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## Title

# Robustness analysis for closed-loop model reference adaptive attitude control for a satellite launcher


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## Abstract

Reference model adaptive control systems are a class of controllers capable of adjusting its own parameters by monitoring the performance on a feedback loop and comparing the output to a reference model. This behaviour makes adaptive systems particularly interesting when dealing with problems with uncertainties on the system dynamics or external disturbances, as it is often true in aeronautics and space applications [1, 2]. However, due to the nonlinear nature of the system, the future use of such controllers in critical systems is still dependent on the development of performance and stability metrics capable of leading to a certifiable control system, and the study of stability and robustness metrics have been a very active field in the past decade [2].

A relevant part of such effort concerns the transient response of such systems. Even in situations where it is possible to prove the overall system stability, the plant behaviour during the transient may be very different from the reference model [3]. One of the modifications proposed to address these concerns uses the tracking error as a feedback signal to the reference model to maintain fast adaptation while improving transient behaviour [4]. This paper presents a closed loop reference model (CRM) architecture for an adaptive control system and analyses its robustness in the presence of bounded disturbances. The original CRM architecture is modified by an $e$ modification adaptive law and its bounded stability is proven using concepts of uniform ultimate boundedness (UUB) [5]. Furthermore, this work proposes a strategy for calculating the size of the bounded set based on the bounds of the solution of algebraic matrix equations [6], showing the influence of the CRM architecture gains in the overall robustness of the system. Finally, the results are applied to a satellite launcher attitude control, illustrating how different controller choices influence the robustness metrics for a real critical system.


## References


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