
Contents

1	Introduction	1
1.1	Nonholonomy	1
1.2	Previous and concurrent works	5
1.2.1	Various examples of nonholonomic systems	5
1.2.2	Open loop strategies	7
1.2.3	Closed loop strategies	10
1.3	Contributions and outline of this book	12
2	Design of the nonholonomic manipulator	17
2.1	Introduction	17
2.2	The nonholonomic gear	18
2.3	Theoretical design of the nonholonomic manipulator	20
2.3.1	Joint driving mechanism	20
2.3.2	Kinematic model of the nonholonomic manipulator	22
2.4	Controllability	23
2.5	Conversion to the chained form	26
2.5.1	Triangular structure and chained form conversion	26
2.5.2	Chained form conversion of the nonholonomic manipulator	28
2.6	Conclusion	29
3	Prototyping and control of the nonholonomic manipulator	31
3.1	Introduction	31
3.2	Issues in mechanical design	32
3.2.1	Traction drive and friction drive	32
3.2.2	Supporting mechanism and adjusting spring force	32
3.2.3	Other issues related to mechanical design	34
3.3	Analysis and computation of driving force	34
3.4	Prototype of the nonholonomic manipulator	37
3.5	Control of the nonholonomic manipulator	40
3.5.1	Open loop control	41

3.5.2	Feedback control with exponential convergence	49
3.5.3	Feedback control by pseudo-linearization	52
3.6	Conclusion	57
4	Design of the chained form manipulator	59
4.1	Introduction	59
4.2	Problems of the nonholonomic manipulator	60
4.2.1	Numerical computation of the coordinate transformation	60
4.2.2	Simulated motion of the 5 joint nonholonomic manipulator	61
4.2.3	Mechanical problem related to the power transmission	64
4.3	Design of the chained form manipulator	64
4.3.1	Design of the main power train	64
4.3.2	Joint driving of the chained form manipulator	66
4.4	Kinematic model	69
4.5	Advantages of the chained form manipulator	71
4.5.1	Numerical mapping of the conversion equations	71
4.5.2	Simulated motion of the 6 joint chained form manipulator	72
4.6	Conclusion	74
5	Prototyping and control of the chained form manipulator	75
5.1	Introduction	75
5.2	Prototype of the chained form manipulator	76
5.3	Motion planning	80
5.3.1	Related studies and unsolved problems	80
5.3.2	Motion planning to approximate the given holonomic path	81
5.4	Initial-condition sensitivity of planned motion	88
5.5	Experiments	95
5.5.1	Feedback control by pseudo-linearization	95
5.5.2	Efficient motion planning using sinusoids	99
5.6	Conclusion	105
6	Conclusion	107
	References	109



<http://www.springer.com/978-3-540-22108-1>

Nonholonomic Manipulators

Chung, W.

2004, XIV, 114 p., Hardcover

ISBN: 978-3-540-22108-1