Contents

1 Brief History of Rail Transit Development 1
1.1 A Brief Introduction to the Development History of Modern Rail Transit in the World 2
1.2 Brief History of Rail Transit Development in China 4
1.2.1 Sad Situation of Science and Technology in the Qing Dynasty of Old China 4
1.2.2 Rail Transit Construction After the Founding of New China 5
1.3 Disasters of World Rail Transit 8
1.3.1 Examples of Train Accidents in the World 9
1.3.2 Causes of Train Accidents 11
1.3.3 Basic Elements of Safe Operation of Modern Train 13
1.4 Enlightenment from the Development History of Rail Transit 19
1.4.1 Rail Transit is Inseparable from the Support of Scientific Basic Theory and Technological Innovation 19
1.4.2 Institutional Guarantee for China's Rail Transit Development 23
References 26

2 Intelligent Monitoring of Rail Transit System 29
2.1 Basic Working Principle of CBTC 30
2.1.1 Working Principle of Train Moving Block 30
2.1.2 Working Principle of Train Movement Authorization 31
2.2 Basic Analysis and Evaluation About CBTC 32
2.2.1 Overview of the Development Process of WLAN 32
2.2.2 Technical Limitations of the Original CBTC 33
2.3 System Wide Intelligent Communication and Monitoring 34
2.3.1 Data Communication System 35
2.3.2 Status Information Wireless Sensor Network 38

2.3.3 Wireless Sensing and "High-Speed Rail Vehicle Networking" 61
2.4 Brief Description of Working Principle of Train Subsystem 64
2.4.1 Signal Interlocking 65
2.4.2 Automatic Train Protection Subsystem 65
2.4.3 Automatic Train Supervision Subsystem 66
2.4.4 Automatic Train Drive Subsystem 67
2.4.5 Data Communication Subsystem 68
2.5 Communication Coordination Principle Between Vehicles 68
2.5.1 Communication Technology Structure Between Vehicles 69
2.5.2 Steps of Communication Principle Between Vehicles 69
2.5.3 Functional Differentiation of Communication Between Vehicles and Automatic Train Supervision System 70
2.6 Intelligent Identification and Decision of Road Conditions 71
2.6.1 Train Independent Intelligent Visual Perception System 71
2.6.2 Fast Identification Method for the Train Ahead 76
References 81

3 Intelligent Sensing and Identification of Train Power System 83
3.1 Intelligent Sensing Structure and Control of Power Unit of Electric Locomotive 83
3.1.1 Composition Basis of Intelligent Sensing of High-Speed Railway Power Plant 84
3.1.2 Intelligent Control of Train Traction 85
3.2 Intelligent Identification of Abnormal Conditions of Power System 85
3.2.1 Composition of Identification System 86
3.2.2 Intelligent Algorithm Theory of Audio Recognition 88
3.2.3 Basic Algorithm of Support Vector Machine 101
3.3 Fault Diagnosis of Traction Circuit of Metro Locomotive 108
3.3.1 System Composition 109
3.3.2 Identification Principle 112
3.3.3 Algorithm Steps 113
References 115

4 Artificial Intelligence Technology in the Operation and Management of Rail Transit System 117
4.1 Development Overview of AI 117
4.2 Application of Face Recognition Technology in Traffic Management 120
4.2.1 Theoretical Basis of Face Recognition 121
4.2.2 Face Image Feature Extraction 161
4.3 Practical Algorithms for Face Recognition 174

4.3.1 Face Recognition Algorithm Based on Geometric Feature Matching 174
4.3.2 Recognition Algorithm Based on Feature Face 180
4.3.3 Face Recognition Algorithm Based on "Elastic Beam Graph" Matching 190
4.3.4 Face Recognition Algorithm Based on Neural Network 198
4.3.5 Face Recognition Algorithm Based on Support Vector Machine 204
4.3.6 Face Recognition Algorithm Based on Hidden Markov Model 210
References 222

5 Application of AI in Rail Transit Operation and Maintenance 225
5.1 Typical Application Fields 225
5.1.1 Preparation of Train Operation Diagram 225
5.1.2 Preparation of Train Diagram from the Perspective of Energy Saving 235
5.1.3 Telephone Blocking Method 242
5.2 Popularization of Audio and Video Comprehensive Intelligent Recognition Technology 248
5.2.1 Basic Model of AI Security System 248
5.2.2 Role of Voiceprint Recognition in Transportation System 252
5.2.3 Basic Principles of Ensuring Audio and Video Information Security 256
References 257

6 Intelligent Maintenance of Internal and External Environment of Train 259
6.1 Intelligent Adjustment of Compartment Temperature 259
6.1.1 Double Closed-Loop Intelligent Regulation Principle of Carriage Room Temperature 259
6.1.2 Advantages of Intelligent Temperature Regulation in the Carriage 261
6.2 Intelligent Technology of Ride Safety Guarantee 261
6.2.1 Platform Screen Door Intelligent Control System 263
6.2.2 Algorithm Steps 266
6.3 Intelligent Assistance of the Environment in the Carriage 271
6.3.1 Device Structure and Setting Method 271
6.3.2 Core Algorithm 272
References 280

7 Future Technological Development of Rail Transit 281
7.1 Technical Status and Development of High-Speed Train 281
7.1.1 Review of High-Speed Rail Development 281
7.1.2 Weak Links of Existing Technologies in China 282

7.1.3 International High-Speed Train Technology Status and Development Direction 283
7.2 Overall Development Trend of World Rail Transit 289
7.2.1 Development Trend of Wheel Rail Technology 289
7.2.2 Development Trend of Magnetic Levitation Technology 290
7.3 System Architecture of Rail Transit Intelligent Operation and Maintenance 296
7.3.1 Development Ideas of Rail Transit Intelligent Technology and Equipment 296
7.3.2 Vision of Rail Transit Intelligent Technology 303
References 305