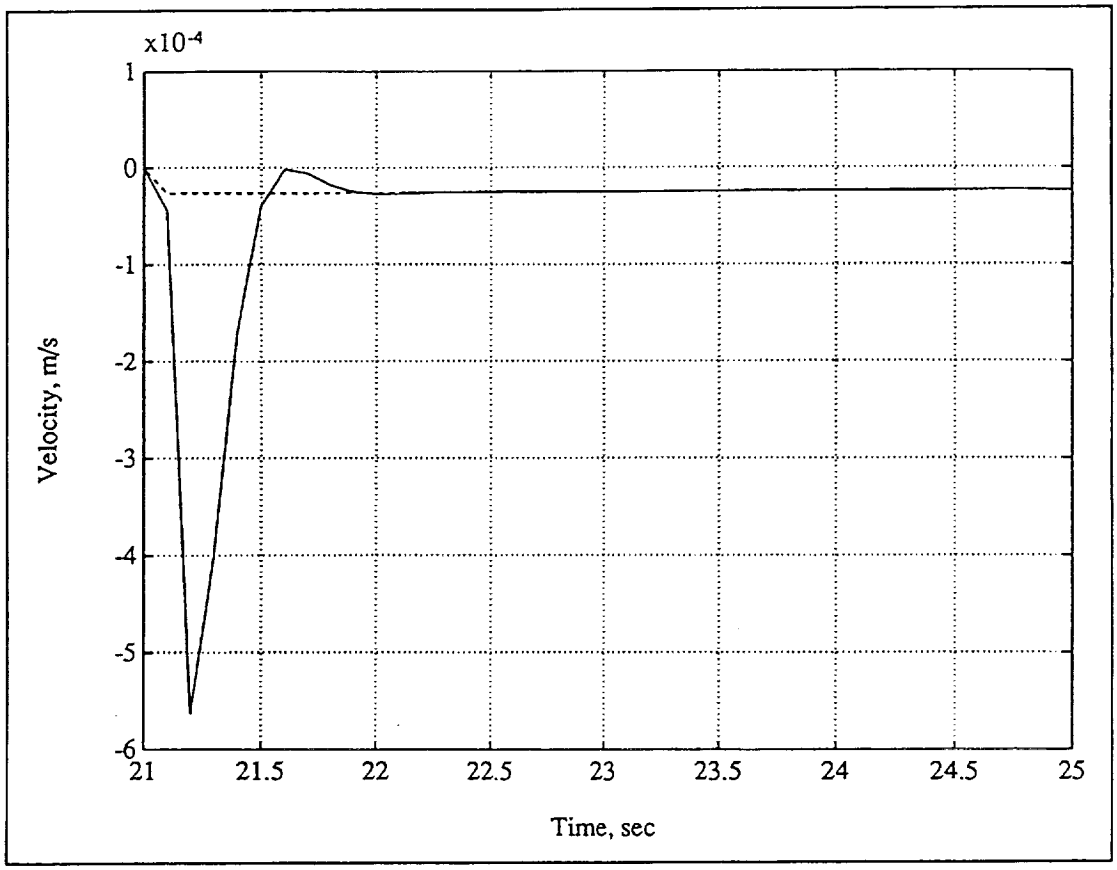

Fig. 1.2 Contact velocity of SRMS and payload: X-axis

