

EBE Faculty: Assessment of Ethics in Research Projects (Rev2)

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zulpha Geyer (Zulpha.Geyer@uct.ac.za; Chem Eng Building, Ph 021 650 4791).
NB: A copy of this signed form must be included with the thesis/dissertation/report when it is submitted for examination

This form must only be completed once the most recent revision EBE EiR Handbook has been read.

Name of Principal Researcher/Student: Nicholas Von Klemperer Department: EBE

Preferred email address of the applicant:

If a Student: Degree: MSc Electrical Engineering Supervisor: Prof. Edward Boje

If a Research Contract indicate source of funding/sponsorship: N/A

Research Project Title: Dual-axis tilting quadrotor aircraft: dynamic modelling and control thereof

Overview of ethics issues in your research project:

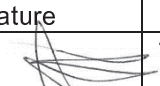
Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	YES	NO
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	NO
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	YES	NO
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	YES	NO

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate. Ensure that you refer to the EiR Handbook to assist you in completing the documentation requirements for this form.

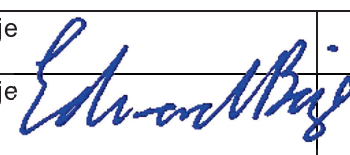
I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	Nicholas Von Klemperer 	19/02/2018

This application is approved by:

Supervisor (if applicable):	Prof E. Boje 	
HOD (or delegated nominee): <i>Final authority for all assessments with NO to all questions and for all undergraduate research.</i>	Prof E. Boje	
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.		

Abstract

Dual-Axis Tilting Quadrotor Aircraft

Nicholas Von Klemperer

Thursday 15th February, 2018

This dissertation aims to apply non-zero attitude and position setpoint tracking to a quadrotor aircraft, achieved by solving the problem of a quadrotor's inherent underactuation. The introduction of extra actuation aims to mechanically accommodate for stable tracking of non-zero state trajectories. The requirement of the project is to design, model, simulate and control a novel quadrotor platform which can articulate all six degrees of rotational and translational freedom (6-*DOF*) by redirecting and vectoring each propeller's individually produced thrust.

Considering the extended articulation, the proposal is to add an additional two axes (degrees) of actuation to each propeller on a traditional quadrotor frame. Each lift propeller can be independently pitched or rolled relative to the body frame. Such an adaptation, to what is an otherwise well understood aircraft, produces an over-actuated control problem. Being first and foremost a control engineering project, the focus of this work is plant model identification and control solution of the proposed aircraft design. A higher level setpoint tracking control loop designs a generalized plant input (net forces and torques) to act on the vehicle. An allocation rule then distributes that *virtual* input in solving for explicit actuator servo positions and rotational propeller speeds.

The dissertation is structured as follows: First a schedule of relevant existing works is reviewed in Ch:1 following an introduction to the project. Thereafter the prototype's design is detailed in Ch:2, however only the final outcome of the design stage is presented. Following that, kinematics associated with generalized rigid body motion are derived in Ch:3 and subsequently expanded to incorporate any aerodynamic and multibody nonlinearities which may arise as a result of the aircraft's configuration (changes). Higher level state tracking control design is applied in Ch:4 whilst lower level control allocation rules are then proposed in Ch:5. Next, a comprehensive simulation is constructed in Ch:6, based on the plant dynamics derived in order to test and compare the proposed controller techniques. Finally a conclusion on the design(s) proposed and results achieved is presented in Ch:7.

Throughout the research, physical tests and simulations are used to corroborate proposed models or theorems. It was decided to omit flight tests of the platform due to time constraints, those aspects of the project remain open to further investigation. The subsequent embedded systems design stemming from the proposed control plant is outlined in the latter of Ch:2, Sec:2.4. Such implementations are not investigated here but design proposals are suggested. The primary outcome of the investigation is ascertaining the practicality and feasibility of such a design, most importantly whether or not the complexity of the mechanical design is an acceptable compromise for the additional degrees of control actuation introduced. Control derivations and the prototype design presented here are by no means optimal nor the most exhaustive solutions, focus is placed on the whole system and not just a single aspect of it.

ADDENDUM 2: To be completed if you answered YES to Question 2:

It is assumed that you have read the UCT Code for Research involving Human Subjects (available at <http://web.uct.ac.za/depts/educate/download/uctcodeforresearchinvolvinghumansubjects.pdf>) in order to be able to answer the questions in this addendum.

2.1 Does the research discriminate against participation by individuals, or differentiate between participants, on the grounds of gender, race or ethnic group, age range, religion, income, handicap, illness or any similar classification?	YES	NO
2.2 Does the research require the participation of socially or physically vulnerable people (children, aged, disabled, etc) or legally restricted groups?	YES	NO
2.3 Will you not be able to secure the informed consent of all participants in the research? (In the case of children, will you not be able to obtain the consent of their guardians or parents?)	YES	NO
2.4 Will any confidential data be collected or will identifiable records of individuals be kept?	YES	NO
2.5 In reporting on this research is there any possibility that you will not be able to keep the identities of the individuals involved anonymous?	YES	NO
2.6 Are there any foreseeable risks of physical, psychological or social harm to participants that might occur in the course of the research?	YES	NO
2.7 Does the research include making payments or giving gifts to any participants?	YES	NO

If you have answered YES to any of these questions, please describe below how you plan to address these issues:

ADDENDUM 3: To be completed if you answered YES to Question 3:

3.1 Is the community expected to make decisions for, during or based on the research?	YES	NO
3.2 At the end of the research will any economic or social process be terminated or left unsupported, or equipment or facilities used in the research be recovered from the participants or community?	YES	NO
3.3 Will any service be provided at a level below the generally accepted standards?	YES	NO

If you have answered YES to any of these questions, please describe below how you plan to address these issues:

ADDENDUM 4: To be completed if you answered YES to Question 4

4.1 Is there any existing or potential conflict of interest between a research sponsor, academic supervisor, other researchers or participants?	YES	NO
4.2 Will information that reveals the identity of participants be supplied to a research sponsor, other than with the permission of the individuals?	YES	NO
4.3 Does the proposed research potentially conflict with the research of any other individual or group within the University?	YES	NO

If you have answered YES to any of these questions, please describe below how you plan to address these issues: