

# Contents

---

**Preface . . . . . i**

---

## **Chapter 1      Basics for Scientists**

1 Mega-Competition Era in Science and Technology . . . . . 1  
2 The First Step Is Thinking . . . . . 2  
3 A Scientist’s Way of Life and Philosophy . . . . . 5  
4 “Useful” Versus “Hopeful” Research . . . . . 6  
5 How Do Creative Ideas Appear? . . . . . 7  
    5.1 Energy Quantum    8  
    5.2 iPS Cells (Embryo Stem Cells)    9  
    5.3 SCARA Robot    10

---

## **Chapter 2      Parallel Bicycles and                     Their Applications**

1 Introduction . . . . . 16  
2 Posture Control of PB Robots: Prototypes P-1 and P-2 . . . . 16  
    2.1 Prototypes P-1 and P-2    17  
    2.2 Posture Control of P-1 Using Wheels    17  
3 Posture Restoration of PB Robots: Prototype P-3 . . . . . 21  
    3.1 Principle of Posture Restoration Using Arms    22  
    3.2 Compound Center of Gravity Feedback Control    24  
    3.3 Dynamic Compensation    25

4	Transformation of PB Robots: Prototypes P-4 Through P-6.	26
4.1	Prototype P-4	26
4.2	Prototypes P-5 and P-6	29
5	Other R&D Activities on PB Robots.	30
6	Commercial Applications of PB	33
7	Conclusions	33

## Chapter 3

### Robotic Unicycles Emulating Human Unicycle Riding

1	Research on Posture Stability and Drive Control of Unicycles.	36
2	Robotic Unicycle I : Nonstandalone	37
2.1	Robotic Unicycle I	39
2.2	Unicycle Control Rules	42
2.3	Experimental Results for Robotic Unicycle I	42
2.4	Unicycle I Simulation Results	46
3	Robotic Unicycle II : Standalone.	47
3.1	A 2D Unicycle Driving Simulation	48
3.2	Effects of Closed Linkages on Unicycle II	51
3.3	Rotor Rotation Stabilization with the Wheel Fixed	52
3.4	Wheel and Rotor Rotation Gyroeffect	53
3.5	Effect of Varying Forward Direction	54
3.6	Experimental Results	54
4	Conclusions on Unicycle Posture Stability and Drive.	61

---

## **Chapter 4**      **Unconventional Mobile Robots**

---

1	Introduction .....	66
2	Spherical Mobile Robot .....	66
2.1	Mechanisms	66
2.2	Sensors and Control Systems	69
2.3	Results of the Computer Simulation	70
2.4	Experimental Results	72
2.5	Conclusions	76
3	One-Legged Mobile Robot.....	77
3.1	Dynamic Walking	77
3.2	Structure, Motors, and Sensors	78
3.3	Results of Simulation and Experiment	80
4	Locomotion Robot Composed of Three Serial Links.....	81
4.1	Robot Developed	82
4.2	Several Unique Motions of the Robot	84
4.3	Results of Simulation and Experiment	85

---

## **Chapter 5**      **Brachiation and Jumping Rope**

---

1	Introduction .....	92
2	The Brachiation Robot.....	94
2.1	Hardware of the Robot	95
2.2	Position Control Method and Control Path	96

2.3	Torque Control Method and Control Path	99
2.4	Computer Simulation	99
2.5	Experimental Results	102
2.6	Conclusions	104
3	The Rope-Jumping Robot	105
3.1	The Robot Developed	105
3.2	Observation and Simulation of Human Rope-Jumping	107
3.3	Simulation When the Foot Receives Impact While the Robot Has No Rope	108
3.4	Observation of Human Rope Rotation	110
3.5	Modeling and Design of the Rope Rotation Path	112
3.6	Continuous Rope-Jumping	114
3.7	Continuous Rope-Jumping Experiment	116
3.8	Conclusions	118

## Chapter 6

### Cat-Turn Motion by a Robot and Its Applications

1	Introduction	120
2	A Robotic Cat Can Do a Cat-Turn?	120
2.1	Past Explanations of the Cat-Turn Motion and Their Refutations	121
2.2	Analysis of the Cat-Turn Motion	122
2.3	The Robotic Cat Developed and Vertebrate-Type Backbones	126
2.4	Pneumatic Control System and Control Method	127
2.5	Hip-Swing Motion of a Robotic Cat	128