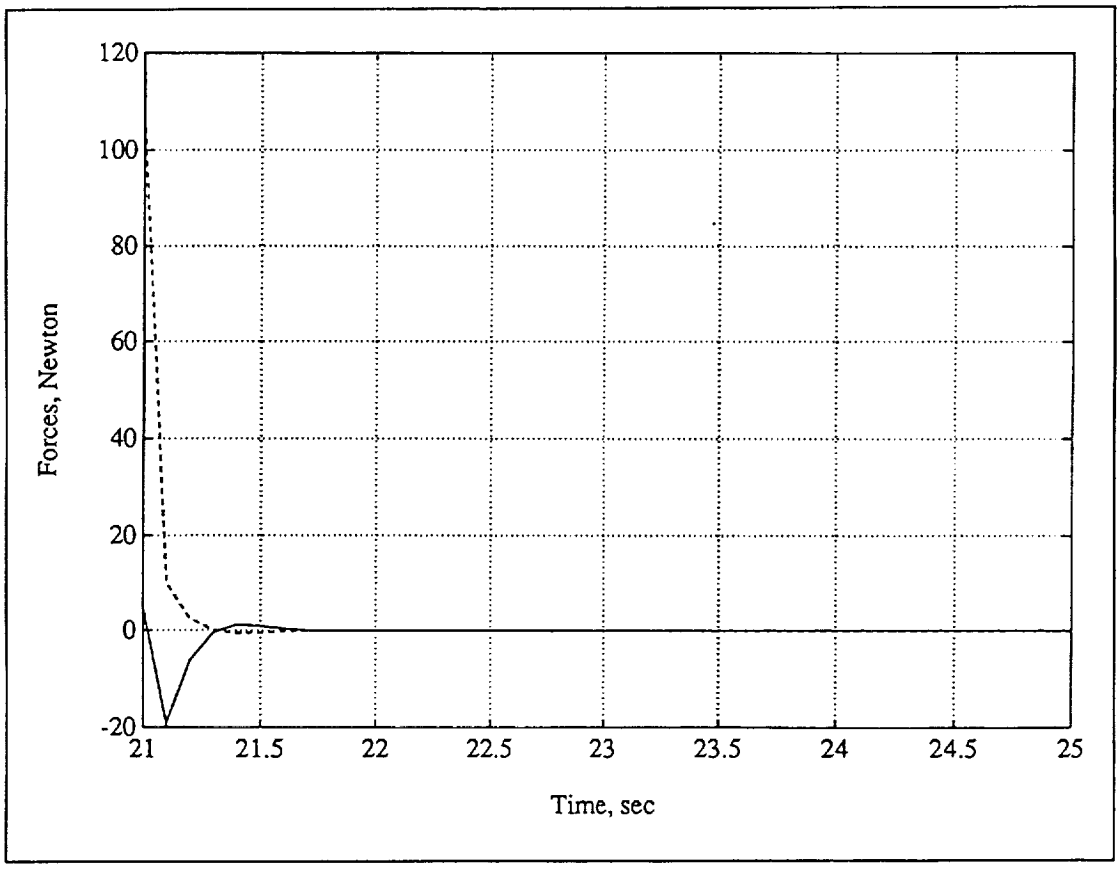

Fig. 1.3 Contact forces of SRMS and payload: X-axis

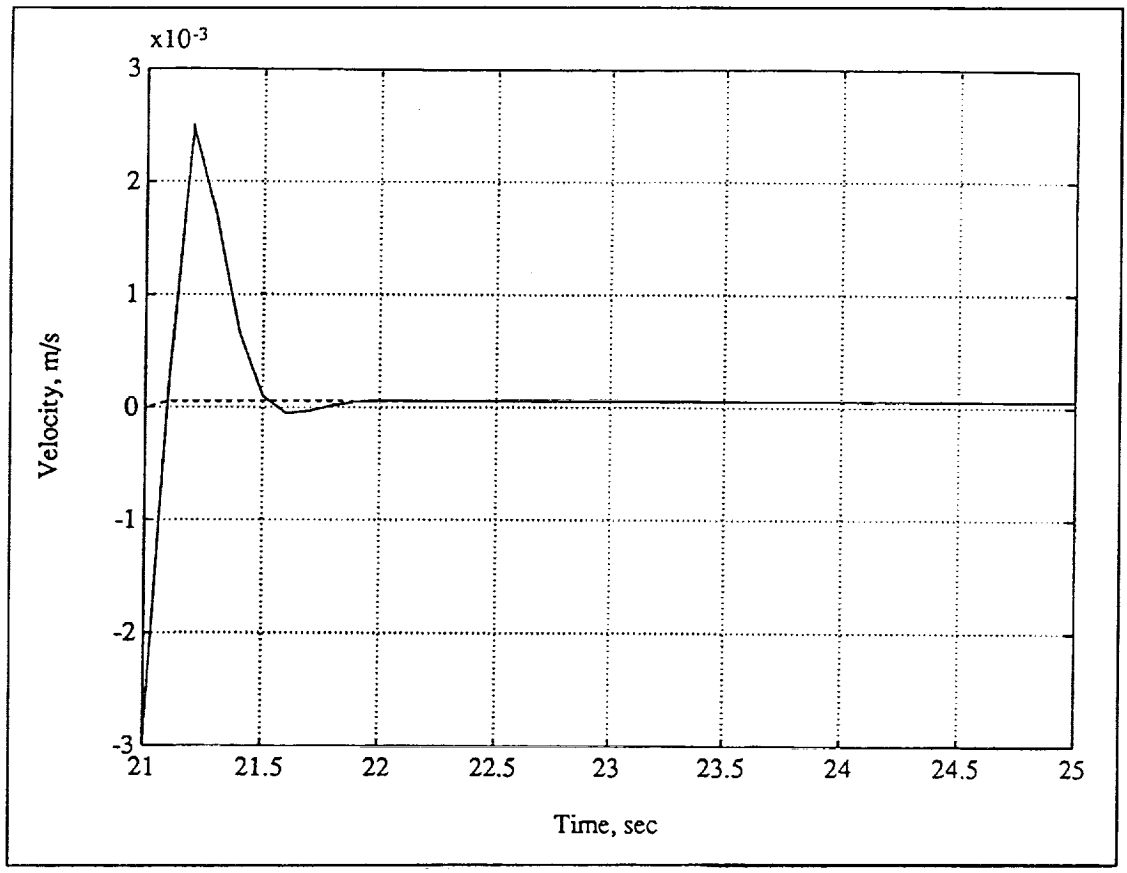

