TUM Practical Research Experience Program (PREP)

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TUM San Francisco
Technical University of Munich

San Francisco, February 25, 2019

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www.international.tum.de/sanfrancisco
Locations in Bavaria
European Metropolitan Region Munich

Research Network

Industry Network

Technical University of Munich

European Metropolitan Region Munich

Research Network

Industry Network

Technical University of Munich
# TUM at a Glance

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>~ 41,500</td>
</tr>
<tr>
<td>Graduates</td>
<td>~ 9,500</td>
</tr>
<tr>
<td>Professors</td>
<td>548</td>
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<tr>
<td>Faculties</td>
<td>14</td>
</tr>
<tr>
<td>ERC Grants</td>
<td>96</td>
</tr>
<tr>
<td>Humboldt Laureates</td>
<td>47</td>
</tr>
<tr>
<td>Leibniz Laureates</td>
<td>18</td>
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<tr>
<td>Nobel Laureates</td>
<td>17</td>
</tr>
<tr>
<td>Startups</td>
<td>700+</td>
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<tr>
<td>doctoral Theses</td>
<td>&gt; 1,000</td>
</tr>
<tr>
<td>ISI Publications</td>
<td>~ 6,000</td>
</tr>
<tr>
<td>Research Agreements</td>
<td>&gt; 1,000</td>
</tr>
<tr>
<td>University of Excellence since</td>
<td>2006</td>
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</tbody>
</table>

- **548** Professors, **14** Faculties, **178** Degree Courses
- **> 1,000** Doctoral Theses, ~**6,000** ISI Publications
- **96** ERC Grants, **47** Humboldt Laureates, **18** Leibniz Laureates
- **200+** Startups, ~**280M** Fundraising, **285 M** 3rd party funding, **7** Locations Abroad
- University of Excellence since 2006
TUM in Rankings 2017/18

- Best Global Universities
- U.S. N&W Report
- QS World Universities
- Global University Employability Ranking
- THE World University Rankings
- Nature Index – Top Academic Institutions
- Academic Ranking of World Universities „Shanghai“
- Reuters Most Innovative Universities
Departments

Center of Life and Food Sciences
Weihenstephan

Mechanical Engineering
Mathematics
Physics
Informatics
Electrical Engineering and Information Technology
TUM School of Management

Sport and Health Science
TUM School of Education

Medicine
Chemistry
Architecture
Civil Engineering and Surveying
PREP

Practical Research Experience Program

Your Summer in Munich, Your Research in Excellence

www.international.tum.de/en/prep
Program Overview

Research Project Participation
Structured research internship program
For select North American partners
Min. 10 weeks in summer (May 28 – August 13, 2019)
Highly competitive admission process

Framework Program
Orientation Week & PREP Events
   Industry Visits
   Excursions
   Local Activities
   Student Buddies

Central Services
Scholarship
Accommodation - Dorm Offer
Designated Program Manager

(Image: Nancy Zhang / TUM)
(Image: Ulrich Benz / TUM)
(Image: Christina Riedl / TUM)
(Image: Ulrich Benz / TUM)
Participation Prerequisites

Candidate Prerequisites

- Undergraduate or graduate students (min. 2 years of undergraduate studies upon arrival)
- GPA of 3.0 or better (4.0 scale)
- Project-specific skills (for some projects)
- No German skills required

(Image: Ulrich Benz / TUM)
PREP Projects

- PREP 2019: over 70 projects offered in 13 departments
- Project descriptions list specific prerequisites, required study level and planned working hours per week

Prep Project description

Project Description

Rotorcraft performance can potentially be improved using adaptive structural mechanisms that are placed on a rotor blade and actively actuated. The actuation schedule and location of these mechanisms can have significant effect on the resulting performance. For the current problem, the above helicopter (see figure) is proposed with an array of active control mechanisms installed, and the objective is to find an optimum set of design variables (the on-blade location, size and actuation phasing of different active blade mechanisms (see figure above)) that lead to best rotor performance at a given flight condition.

