OBSTACLE AVOIDANCE FOR UNMANNED SURFACE VEHICLES: SIMULATIONS AND EXPERIMENTS

A thesis submitted to the
Department of Electrical Engineering, University of Moratuwa
in partial fulfillment of the requirements for the
Degree of Master of Philosophy

by
RANDOBAGEGEETHJAYENDRA

Supervised by: Dr. Sisil Kumarawadu

Department of Electrical Engineering
University of Moratuwa, Sri Lanka

2009

Abstract

Sri Lanka ports authority and many other organizations are increasingly interested in the use of Unmanned Surface Vehicles (USV) for harbor security and surveillance applications. USVs can be used to collect information, samples and perform experiments inside a harbor or outside by. Navigating through ships and other objects.

This research study is focused on finding algorithms for obstacle avoidance (OA) of USVs. The initial paradigm that is used to establish the solution was the OA of Unmanned Ground Vehicles (UGV). The algorithms developed for UGV were implemented practically with the limitations of hardware. Then, effort is taken to apply those algorithms to the surface vehicles with some modifications.

In this study, a novel OA algorithm is proposed for static obstacles based on the Morphin algorithm. This proposed algorithm and the previous algorithm which is developed based on ground vehicles are compared with the potential field method.

Static OA without dynamic OA is not helpful for unmanned vehicles on sea. A lot of researches have been carried out to avoid dynamic objects, but have failed to find an optimum solution although comparatively good approaches have been presented. Intelligent techniques have been rarely applied for dynamic obstacle avoidance. In this research, the effectiveness of applying intelligent or mathematical techniques for path prediction of dynamic obstacles is discussed with simulations to pick the best for a given situation. Then a noval projected dynamic obstacle area method is presented to avoid dynamic obstacles effectively. Comparative results are presented at the end to prove the strength "of the noval dynamic obstacle area method.

DECLARATION

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

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

UOM Verified Signature

R.G. Jayendra

(Candidate)

23rd March 2009

I endorse the declaration by the candidate.

UOM Verified Signature

Dr. Sisil Kumarawadu

(Supervisor)

CONTENTS

Acknowledgement

Many thanks are due first to my supervisor, Dr. Sisil Kumarawadu, for his great insights, perspectives and guidance throughout the entire duration of the study.

Author extends his sincere gratitude to Dr. J.P. Karunadasa, Head of the Department of Electrical Engineering, for providing him the Research Assistantship and excellent assistance during the study period. Many thanks and appreciations are due to Professor H.Y.R. Perera, Commissioner General of Public Utilities Commission of Sri Lanka as well.

Sincere thanks are also due to the officers in Post Graduate Office of the Faculty of Engineering, University of Moratuwa for helping in various ways to clarify the things related to academic works in time with excellent cooperation and guidance. Thanks are also due to the staff of the Department of Electrical Engineering for the support extended during the study period. Also, I wish to gratefully acknowledge the assistance extended by Mr. Ravipriya Ranatunga, Mr. Samitha Ransara, Mr. Sanjeewa Priyadharshana, Mr. Gamini Jayasighe, Mr. Lackshan Piyasighe, Mr. Kolitha Dharmapriya, Mr. J. Baek, Mr. Harshana Somapriya, Mr. Nadun Chamikara and my brother Chanuka Jayendra.

Many thanks are also due to many individuals, friends and colleagues who have not been mentioned here by name in making this educational process as success.

Lastly, the author expresses his deep appreciation towards his family for their encouragement and support. This work is dedicated to his beloved mother and late father.

List of Figures

List of Tables

ACRONYMS

USV	-	Unmanned Surface Vehicles
UGV	-	Unmanned Ground Vehicles
DAMN	-	Distributed Architecture for Mobile Navigation
GPS	-	Global Position System
INU	-	Inertial Navigation Unit
PFM	-	Potential field method
VOM	-	Velocity Obstacle method
DNC	-	Digital Nautical Chart
GRNN	-	Generalized Regression Neural Network