

- Preface p. xix
- 1 Sensors in Modern Traffic Management Systems p. 1
  - 1.1 Prevalence of Recurring Congestion p. 5
  - 1.2 Impact of Traffic Management Strategies on Congestion p. 8
  - 1.3 Impact of Congestion on Accident Rates p. 14
  - 1.4 Impact of Congestion Mitigation on Fuel Consumption and Pollution Emissions p. 17
  - 1.5 Optimizing the Existing Transportation Network Through Information Gathering and Dissemination p. 23
  - 1.6 Sensors as Part of an Intelligent Transportation Traffic Management System p. 25
  - 1.7 Evolution of Sensor Requirements p. 28
  - 1.8 Chapter Synopses p. 32
  - References p. 34
- 2 Traffic Flow Characterization p. 37
  - 2.1 Traffic Parameters For Uninterrupted Flow p. 37
  - 2.2 Traffic Parameters for Interrupted Flow p. 44
  - 2.3 Traffic Parameters as Measures of Effectiveness p. 45
  - 2.4 Traffic Flow Parameter Definitions p. 45
  - 2.5 Measures of Data Uniformity p. 74
  - 2.6 Statistical Measures of Data p. 77
  - 2.7 Summary p. 88
  - Exercises p. 89
  - References p. 90
- 3 Applications of Sensor Data to Traffic Management p. 93
  - 3.1 Traffic Signal Timing Parameters p. 94
  - 3.2 Local Isolated Intersection Signal Control p. 94
  - 3.3 Interconnected Intersection Signal Control p. 98
  - 3.4 Interconnected Intersection Signal Control Using Online-Generated, Traffic-Adaptive Timing Plans p. 113
  - 3.5 Freeway Incident Detection p. 133
  - 3.6 Freeway Metering p. 142
  - 3.7 Coordinated Operation of Freeways and Surface Streets p. 156
  - 3.8 Enhanced Information Dissemination to Travelers p. 157
  - 3.9 Traffic Data Collection p. 159
  - 3.10 Using Sensor Data to Characterize, Detect, and Analyze Sensor Failure Modes p. 169
  - 3.11 Detection of Priority Vehicles p. 181
  - 3.12 Overheight Sensors p. 185
  - 3.13 Weather Sensors p. 186
  - 3.14 Vehicle-Mounted Sensors that Enhance Safe Operation p. 186
  - 3.15 Specifications for Inductive Loop Detectors p. 193
  - 3.16 Traffic Parameter Accuracy Requirements for Current Applications p. 193
  - 3.17 Summary p. 196
  - Exercises p. 197
  - References p. 200
- 4 Data Requirements for Future Traffic Management Applications p. 209

- 4.1 Sensor Data Requirements for Evolving Applications p. 209
- 4.2 Detection Technology for IVHS Program p. 217
- 4.3 Traffic Surveillance and Detection Technology Development Program p. 230
- 4.4 Summary p. 236
- References p. 237
- 5 Traffic Flow Sensor Technologies p. 239
- 5.1 Video Image Processor p. 243
- 5.2 Microwave Radar p. 262
- 5.3 Infrared Sensors p. 269
- 5.4 Ultrasonic Sensors p. 276
- 5.5 Passive Acoustic Array Sensors p. 279
- 5.6 Inductive Loop Detectors p. 281
- 5.7 Magnetic Sensors p. 288
- 5.8 Sensor Combinations p. 295
- 5.9 Relative Cost of Sensors p. 296
- 5.10 Traffic Flow Data from Automatic Vehicle Identification Transponders p. 299
- 5.11 Traffic Flow Data from Cellular Telephones p. 304
- 5.12 Sensor Technology Comparison p. 305
- 5.13 Sensor Specification Summaries p. 311
- 5.14 Summary p. 311
- Exercises p. 312
- References p. 314
- 6 Overhead Sensor Installation Along a Highway p. 319
- 6.1 Initial Sensor Evaluations p. 320
- 6.2 Video Image Processors p. 321
- 6.3 Microwave Radar Sensors p. 335
- 6.4 Laser Radar Sensors p. 340
- 6.5 Passive Infrared Sensors p. 343
- 6.6 Ultrasonic Sensors p. 344
- 6.7 Passive Acoustic Array Sensors p. 346
- 6.8 Sensor Combinations p. 348
- 6.9 Summary p. 349
- References p. 349
- 7 Transponders and Standards for Dedicated Short-Range Communications p. 351
- 7.1 Transponder Types p. 352
- 7.2 Open Systems Interconnection Communications Model p. 354
- 7.3 DSRC Standards p. 357
- 7.4 Summary p. 392
- Exercises p. 395
- References p. 395
- 8 Data Fusion at the Traffic Management Center p. 399
- 8.1 Bayesian Inference p. 400
- 8.2 Dempster-Shafer Inference p. 411
- 8.3 Artificial Neural Networks p. 424

