CONTENTS

1

Titl	e Page	i			
Арр	oroval	ii			
Dec	laration	iii			
Cer	Certificate				
Ack	Acknowledgements				
Ded	ication	vii			
Non	nenclature	viii			
List	of Figures	xvi			
List	of Tables	xx			
Abs	tract	xxi			
Contents					
Introduction 1					
1.1	Introduction to Robotic System	1			
	1.1.1 Work on Two Robotic Systems	2			
1.2	Literature Survey	3			
	1.2.1 Design and Control of 2-DOF Manipulator for Trajectory Tracking	3			
	1.2.2 Biped Robot Gait Planning Staircase	6			
	1.2.2.1 Biped Robot Gait Planning in Single Support Phase	6			
	1.2.2.2 Biped Robot Gait Planning in Double Support Phase	9			
1.3	Gaps in the Literature	13			
1.4	.4 Aims and Objective 14				
1.5	.5 Contributions Made by the Scholar 15				

	1.6	Layout of the Thesis	15
	1.7	Summary	16
2	Intr	oduction to the Tools and Techniques Used	17
	2.1	Introduction to Soft Computing	17
	2.2	Introduction to Genetic Algorithm	18
		2.2.1 Real-coded Genetic Algorithm	19
		2.2.1.1 Crossover operator	19
		2.2.1.2 Mutation operator	20
		2.2.2 Genetic Algorithm to solve Multi-objective Optimization	21
	2.3	Introduction to Particle Swarm Optimization (PSO)	22
		2.3.1 Working principle of Particle Swarm Optimization (PSO)	22
		2.3.2 Particle Swarm Optimization (PSO) algorithm to solve Multi- objective Optimization	24
	2.4	Introduction to Fuzzy Sets and Fuzzy Reasoning Process	25
	2.5	Introduction to Artificial Neural Networks	28
		2.5.1 Working Principle of a Feed Forward Multi-layer Neural Network	29
	2.6	Combined Genetic Algorithm-Neural Networks(GA-NN)	32
	2.7	Adaptive Neuro-Fuzzy Inference System (ANFIS)	32
	2.8	Summary	35
3		gn of an Integrated Scheme for Optimal Structure and Adaptive troller of 2-DOF Manipulator	36
	3.1	Introduction	36
	3.2	Mathematical Formulation of the Problem	37
		3.2.1 Trajectory Analysis	37
		3.2.2 Determination of Power Consumption	39

	3.2.3	Structura	al Analysis: Bending of the links	40
	3.2.4	Stability	and Response Analysis in Trajectory Tracking	41
3.3	Propos	ed Algori	43	
	3.3.1	Approac	h 1: Optimization using a real-coded GA only	43
	3.3.2		h 2: Optimization using a combined neural network coded GA	44
	3.3.3	Approac (PSO) or	h 3: Optimization using Particle Swarm Optimization nly	45
	3.3.4		h 4: Optimization using combined neural network algorithm	45
3.4	Result	esults and Discussions		45
	3.4.1	Straight	Path Tracking	46
		3.4.1.1	Results of Approach 1	46
		3.4.1.2	Results of Approach 2	49
		3.4.1.3	Results of Approach 3	50
		3.4.1.4	Results of Approach 4	50
		3.4.1.5	Comparisons	51
	3.4.2	Circular	Path Tracking	56
		3.4.1.1	Results of Approach 1	56
		3.4.1.2	Results of Approach 2	56
		3.4.1.3	Results of Approach 3	56
		3.4.1.4	Results of Approach 4	58
		3.4.1.5	Comparisons	59
3.5	Compa	arisons wi	63	
3.6	Summ	ary	64	
			65	

4	Multi-Objective Optimization in Gait Planning of Biped Robot (SSP) Using Genetic Algorithm and Particle Swarm Optimization Algorithm						
	4.1	Mather	matical Fo	65			
		4.1.1	Staircase	e Ascending	65		
		41.2	Staircase	e Descending	70		
		4.1.3	Case A	Unconstrained gait planning for ascending and descending staircase	71		
		4.1.4	Case B	Constrained gait planning for ascending and descending staircase	72		
	4.2	Propos	ed Algori	73			
	4.3	Results	s and Disc	76			
		4.3.1	Results of	of Unconstrained Optimization	76		
			4.3.1.1.	Ascending the Staircase	76		
			4.3.1.2	Descending the Staircase	79		
			4.3.1.3	Discussion	82		
		4.3.2	Results of	of Constrained optimization	82		
			4.3.2.1.	Ascending the Staircase	82		
			4.3.2.2	Descending the Staircase	85		
			4.3.2.3.	Discussion	87		
	4.4	Compa	arison wit	h Others' work	88		
	4.5	Summ	ary		85 87 88 88 88 88 88		
5	5 Multi-Objective Optimization in Double Support Phase of Biped Robot Using Genetic Algorithm and Particle Swarm Optimization Algorithm						
	5.1	Introdu	iction		89		
	5.2	Mather	90				

	5.2.1Staircase Ascending905.2.2Staircase Descending965.2.3Case AUnconstrained gait planning for ascending and descending staircase975.2.4Case BConstrained gait Planning for ascending and descending staircase985.3Proposed Algorithms995.4Results and Discussion995.4.1Results of Unconstrained optimization 5.4.1.11005.4.1.1Ascending the staircase100		90		
		5.2.2	Staircase	Descending	96
		5.2.3	Case A		97
		5.2.4	Case B		98
	5.3	Propos	ed Algori	thms	99
	5.4	Results	s and Disc	ussion	99
		5.4.1	Results of	of Unconstrained optimization	100
			5.4.1.1	Ascending the staircase	100
			5.4.1.2	Descending the staircase	107
			5.4.1.3	Discussion	109
		5.4.2	Results of	of Constrained optimization	109
			5.4.2.1	Ascending the staircase	109
			5.4.2.2	Descending the staircase	111
			5.4.2.3	Discussion	113
	5.5	Compa	arison with	n Others' Work	113
	5.6	Summa	ary		114
6	Con	Concluding Remarks and Scope for Future Work		115	
	6.1	Conclu	iding Rem	arks	115
	6.2	Scope	for Future	Work	117
	Ref	erences			119
	Арр	oendix A	A: 2-4-2 N	eural Network	126
	Appendix B: Angles and mass variations in a cycle				127
Curriculum Vitae					142