

UNIVERSITI TEKNOLOGI MARA

**REAL-TIME OPTIMAL
TRAJECTORY CORRECTION
(ROTC) FOR AUTONOMOUS
QUADROTOR**

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PhD

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

Attaining navigation precision for an autonomous quadrotor when it moves on the planned route in windy environment possesses huge challenge. The wind will cause the quadrotor diverges from the route and certainly affects the navigation accuracy. Integrating a trajectory correction algorithm in the navigation control can overcome this problem. However, existing algorithm seems too complicated to be applied. Since there is no technique can enable the quadrotor to implement precision navigation application, the research proposed a Real-Time Optimal Trajectory Correction (ROTC) algorithm. The algorithm works if the quadrotor undergoes a deviation, an admissible trajectory path is generated for the quadrotor rapidly return on the straight-line route. There are two stages implicated in the algorithm. First stage comprises a deviation scheme used to sense a deviation via an accelerometer and formulates a vector by applying double integration techniques fused with Kalman's Filter (KF). The second stage focuses on using the vector to generate an admissible cubic path via Hermite interpolation technique integrated with time and tangent transformation scheme. A Dead Reckoning (DR) navigation technique is employed to steer the quadrotor on the path. The scheme and algorithm are experimented in low, moderate and high categories of deviation acceleration via a customized quadrotor. The scheme performance is evaluated according to its accuracy to compute the vector compared to estimation method using Laser Range Finder (LRF) modules. As for the algorithm, the navigation system with and without it are compared to justify its workability. Parameters, specifically distance and time utilized by the quadrotor to return on the route after a deviation happened and also complete the navigation are evaluated. The results signify the deviation scheme gains more than 80% accuracy in estimating the vector in any experiment conducted. Hence, fewer distances and time are consumed by the quadrotor navigation with the algorithm to return to the route after a deviation happened as compared to its navigation without it. Consequently, the differences of distance travelled by the quadrotor between both navigation systems to complete the navigation for high, moderate and low categories of deviation acceleration are 143 centimeter (cm), 84 cm and 87 cm. As for the time, the differences are 5.5 seconds (s), 3.6 s and 2.5 s for the respective categories. Conclusively, the results show the ROTC algorithm is relevant to assist the quadrotor autonomous navigation in windy environment.

TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vi
LIST OF TABLES	ix
LIST OF FIGURES	xi
LIST OF SYMBOLS	xiv
LIST OF ABBREVIATIONS	xx
LIST OF NOMENCLATURES	xxi
CHAPTER ONE: INTRODUCTION	1
1.1 Motivation	1
1.2 Problem Statement	3
1.3 Hypotheses	4
1.4 Objectives	6
1.5 Scope of work	6
1.6 Summary	7
1.7 Thesis Organization	8
CHAPTER TWO: LITERATURE REVIEW	10
2.1 Introduction	10
2.2 Autonomous Navigation and Control Schemes for UAV	10
2.3 Trajectory Correction	15
2.4 Research Gap	17
2.5 Vector Estimation Technique	19
2.6 Trajectory Path Generation Technique	23
2.7 Summary	28

CHAPTER THREE: RESEARCH METHODOLOGY	30
3.1	Introduction 30
3.2	Research Design 30
3.3	Conceptual Design Setup 31
3.3.1	Deviation Detection and Vector Measurement Scheme 36
3.3.1.1	<i>Accelerometer Interfacing and Setting</i> 38
3.3.1.2	<i>KF for Accelerometer Drift and Double Integration Error</i> 39
3.3.1.3	<i>Deviation Scheme Algorithm Design</i> 42
3.3.2	Real-Time Optimal Trajectory Correction (ROTC) 46
3.3.2.1	<i>Trajectory Correction Path Design</i> 49
3.3.2.2	<i>Tangent Transformation Design</i> 59
3.3.2.3	<i>Time Transformation Design</i> 62
3.3.2.4	<i>Formation of Left and Right Trajectory Correction</i> 65
3.4	Experimental Platform Setup and Navigation Techniques 67
3.4.1	Controller Board 67
3.4.2	Quadrotor 72
3.4.3	Navigation Techniques 83
3.5	Software Design 89
3.5.1	Programming Tool and Implementation of Algorithm in C Program 89
3.5.2	Graphical User Interface (GUI) Window 93
3.6	Experimental Setup and Data Validation 99
3.6.1	Deviation Scheme 99
3.6.1.1	<i>Quadrotor Experiment Setup</i> 100
3.6.1.2	<i>Data Validation Method</i> 103
3.6.2	ROTC Algorithm 106
3.6.2.1	<i>Quadrotor Experiment Setup</i> 107
3.6.2.2	<i>Data Validation Method</i> 108
3.7	Summary 113