- 8.4 Voting Fusion p. 440
- 8.5 Fuzzy Logic p. 465
- 8.6 Knowledge-Based Expert Systems p. 485
- 8.7 Summary p. 494
- Exercises p. 495
- References p. 497
- 9 Sensor Plan and Specification Requirements p. 501
- 9.1 Planning for Sensor Use p. 502
- 9.2 Sensor Specification Issues p. 502
- 9.3 Summary p. 510
- List of Symbols, Abbreviations, and Acronyms p. 511
- About the Author p. 525
- Index p. 527
- Appendix A Elements of Selected United States and Canadian Traffic Management Systems p. 1
- Appendix B Freeway Incident Detection Algorithms p. 1
- B.1 Detection Rate and False Alarm Rate p. 1
- B.2 California Algorithms p. 2
- B.3 McMaster Algorithms p. 6
- B.4 Other Speed-Based Incident Detection Algorithms p. 9
- B.5 Incident Detection in Japan p. 9
- B.6 Incident Detection in Europe p. 10
- B.7 Incident Detection Algorithm Performance Comparison p. 11
- B.8 Summary p. 15
- References p. 16
- Appendix C Energy Use and Emissions by Transportation Mode p. 1
- Appendix D Inductive Loop Detector Specifications p. 1
- References p. 6
- Appendix E Deterministic and Random Components of Traffic Data p. 1
- References p. 4
- Appendix F Axel Counting and Weigh-in-Motion Sensors p. 1
- F.1 Pneumatic Road Tube p. 1
- F.2 Fiberoptic Sensors p. 3
- F.3 Piezoelectric Sensors p. 4
- F.4 Weigh-in-Motion Systems p. 7
- F.5 Weigh-in-Motion System Costs p. 15
- F.6 Summary p. 18
- References p. 18
- Appendix G Transmission Rate Requirements for Selected Traffic Management Applications p. 1
- References p. 5
- Appendix H Specifications of Representative Sensor Models p. 1
- Appendix I Sensor Manufacturers and Vendors p. 1
- Appendix J Data Fusion Algorithms and Architectures p. 1

- J.1 Definition of Data Fusion p. 2
- J.2 Level 1 Processing p. 4
- J.3 Levels 2, 3, and 4 Processing p. 17
- J.4 Definition of an Architecture p. 19
- J.5 Data Fusion Processes p. 19
- J.6 Data Fusion Architectures p. 20
- J.7 Sensor Footprint Registration and Size Considerations p. 27
- J.8 Summary p. 28
- Exercises p. 30
- References p. 30
- Appendix K Freeway and Multilane Highway Capacity for Other Than Base Conditions p. 1
- K.1 Free-Flow Speed Estimate p. 1
- K.2 Equivalent Passenger Car Flow-Rate Estimate p. 5
- K.3 Summary p. 7
- Reference p. 9
- Appendix L Answers to Chapter Exercises p. 1