DESIGN AND SIMULATION OF FUZZY INFERENCE BASED MULTIPLE PID CONTROLLERS FOR 6-DOF UNMANNED UNDERWATER VEHICLE

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Master's thesis under my supervision.

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ABSTRACT

Design and Simulation of Fuzzy Inference Based Multiple PID Controllers for 6-DOF Unmanned Underwater Vehicle

Keywords: PID, fuzzy, inference, multiple controllers, UUV, unmanned, underwater vehicle

Unmanned underwater vehicles are currently being utilised for scientific, commercial and military underwater applications. These vehicles require autonomous guidance and control systems in order to perform underwater tasks. Modelling, simulation and control of these vehicles are still major active areas of research and development.

This thesis explores the design of a control system for a 6-Dof unmanned underwater vehicle. The thesis consists of two phases; the first involves the design of three single decoupled PID controllers for surge, yaw and depth. Then it is shown that it is not possible to cover the entire range of operations of UUV using only single controller by simulation using MATLAB SIMULINK. The second phase is concerned with the design of multiple PID controllers covering the entire range of UUV operation, as well as the fuzzy inference based supervisor design to switch between the different controllers as the operations conditions vary.

The design of the PID controllers are based on MATLAB PID tuning algorithms which is a robust response time tuning algorithms that allows for faster design process with robust gain values. It is shown that these new tuning methods as well as graphical tuning interface overcome the adhoc and time consuming process of finding the PID gains. Further it is shown that fuzzy gain scheduling using fuzzy inference mechanism is a valid method for controlling a UUV with nonlinear dynamics.

It can be concluded that new tools such as MATLAB tuning algorithms and Fuzzy toolbox allows for fast and accurate design of controllers for highly complex systems as well as the viability of fuzzy inference multiple controllers as a method for UUV control with desired response characteristics. Finally the author recommends an actual vehicle implementation and testing as future work to be carried out.

To my parents and teachers

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LIST OF ABBREVIATIONS

Abbreviation	Description
AUV	Automated Underwater Vehicle
CB	Centre of Buoyancy
CG	Centre of Gravity
CGS	Conventional Gain Scheduling
DOF	Degrees Of Freedom
FGS	Fuzzy Gain Scheduling
GUI	Graphical User Interface
GUIDE	GUI Development Environment
NED	North–East–Down
NPS	Naval Postgraduate School
MSS	Marine systems Simulator
PD	Proportional Derivative
PI	Proportional Integral
PID	Proportional Integral Derivative
ROV	Remotely Operated Vehicle
UAV	Unmanned Aerial Vehicle
URV	Underwater Recovery Vehicle
UUV	Unmanned Underwater Vehicle