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Dynamic Stability of Rolling Missile with Proportional Navigation & PI Autopilot Considering Parasitic Radome Loop

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Abstract

The dynamic stability of coning motion for a radar homing rolling missile is studied in this paper, and the parasitic radome loop is considered and introduced into the guidance system of the radar homing rolling missile. A mathematical model with complex summation considering the parasitic radome loop is proposed, and the sufficient and necessary conditions for the dynamic stability of the coning motion for the rolling missile are analytically derived by using the stability criterion of third-order characteristic equation with complex coefficients. Numerical simulations with different parameters are conducted to demonstrate the effectiveness of the proposed stability condition. The stability condition proposed in this paper can be used in the guidance and control system design of a radar homing rolling missile while considering the parasitic radome loop.

Keywords

Rolling missile, PI autopilot, dynamic stability, parasitic radome loop, proportional navigation

1. Introduction

For all radar homing missiles, the radome is designed and equipped to protect the seeker antenna both mechanically and thermally. However, when the radar signal passes through the radome, the radar wave will be bent or refracted by the radome, thereby generating a false LOS rate. The introduction of the false LOS rate coupled with angular body motion into the guidance system adds a parasitic feedback loop to the missile's guidance system, which in turn affects the miss distance (MD) and even the dynamic stability of the radar homing missile. As a result, the parasitic radome loop must be considered in the guidance system design of radar homing missiles.

A detailed analysis of the radome error slope (RES) was conducted by Nesline and Zarchan [1]; in their papers, the missile guidance system was replaced by the linear fifth-order binomial, and the radome error