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# Robust autopilot design for bank-to-turn missiles using adaptive dual-layer sliding mode control

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## Abstract

This paper focuses on robust autopilot design for bank-to-turn (BTT) missiles by using adaptive dual-layer sliding mode control (ADSMC) under model uncertainties and external disturbances. This adaptive sliding mode scheme has a dual-layer structure. One layer drives the system reach the sliding surface in finite time, and the other minimizes the size of the control gains, whilst still guaranteeing the existence of a sliding motion. Therefore, the resulting adaptation law enables reducing the chattering magnitude compared with the traditional super-twisting method. The relationship between the gains and how to obtain them are also given in detail in this paper. Autopilot design progress for three channels is conducted and the closed-loop stability of bank-to-turn missile dynamics is guaranteed. Promising dynamic performance and strong robustness have been achieved for the bank-to-turn missile dynamics as shown in the simulation.

### *Keywords:*

Dual-layer sliding mode control, Adaptive, Bank-to-turn missiles, Autopilot design, External disturbances

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## 1. Introduction

By orienting the maximum aerodynamic normal force to the desired direction rapidly with a substantially large roll rate, the BTT missile exhibits many advantages over the

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