A Robust Control Approach for Rocket Landing

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Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

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Abstract

Ongoing development of rocket technology has led us to system re-usability, specifically of first stage rockets. In order to decrease monetary as well as temporal costs of production, private companies like SpaceX and Blue Origin have pioneered autonomous recovery and re-usability of rocket engines. This can only be accomplished through control algorithms executing in real-time onboard the rocket. The goal of this project is to further refine an existing vertical rocket landing simulation, where comparisons and benchmarking can be performed on algorithms based on classical control and machine learning.

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INTRODUCTION

The focus of this project is on the control systems behind reusable rockets. Vertical Takeoff, Vertical Landing (VTVL) of rockets is a field still in its infancy, but rapidly developing in both the private and public sector. Russia and China are developing their own reusable systems, while private companies such as Blue Origin and SpaceX have had early successes. The motivations for reusable launch systems are economical, but also provide sustainability. Significant cost reductions are attained by reusing just first stage rocket hardware, and this reuse leads to improved scalability and launch frequency.

The focus of our project will be on re-usability of first stage rockets. SpaceX's Falcon 9 rocket, the first successful reused orbital booster, has two main stages: a first stage booster, and a second stage payload. These stages separate, and the second stage uses a single engine to propel itself to desired orbit. The first stage houses clustered rocket engines and aluminium-lithium alloy tanks, used to stabilize and propel itself back to earth in Vertical Landing.

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