Bi-Directional Tilting Quadrotor

An investigation into the overactuatedness thereof

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Abstract

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The aim of this thesis is to design, simulate and control a novel quadrotor platform which can articulate all 6 Degrees of Freedom by vectoring thrust produced by the lift propellers. To achieve this the airframes' structure needs to be able to be changed dynamically during flight, namely adding 2 additional axes of actuation about which each lift propeller can be rotated. The introduction of such actuation to what is otherwise a well understood platform results in an over-actuated control problem. The allocation of actuator priority is the primary contribution of this paper with novel elements of non-linear control treatment for UAV airspace platforms.

A high fidelity simulation environment was constructed which incorporated all known non-linearities associated with airspace bodies. The effects unique to the proposed design were investigated and incorporated too. After which control algorithms where developed and compared, the affects which discretization would have on the system were included in this comparison. The relative performance of the controllers was evaluated on standard performance metrics of attitude and position controllers. Finally the design built and tested using readily available Radio-Control components.

Acknowledgements

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Chapter 1

Introduction

1.1 A Brief Background to the Study

A popular topic for control and automation research is that of UAVs, specifically into the non-linear control thereof. The avenues for potential applications of both fixed wing and VTOL UAVs is expansive. Commercial drone usage is an emerging sector; especially in Southern Africa following the revision of aviation laws which have legalized the use of UAVs for commercial application.

Large scale quadrotor helicopters are a popular intermediate choice for aerial cinematography. Whilst still expensive, the cost of a commercial drone like the SteadiDrone Maverik [1] is far less than the cost of chartering a helicopter to achieve the same photographic scenes. Another interesting application for UAVs is in the agricultural sector, introducing crop dusting drones instead of the traditional bi-planes which perform the same job. One difficulty which hinders the progress of the commercial drone sector is that of inertia, specifically when scaling up any vehicle, its performance is adversely affected, due to the increased mass inertial effect.

1.2 Research Questions & Hypotheses

1.3 Significance of Study

1.4 Other Applications of Proposed Investigation

1.5 Scope and Limitations

1.5.1 Subsection

Bibliography

[1] steadidrone.com.