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Master Thesis

Morphology Optimization of a Tilt-Rotor MAV

Spring Term 2018

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Declaration of Originality

I hereby declare that the written work I have submitted entitled

Morphology Optimization of a Tilt-Rotor MAV

is original work which I alone have authored and which is written in my own words.[1]

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Contents

Abstract

Hier kommt der Abstact hin ...

Symbols

Symbols

ϕ, θ, ψ	roll, pitch and yaw angle
b	gyroscope bias
Ω_m	3-axis gyroscope measurement

Indices

x	x axis
y	y axis

Acronyms and Abbreviations

ETH	Eidgenössische Technische Hochschule
EKF	Extended Kalman Filter
IMU	Inertial Measurement Unit
UAV	Unmanned Aerial Vehicle
UKF	Unscented Kalman Filter

Chapter 1

Introduction

1.1 Motivation

1.2 Literature review

[1] [2] [3] [4] [5] [6] [7] [8] [9]

1.3 Problem Statement

Chapter 2

Method

2.1 Modelisation of MAVs

Describe the modeling for the optimization engine

2.2 Optimization problem

Define morphology optimization problem

2.3 Optimization tool

Show resulting optimization tool.

2.4 Control Approach

Chapter 3

Optimization Results

Show results produced by the engine.

3.1 Even Designs

3.1.1 Platonic Solids

3.1.2 Quad-copter

3.1.3 Hexa-copter

3.1.4 Octa-copter

3.2 Odd Designs

3.2.1 Tri-copter

Show tricopter.

3.2.2 Penta-copter

3.2.3 Hepta-copter

3.3 Comparison of Different Designs

$\cos(\beta) = \sqrt{(\frac{2}{3})} => \beta = 35.26°$
$F_{min} = 34.74, F_{max} = 42.55, M_{min} = 17.42, M_{max} = 21.34, H_{eff,min} = 81.65\%, H_{eff,max} = 100\%$
$F_{min} = 26.6, F_{max} = 52.11, M_{min} = 15.1, M_{max} = 26.13, H_{eff,min} = 75\%, H_{eff,max} = 100\%$
Design 1: $F_{min} = 23.18, F_{max} = 28.56, M_{min} = 11.61, M_{max} = 14.3, H_{eff,min} = 81.11\%, H_{eff,max} = 95.2\%$
Design 2: $F_{min} = 23.22, F_{max} = 28.37, M_{min} = 11.65, M_{max} = 14.23, H_{eff,min} = 81.65\%, H_{eff,max} = 94.73\%$
$F_{min} = 44.7, F_{max} = 58.8, M_{min} = 22.4, M_{max} = 29.5, H_{eff,min} = 81.78\%, H_{eff,max} = 96.65\%$
$F_{min} = 46.46, F_{max} = 56.73, M_{min} = 23.3, M_{max} = 28.45, H_{eff,min} = 81.64\%, H_{eff,max} = 94.77\%$

Table 3.1: Comparison between the different number of propellers.

MAV Design	$F_{min}[N]$	$F_{max}[N]$	$F_{mean}[N]$	$M_{min}[Nm]$	$M_{max}[Nm]$	$M_{mean}[Nm]$	$H_{eff,mean}[\%$
Tri-copter	17.17	21.21	17.95	8.61	10.64	9	85.46
Quad-copter	23.22	28.37	26.87	11.65	14.23	13.47	87.1
Penta-copter	28.95	35.46	29.4	14.52	17.78	14.74	85.35
Hexa-copter	34.74	42.55	39.52	17.42	21.34	19.82	88.9
Hepta-copter	39.96	49.44	47.2	20.04	24.8	23.66	91.1
Octa-copter	44.7	58.8	53.95	22.4	29.48	27.06	91.42

Chapter 4

Simulation Results

Evaluate results in simulation.

4.1 Hexa-copter

4.2 Hepta-copter

4.3 Octa-copter

Chapter 5

Conclusion

5.1 Summary/Achieved

5.2 Improvements

5.3 Further Developement

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Appendix A

UML: Activity Diagram