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Mechatronics Skripsie Proposal

Mechatronic Project 478
Final Report

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Executive summary

Title of Project
...
Objectives
...
What is current practice and what are its limitations?
...
What is new in this project?
...
If the project is successful, how will it make a difference?
...
What are the risks to the project being a success? Why is it expected to be successful?
...
What contributions have/will other students made/make?
...
Which aspects of the project will carry on after completion and why?
...
What arrangements have been/will be made to expedite continuation?
...

Acknowledgements

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Constants

$L_0 =$	300 mm

Variables

Re_{D}	Reynolds number (diameter)	[ ]
x	Coordinate	[m]
$\ddot{x}$	Acceleration	[m/s^2]
θ	Rotation angle	[rad]
τ	Moment	[N·m]

Vectors and Tensors

$\vec{\boldsymbol{v}}$	Physical vector, see equation ...

Subscripts

a	Adiabatic
a	Coordinate

Abreviations

DEM	Discrete Element Method
FEA	Finite Element Analysis

Chapter 1

Introduction

1.1 Background

Helicopters are said to be the only aircrafts that, since its conception, has saved more lives then they have taken. Their high level of mobility, vertical take off and landings and their ability to hover give helicopters great versatility. Helicopters are the most common example of a rotary aircraft and are used in environments ranging from rocky, mountainous to stormy seas. With such high stakes it is vital to minimise points of potential failure. One of these failure points is the helicopter's tail rotor. It is required to counter the toque produced by the engine which rotates the main rotor to produce lift. If the tail rotor were stop working, the helicopter would lose its controlability and would have to land immediately. A jet-tipped rotary aircraft places the propulsion on the tips of the aircraft's rotor and thus does not produce any toque that needs to be canceled, eliminating the need of a tail rotor. As the tail rotor uses the same engine, which turns the rotor, to rotate it's blades, high speed gearboxes, clutches and transmission shafts are required, which can all be omitted in a jet-tipped rotary aircraft, reducing both its weight and its complexity.

This project will research, design, construct and test a jet-tipped rotary aircraft which will acctuate the pitch of the rotor through the the use of propulsion situated at the tip of the blades. Traditional rotaty wing aircrafts change the rotor's pitch for portions of it's rotation, this creates an unbalanced, causing the aircraft to move in the disred dirction. Different methods for directional thrust will invetigated varying from traditional methods to using the propulsion force itself to control the direction of the aircraft. This project, which is

prepared for Mechanical Project 448 and prepared by Mr RA Krüger, was proposed by the student after devising the concept with Dr A Gill. The reseach and results from this projects hopes to further the development of tip-propelled rotary aircrafts, which currently is a relativley unresearched field. Stated below include the projects scope, objectives, literature review, motivation and planning of the project are outlined.

1.2 Objectives

The objectives of the project (in some cases the objectives of the report). If necessary describe limitations to the scope.

1.3 Motivation

Why this specific project/report is worthwhcile.

Chapter 2

Objectives

2.1 Scope and limitations

2.2 Objectives

2.3 Research questions

2.4 Motiviation

Chapter 3

Literature Review

3.1 Historical development

The advantage of the [[Jet-Tipped Helicopter]] is the omission of the transmission and [[tail rotor]], thus making it more simple and cheaper to produce. The decreased weight allows it to have a larger payload. No need for a high-speed gear boxes, clutches, transmission shafts, oil system w/ tanks .

3.2 Rotary wing control system and stability

The objectives of the project (in some cases the objectives of the report). If necessary describe limitations to the scope.

3.3 Current state of the art

Why this specific project/report is worthwhile.

Appendix A

Mathematical proofs

A.1 Euler's equation

Euler's equation gives the relationship between the trigonometric functions and the complex exponential function.

$$e^{i\theta} = \cos\theta + i\sin\theta \tag{A.1}$$

Inserting $\theta = \pi$ in (A.1) results in Euler's identity

$$e^{i\pi} + 1 = 0 \tag{A.2}$$

A.2 Navier Stokes equation

The Navier–Stokes equations mathematically express momentum balance and conservation of mass for Newtonian fluids. Navier-Stokes equations using tensor notation:

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_j}\left[\rho u_j\right] = 0 \tag{A.3a}$$

$$\frac{\partial}{\partial t}\left(\rho u_i\right) + \frac{\partial}{\partial x_j}\left[\rho u_i u_j + p\delta_{ij} - \tau_{ji}\right] = 0, \quad i = 1, 2, 3 \tag{A.3b}$$

$$\frac{\partial}{\partial t}\left(\rho e_0\right) + \frac{\partial}{\partial x_j}\left[\rho u_j e_0 + u_j p + q_j - u_i \tau_{ij}\right] = 0 \tag{A.3c}$$

Appendix B

Experimental results

List of references