Control of the Twin-Rotor System

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A thesis submitted to the Universitat Politècnica de Catalunya in partial fulfilment of the requirements for the degree of

Master of Engineering

Universitat Politècnica de Catalunya

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June 2010
Declaration

I declare that I am the sole author of this thesis and that all the work presented in it, unless otherwise referenced, is my own. I also declare that this work has not been submitted, in whole or in part, to any other university or college for any degree or any other qualification.

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Than Tien Thinh

June, 2010
Abstract:

The problem of Multi-Input-Multi-Output (MIMO) control has always been an interesting sub-field within the field of control. Among the systems that require MIMO control, the helicopter stands out as one of the prominent examples. This type of aircraft requires two rotors, rotating in perpendicular planes, therefore can not rely on Single-Input-Single-Output controllers to maneuver in the space. Also, un-manned helicopters have not yet been seen in armies worldwide, this fact gives the task of developing MIMO control systems for helicopters a large room to grow.

In order to model the helicopter in laboratorial space, a Twin-Rotor Apparatus has been developed by Feedback company. This apparatus is being studied in Universitat Politècnica de Catalunya, Spain, to provide a good model for teaching and research in the field of MIMO control, with the aim to develop more efficient control methods for the real helicopter.

The complete mechanical model for this apparatus has been developed using the software MAPLE. Based on this mechanical model, several control schemes are created to control the apparatus using MATLAB-Simulink. These control schemes are designed to make the Twin-Rotor system go to predetermined points and follow periodical input signals.

The task of designing the control schemes requires the author to work on state-space configuration, linearization and experimental works. Mathematical approximation is also applied to get the approximated polynomials for variables relationship.

The controllers designed work successfully and make ways for the design of similar controllers using for other MIMO systems.
## Nomenclature

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>$q_1$</td>
<td>Generalized coordinate for pitch angle</td>
<td>radian</td>
</tr>
<tr>
<td>$q_2$</td>
<td>Generalized coordinate for yaw angle</td>
<td>radian</td>
</tr>
<tr>
<td>$q_3$</td>
<td>Generalized coordinate for main rotor angle</td>
<td>radian</td>
</tr>
<tr>
<td>$q_4$</td>
<td>Generalized coordinate for tail rotor angle</td>
<td>radian</td>
</tr>
<tr>
<td>$\theta_v$</td>
<td>Pitch angle, the same as $q_1$</td>
<td>radian</td>
</tr>
<tr>
<td>$\theta_h$</td>
<td>Yaw angle, the same as $q_2$</td>
<td>radian</td>
</tr>
<tr>
<td>$\alpha_{main}$</td>
<td>Main rotor angle, the same as $q_3$</td>
<td>radian</td>
</tr>
<tr>
<td>$\alpha_{tail}$</td>
<td>Tail rotor angle, the same as $q_4$</td>
<td>radian</td>
</tr>
</tbody>
</table>
Acknowledgements

First and foremost, I would like to thank Professor Ramon Costa for his guidance and encouragement throughout the course of this work. Without his expertise and enthusiasm, this project may have never been accomplished.

I would also like to thank Professor Ana Barjau for her assistance during the academic year, since the very beginning of my student life in Barcelona.

I would like to thank the technical and administrative staff at the Escola Tècnica Superior d’Enginyeria Industrial de Barcelona. Their assistance during this academic year has been invaluable.

I would also like to thank all my fellow Erasmus Mundus students. As we know, we meet each other here among billions of people and millions of years, and we will never forget our time together.

My friends, both in Vietnam and Spain, help me a lot and they deserve a big thank from the bottom of my heart.

Finally, a big warm thank to my parents, my younger brother and Phuong Loan. I could never express how thankful I am to them and how much they have helped me along the way.

Thank you very much!
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