

## Table of Contents

<b>Preface</b>	<b>vii</b>
<b>Abstract</b>	<b>ix</b>
<b>Abstrak</b>	<b>x</b>
<b>Contents</b>	<b>xi</b>
<b>List of Figures</b>	<b>xiv</b>
<b>List of Tables</b>	<b>xvii</b>
<b>Nomenclature</b>	<b>xviii</b>
<b>I INTRODUCTION</b>	<b>1</b>
1.1 Background . . . . .	1
1.2 Problem Statements . . . . .	6
1.3 Objectives of The research . . . . .	7
1.4 Significance of the Study . . . . .	7
1.5 Contributions of Research . . . . .	7
1.6 Organization of the dissertation . . . . .	8
<b>II LITERATURE REVIEW</b>	<b>9</b>
2.1 Path Planning Algorithm . . . . .	9
2.1.1 Taxonomy of Path Planning Algorithm . . . . .	9
2.1.2 Grid-based Algorithm . . . . .	10
2.1.3 Sampling based Algorithm . . . . .	14
2.1.4 Evolutionary algorithm . . . . .	16
2.1.5 Curve Algorithm . . . . .	22
2.1.6 Resume of Path Planning Algorithm . . . . .	25
2.2 Theoretical Background . . . . .	27
2.2.1 Configuration Space . . . . .	27
2.2.2 Artificial Potential Field . . . . .	28
2.2.3 Nonholonomic Constraints . . . . .	31
2.2.4 Kinematic Control . . . . .	33

2.3	Convex Hull . . . . .	36
2.3.1	Definition . . . . .	36
2.3.2	Computing Planar Convex Hulls . . . . .	38
2.4	Summary . . . . .	39
<b>III</b>	<b>RESEARCH METHODOLOGY</b>	<b>40</b>
3.1	Local Minima and GNRON. . . . .	41
3.1.1	Introduction . . . . .	41
3.1.2	Local Minima . . . . .	43
3.1.3	GNRON . . . . .	44
3.1.4	Repulsive Function for Local Minima Problem . . . . .	45
3.1.5	Repulsive Function for GNRON Problem . . . . .	48
3.2	Integrated APF Path Planning with Kinematic Control . . . . .	50
3.2.1	Introduction . . . . .	50
3.2.2	The Proposed Method . . . . .	51
3.2.3	Design of Artificial Potential Field Control . . . . .	52
3.3	Local Information on APF . . . . .	54
3.3.1	Introduction . . . . .	54
3.3.2	Conceptual Framework . . . . .	55
3.3.3	Laser Detection . . . . .	57
3.3.4	SURF+RANSAC . . . . .	58
3.3.5	K-means Clustering . . . . .	60
3.3.6	Framework Transformation . . . . .	62
3.3.7	Convex Hull Algorithm . . . . .	66
3.3.8	Goal Point based on Local Information . . . . .	68
3.3.9	Global Optimum . . . . .	69
3.4	Proof of concept . . . . .	70
3.4.1	Research Material . . . . .	70
3.4.2	Experimental Design . . . . .	74
3.4.3	Evaluation and Validation . . . . .	78
3.5	Summary . . . . .	79
<b>IV</b>	<b>RESULT AND ANALYSIS</b>	<b>81</b>
4.1	Local Minima and GNRON Problem . . . . .	81
4.1.1	Scenario 1 . . . . .	81
4.1.2	Scenario 2 . . . . .	85
4.1.3	Real Time Platform . . . . .	89
4.1.4	Stability analysis . . . . .	90
4.1.5	Big-O analysis . . . . .	94
4.2	Integrated APF with the Kinematic Control . . . . .	94
4.2.1	Matlab . . . . .	94
4.2.2	ROS . . . . .	96
4.2.3	Real Time Platform . . . . .	97
4.2.4	Stability Analysis of Artificial Potential Field Control . . .	101



4.3	Local Information on APF . . . . .	104
4.3.1	Scenario 1 . . . . .	104
4.3.2	Scenario 2 . . . . .	105
4.3.3	Scenario 3 . . . . .	107
4.4	Main Findings . . . . .	108
<b>V</b>	<b>CONCLUSION AND FUTURE WORKS</b>	<b>111</b>
5.1	Conclusion . . . . .	111
5.2	Future Works . . . . .	112

## **REFERENCES**