Fig. 1.4 Contact velocity of SRMS and payload: Y-axis

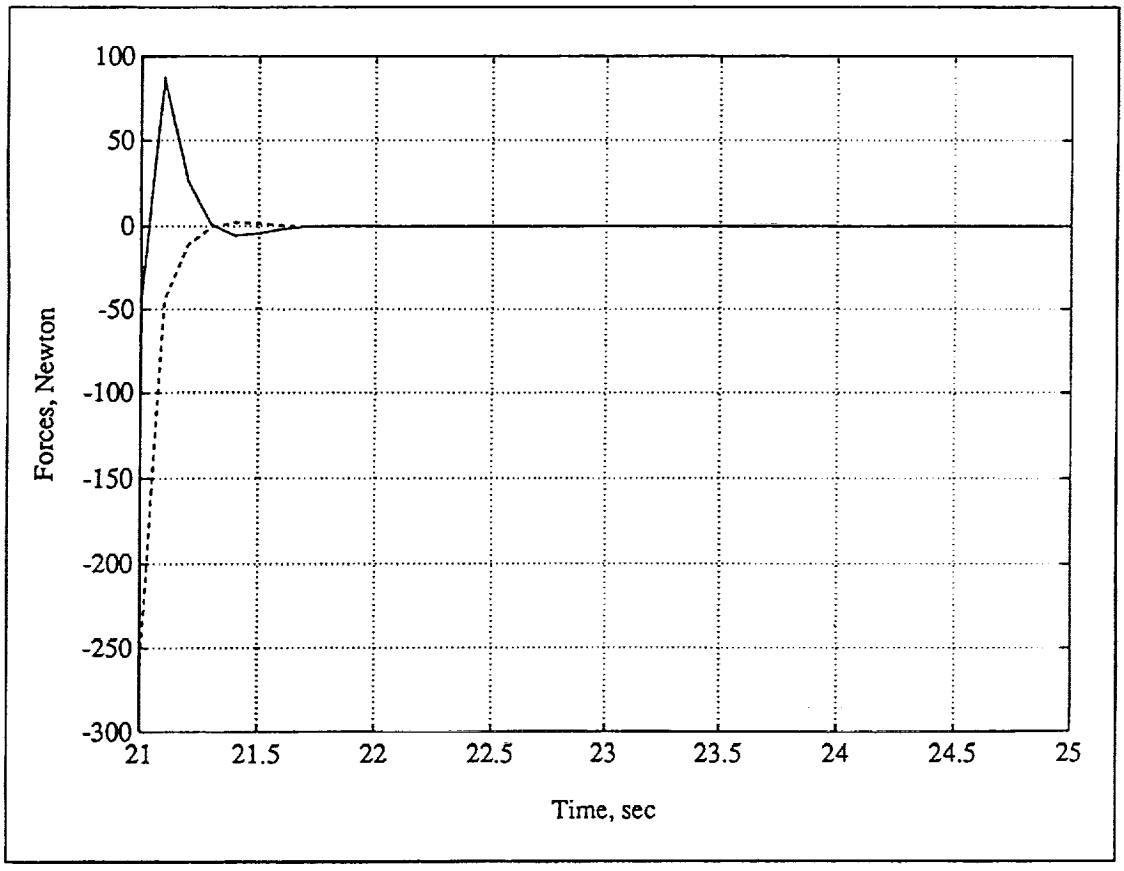