2.6 Experiments	129
2.7 Conclusions	134
3 The 3D Robotic Cat . . . . .	135
3.1 A 2-Axes Cat-Turn Model and Computer Simulation	135
3.2 The 3D Robotic Cat Developed and Experiment	137
4 Soft Landing of a Robot Thrown into Midair . . . . .	138
4.1 Structure and Action of the Robot	138
4.2 Detection and Control of the Robot Posture: Eulerian Angles and Angular Velocities	139
4.3 Detection of a Robot Posture in Midair	141
4.4 Position Angle Parameters $\alpha, \beta$	142
4.5 Control and Experimental Method on Bending Angle of the Legs	143
4.6 Experiments	144
4.7 Conclusions	146

## Chapter 7

### **“Teaching by Showing” Instruction, Non-Contact 3D Measurement, and Biological Pattern Extraction**

1 Introduction . . . . .	148
2 “Teaching by Showing” Method of Instruction for Robots	148
2.1 Concept and Methodology of Teaching by Showing	149
2.2 Examples of Teaching by Showing	149
2.3 Conclusions	155
3 Non-Contact 3D Measurement Using a Robot . . . . .	156

3.1	Experimental Equipments	156
3.2	Object Measurement Using a CCD Camera and a Laser Sensor	157
3.3	Processing Method for Image Data Taken in from a CCD Camera	158
3.4	3D Measurement of Objects Using a Laser Sensor	160
3.5	Measurement Results	162
3.6	Conclusions	163
4	Biological Pattern Extraction.....	164
4.1	Methodology of AME System	164
4.2	Pattern Extraction Experiment Using AEs	167
4.3	Conclusions	168

## **Chapter 8**

### **Development of the SCARA Robots**

1	Needs and Problems of Robots for Assembly.....	172
2	Impact of SIGMA Robot and Debut of SCARA Robot ...	174
3	Concepts and Characteristics of the SCARA Robot.....	175
3.1	Concepts of the SCARA Robot	175
3.2	Structure and Characteristics of the SCARA Robot	176
3.3	Structural Features of SCARA Robots	177
3.4	Motion Control of SCARA Robot	179
4	R&D Consortium of SCARA Robot.....	181
5	The SCARA Robot Families.....	184
5.1	SCARA Robots Manufactured by the Consortium Members	184

5.2 SCARA Robots by the Non-Consortium Members	190
6 Conclusions . . . . .	198

<b>Chapter 9</b>	<b>Unattended Production Using Intelligent Robots</b>
------------------	---

1 Incorporation of Intelligent Robot Study Results into Unattended Production . . . . .	202
2 Automatic Assembly Technology Development in Japan. .	204
3 Unattended Production Basics. . . . .	206
3.1 Humanoid Robots and Unattended Production Applications	206
3.2 Automatic Assembly Problems and Zero Minor Stoppage	206
4 Intelligent Robots for Unattended Production. . . . .	210
4.1 Unattended Production and Concepts	210
4.2 Intelligent Robot Supporting Unattended Production	210
4.3 Parts Feeding Failures and Solutions	212
5 Offline Robots and Peripheral Development. . . . .	213
5.1 Offline Robot Overview	213
5.2 Problem Generation and Recovery Simulator	215
5.3 Optimal Offline Robot's Load	215
5.4 Pilot Plant Experiment, Problem Determination and Resolution	218
6 Conclusions . . . . .	219

---

# Chapter 10

## Fostering Children’s Curiosity, Creativity, and University- Originated Intellectual Property

---

1	Robotic Studio Fostering Children’s Curiosity and Creativity	222
1.1	Play Culture of Children’s World	222
1.2	Environments Satisfying Children’s Curiosity and Fostering Their Creativity	223
1.3	Robot and Mechatronics Studio Satisfying Children’s Curiosity and Fostering Their Creativity	225
1.4	“Broom-Standing” and “Upended Cat”	227
2	Ensuring the Safety of University-Originated Intellectual Property	229
2.1	Current Intellectual Property Rights Status at Universities in Japan	229
2.2	Infringement on Intellectual Property Rights	230
2.3	Intellectual Property Rights Protection and Measures	235
3	Conclusions	236
	<b>References</b>	<b>239</b>
	<b>Index</b>	<b>251</b>