Each of the active blade mechanisms changes the rotor structural properties, due to presence of actuators and associated structural stiffening of the sections for additional load bearing, as well as the aerodynamic efficiency of corresponding sections. Therefore, a complete rotor optimization problem involves accounting for the aerodynamic effects of the mechanisms as well as the associated structural modifications.

A working numerical simulation model for comprehensive analysis of a (BC-105) helicopter rotor will be provided. It is a physics-based model wherein the rotor structure, the trim state and the associated aerodynamic modeling parameters are defined in detail. Upon execution, the output consists of an exhaustive set of overall performance parameters, and structural and aerodynamic loads over the entire rotor disk.

Using parametric sweeps with the aforementioned rotor analysis model to locate best design points is not practical because an optimized design would only result after analyzing a large design space, which is computationally prohibitive to investigate. Furthermore, a helicopter rotor physics problem is non-linear, and using surrogate methods for approximation makes the optimization problem tenable. However, such approximation methods can sometimes be inept in effectively modeling the high non-linearity within the problem, leading to anomalous results. Neural networks have been shown to be capable of approximating such highly non-linear functions.

Objective: This project proposes to use neural-networks-based metamodeling to approximate the given problem for optimizing helicopter performance.

Project Overview

<table>
<thead>
<tr>
<th>Project Code</th>
<th>Project Name: Neural Network-based Meta-modeling for Rotorcraft Optimization</th>
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</thead>
<tbody>
<tr>
<td>TUM Department</td>
<td>Mechanical Engineering</td>
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<tr>
<td>TUM Chair/Institute</td>
<td>Institute of Helicopter Technology</td>
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<tr>
<td>Research area</td>
<td>Neural Networks, Multi-Disciplinary Optimization</td>
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<tr>
<td>Student target group</td>
<td>Computer Science, Mathematics, Mechanical/Aerospace Engineering</td>
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<tr>
<td>Project supervisor(s)</td>
<td>Dr. Juergen Rauleider, Mr. Sumeet Kumar</td>
</tr>
<tr>
<td>Project supervison(s) - Contact Details</td>
<td>E-mail: <a href="mailto:Juergen.rauleider@tum.de">Juergen.rauleider@tum.de</a>, Phone: +49 89 289 16303</td>
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</tbody>
</table>

Working hours per week planned: Flexible, based on the student's productivity and if he/she is on track to meet the project objectives.

Prerequisites

<table>
<thead>
<tr>
<th>Level (at the time of arrival)</th>
<th>Undergraduate (3rd Year)</th>
<th>Senior Undergraduate (4th Year) or Graduate</th>
<th>Both</th>
</tr>
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<tbody>
<tr>
<td>Prerequisites - Subject-related</td>
<td>Fundamental knowledge of neural networks and their applications is essential. It is encouraged that the project be carried out using the Python programming language; alternatively, Matlab can be used. (Knowledge of rotorcraft physics is not essential.)</td>
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</table>
Application and Admission

- **Application period**: October 8 – November 30, 2018
- Online Application via PREP homepage (at least 2 ranked project priorities possible)
- **Pre-selection by partner universities possible**
- TUM International Center tries to place students according to their prioritizations
- Final selection done by project supervisors/researchers
- **Admission letters**: late January

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TUM Practical Research Experience Program Program
# Estimated Expenses
(total amounts for entire stay)

## TUM Scholarship:

- **+ TUM Scholarship:** $1,400 (for students not sponsored otherwise for PREP)

## Expenses

- **- Accommodation** *(dorm)*: ~ $1000 - $2,000
- **- Cost of Living:** ~ $700 € - $1700
- **- German Health Insurance:** ~ $300
- **- Enrolment Fee** *: ~ $150
- **- Semester Ticket** *(public transport)*: ~ $230 *(recommended)*

[Dorm Security Deposit]: ~ $600 *(refunded shortly after the student's stay)*

- **- Travel Expenses** *: ~ $1,000
- **- Visa Expenses** *(if applicable)*: ~ $120

*Expenses due before arrival or in case of accommodation in most cases part of whole expense due before arrival.*
Contact

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www.international.tum.de/prep