Fig. 1.5 Contact forces of SRMS and payload: Y-axis

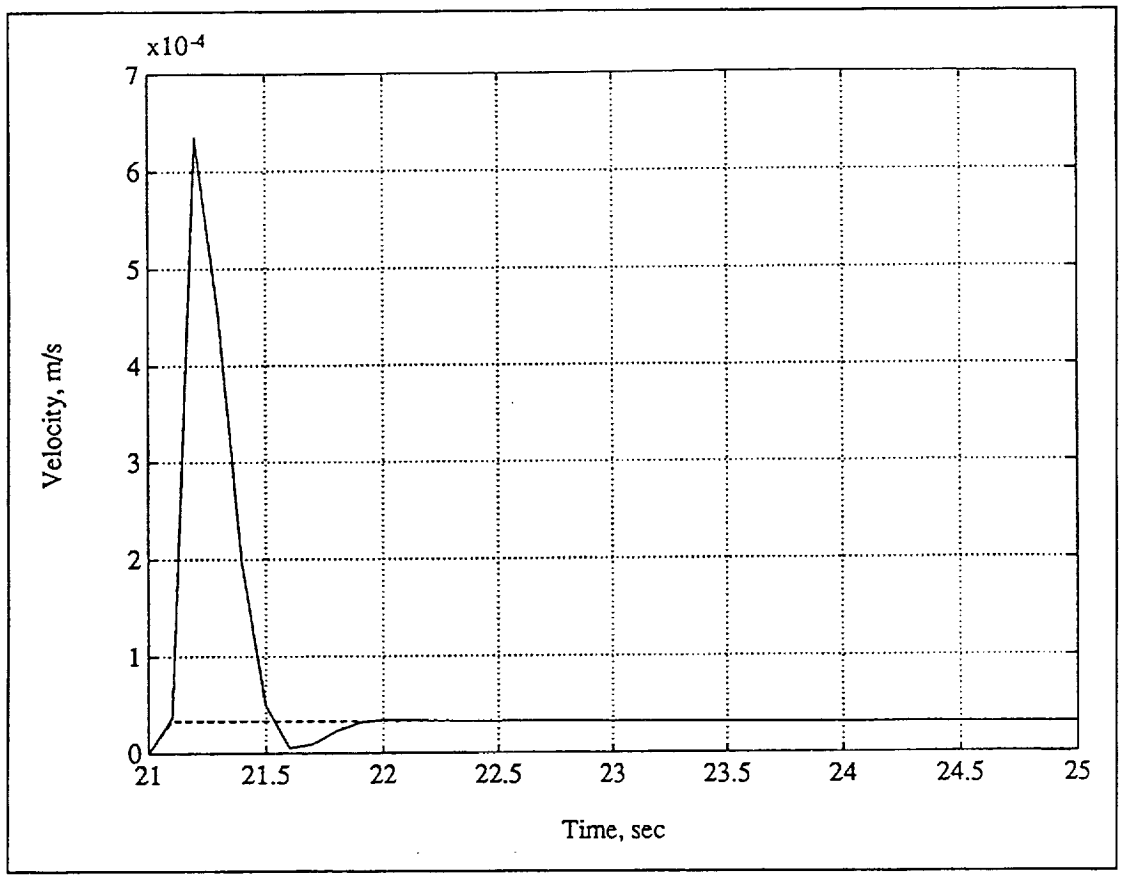

Fig. 1.6 Contact velocity of SRMS