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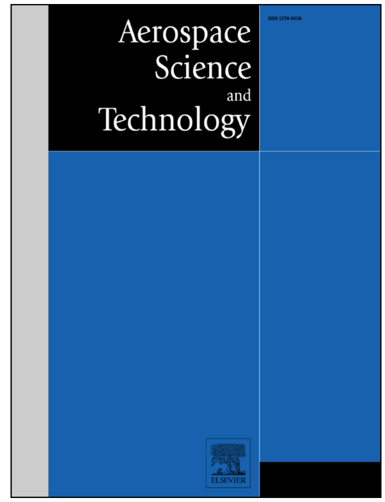

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Dynamic Stability of Rolling Missiles Employing a Two-loop autopilot with Consideration for the Radome Aberration Parasitic Feedback Loop

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Abstract

The dynamic stability of a radar homing rolling missile is extremely complex due to the interaction of the parasitic radome aberration feedback loop and the cross-coupling between the pitch and yaw, which are problems that have not been presented in previous studies. This paper presents mathematical models representative of the parasitic radome aberration feedback loop and proportional navigation guidance (PNG) system with a two-loop autopilot for rolling missile guidance based on reasonable assumptions. A PNG system equation is further proposed in the form of a complex summation. Based on the proposed mathematical models, the sufficient and necessary condition for the dynamic stability of the rolling missile is analytically derived according to the stability criterion of a system with complex coefficients. The proposed dynamic stability condition is verified by numerical simulation. Moreover, the stable region is obtained by solving the dynamic stability condition under different cases. An analysis of the effects of system parameters indicates that the stable region of a rolling missile is smaller than that of a non-rolling missile. Furthermore, it is shown that that the stable region is affected by a number of factors, such as the rolling rate and the total delay angle. The dynamic stability condition derived in this paper is useful for evaluating the stability of a rolling missile with consideration for the parasitic radome aberration feedback loop, and the conclusions obtained can provide guidance for the design of PNG systems for rolling missiles.

Keywords: Dynamic stability; Two-loop autopilot; Cross coupling; Radome Aberration; Parasitic feedback

1. Introduction

For all radar homing missiles, the parasitic feedback loop induced by the radome (herein denoted as the parasitic radome loop; PRL) widely affects the guidance system [1-5]. According to previous studies, the