A Proposal for a Parameratized Circulating Vector Field Guidance for Fixed Wing Unmanned Aerial Vehicles

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This thesis titled

A Proposal for a Parameratized Circulating Vector Field Guidance for Fixed Wing Unmanned Aerial Vehicles

by

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has been approved for

the Department of Something

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Abstract

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A Proposal for a Parameratized Circulating Vector Field Guidance for Fixed Wing Unmanned Aerial Vehicles (17 pp.)

Directors of Thesis: Dr. Jay Wilhelm and Coadvisor's Full Name

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A double backslash can be used to force line breaks if desired.

Acknowledgments

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1 INTRODUCTION

1.1 Motivation and Problem Statement

1.2 Methods Overview

1.3 Phases

1.4 Summary of Objectives

- Develop a parameterized circulation method that eliminates the singularity and guides a UAV around an obstacle and to a target. The parametrized circulation term $f(heading, closingvelocity, position, turnrate)$ and would be determined by minimizing a cost.

- Simulate and compare the parametrized circulation with a non parametrized VF guidance for circular and elliptical obstacles

- Emulate fixed wing algorithm with a ground robot to validate simulation results and demonstrate real time VF guidance is achievable with parametrized circulation modification

2 Literature Review

2.1 Unmanned Aerial Vehicles

2.1.1 Navigation, Guidance, and Control

- Navigation
- Guidance
- Path Planning
- Control

2.1.2 Flight Mechanics

2.1.3 Autopilot

2.1.4 Simulation

2.1.5 Emulation

2.2 Path Planning

- Current state to goal state while passing through objectives
- High level obstacle avoidance
- Line or series of waypoints
- How vehicle reaches line or points not necessarily considered
- Responsibility of guidance
- Avoid collisions, seeking goals

2.3 Guidance

2.3.1 Potential Field

- Potential field (what is it) (edge of bowl, marble, goal, obstacles)
- Calculation time
  - Long time to calculate
  - Environment changes, entire field has to be regenerated
  - Improvements could be made with better computing methods . . .
- Local minimums
  - Local minimums are a significant area of study in potential field
  - Examples of how the problem is being addressed
  - Common issue across the board - No clear solution in sight
  - As missions become more complex, the problem only worsens

2.3.2 Vector Field

- First appearance of vector field (Histogram approach) [Koren 1989] (read before typing it out)
- Experiments with sonar sensor robots [Koren and B 1991]
- [BK90] Improvements on previous vector field histogram
- Ground robot
- Later work provided improvements
- Limitations, size of cells, instability and oscillations

- Problems with VF, used as a general path planner with another local path planner on top
- (transition)
- First instance of generating a field for converging onto paths made of straight line and circular segments (Nelson, Barber, 2006)
- Field construction of Nelson and Barber (More reading)
- Added benefit of VF is adding component to counteract wind
- Cooperative Standoff Tracking of Uncertain moving targets (2007, Frew)
- VF usefulness extended to loitering about an uncertain target
- Lyapunov vector field generation for a circular loiter
- Linear transformation applied to stretch the field into an ellipse shape

2.3.3 Literature Review Summary

3 Methodology

References

[BK90] Johann Borenstein and Yoram Koren. Real-time obstacle avoidance for fast mobile robots in cluttered environments. In *Robotics and Automation, 1990. Proceedings., 1990 IEEE International Conference on*, pages 572–577. IEEE, 1990. URL: http://ieeexplore.ieee.org/abstract/document/126042/

Appendix: An Appendix

A.1 A Section in the Appendix