and payload: Z-axis

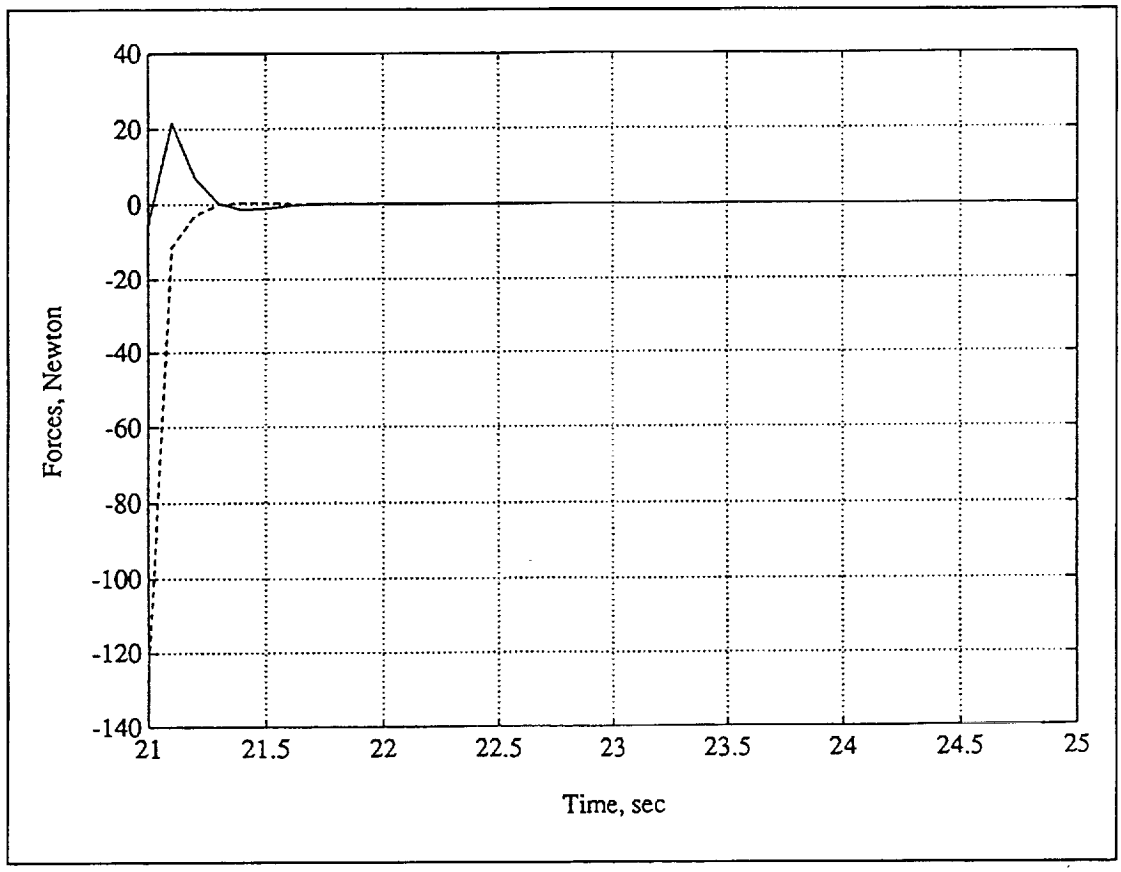

Fig. 1.7 Contact forces of SRMS and payload: Z-axis