Pointing Control for LDR

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One important aspect of the LDR control problem is the possible excitations of structural modes due to random disturbances, mirror chopping, and slewing maneuvers. This problem is particularly significant for LDR with its very stringent set of control and pointing requirements. An analysis has been performed to yield a "first-order" estimate of the effects of such dynamics excitations.

The analysis involved a study of slewing jitters, chopping jitters, disturbance responses, and pointing errors, making use of a simplified planar LDR model which describes the LDR dynamics on a plane perpendicular to the primary reflector. The model simulates the dynamics of the primary reflector, the sunshade, and the center column of mirror supporting structure and instrument module via flexible beams. Seven modes, three of them rigid body modes, are included in the analysis. As such, the model captures the essential LDR dynamics and still enables manageable study of the dynamic excitation problem.

FIGURE 1 presents the results for the chopping analysis. During LDR operation, the quaternary mirror is to be chopped at a 2 Hz frequency with a one arc-min amplitude in an effort to eliminate the effect of sky and telescope background. The simulation was conducted assuming that the quaternary module is located at a specific position in the center column and that the system manages to counterbalance 99% of the chopping torque. The figure shows the residual chopping torque the system reacts to in newton•meters and the resultant pointing error in mrad. The quaternary chopping contributes to the pointing error in two ways. One is the quaternary module rotation due to the bending of the central column. Structural rigidity of the center column is the key in minimizing this error. The other is the center column rotation about the primary reflector. The analysis shows that the steady state pointing error due to quaternary chopping in this simplified study is around 55×10^{-6} mrad, orders of magnitudes lower than the pointing requirement.

Study of jitter excitations due to LDR slewing and on-board disturbance torque was also included in the analysis. Briefly, the results indicate that the command slewing profile plays an important role in minimizing the resultant jitter, even to a level acceptable without any control action. An optimal profile should therefore be studied. For disturbance torque, its allowable level at the bus is determined to be around 0.025 nut-m (standard deviation) given an allocated allowable pointing budget of 0.01 mrad out of a total of 0.1 mrad.

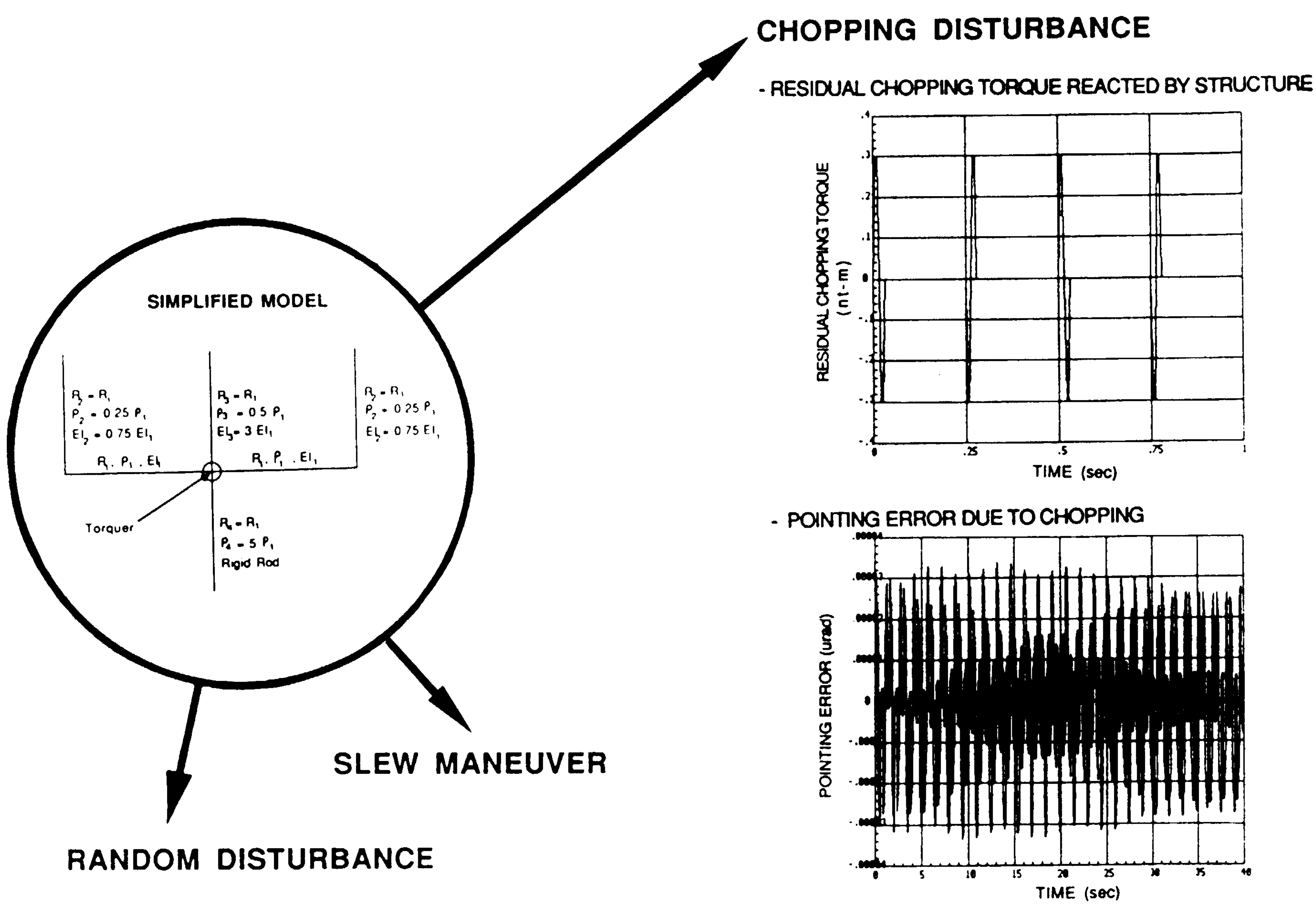

FIGURE 1. LDR Residual Chopping Torque and Pointing Error due to 2 Hz Quaternary Chopping