Modeling and Control of a Surface Vessel for "*ITS for the Sea*" Applications

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by

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DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

1. It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

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07th of September, 2007

I endorse the declaration by the candidate.

UOM Verified Signature

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CONTENTS

Abstract

In the emerging field of intelligent transportation systems (ITS), "*ITS for the sea*" refers to the area of maritime traffic. Automated vehicle control systems are a key technology for ITS. An autonomous surface vessel (ASV) can be defined as a vehicle controlling its own steering and speed for Navigation, dynamic positioning, motion stabilization and obstacle detection and avoidance.

The scope of the research is defined by two main objectives viz. developing complete mathematical model of a surface vessel by analyzing hydrodynamic forces and main other effects arising when manoeuvring in the ocean, and design online-learning adaptive controller for path tracking and speed control using real control inputs; propeller thrust and steering angle. The vessel moves in a hydrodynamic environment where many uncertainties, non-linear and non-predictive behaviours always appear. The ocean vehicle is modelled mathematically using first principles and derivations wherever possible.

In this work, the problem of control with guaranteed sway and yaw stability for automated surface vessel operation is addressed with special emphasis on speed control. A control scheme to solve this problem without simplifying the dynamics is proposed and extensively studied using formative mathematical analyses and simulations.

The main academic motivation of this research was to study and synthesis the power of artificial intelligence techniques in controlling of non-linear dynamical systems with online-learning and adaptive capabilities. A model-based neural network adaptive controller is developed blending a self adaptive neural network module and a classical Proportional plus Derivative (PD)-like control to obtain optimum control performance by complementing each other. The adaptive neural module counteracts for inherent model discrepancies, strong nonlinearities and coupling effects.

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List of Figures

List of Tables

Table **Page**