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Adaptive Reaching Law Based Three-dimensional Finite-time Guidance Law against Maneuvering Targets with Input Saturation

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Abstract: Considering the problem of a missile intercepting a maneuvering target with impact angles constraints, three-dimensional engagement dynamics are established in this paper. Then two finite-time guidance laws are proposed based on the coupled dynamics. The first finite-time anti-saturation guidance law is designed using the finite-time observer. Besides, this guidance law uses the exponential reaching law, which requires the upper bounds of observation errors. Therefore, to solve the defects existing in the exponential reaching law, a novel reaching law is proposed, which can accerate the convergence rate of sliding mode surfaces and weaken the chattering phenomenon. Moreover, it can be widely used in the design of sliding mode controllers. Next, based on the novel reaching law, the second finite-time guidance law is given without the knowledge of the upper bounds of observation errors. Numerical simulations are introduced to demonstrate the effectiveness and superiority of the designed composite guidance laws in theory.

Keywords: Sliding mode control; Impact angle; Anti-saturation guidance law; Finite-time observer; Finite-time guidance law

1. Introduction

In recent years, the high-speed missiles accelerate the rhythm of the warfare. In the air-defense field, the missile technology and related information that can be used to intercept high speed and high-maneuvering targets have attracted much attention. Therefore, it is of great significance to study guidance laws for intercepting this type of targets. There are many kinds of guidance laws, including proportional navigation guidance laws, biased proportional navigation guidance laws [1], optimal guidance laws [2, 3], sub-optimal guidance laws [4], and sliding mode guidance laws [5]. In particular,

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