
Contents

Preface	xix
Acknowledgments	xxi
Author	xxiii
Contributors	xxv
Introduction	xxvii

Part I: Theory of Data Fusion and Kinematic-Level Fusion

(J. R. Raol, G. Girija, and N. Shanthakumar)

1. Introduction	3
2. Concepts and Theory of Data Fusion	11
2.1 Models of the Data Fusion Process and Architectures	11
2.1.1 Data Fusion Models	13
2.1.1.1 Joint Directors of Laboratories Model	13
2.1.1.2 Modified Waterfall Fusion Model	17
2.1.1.3 Intelligence Cycle-Based Model	18
2.1.1.4 Boyd Model	19
2.1.1.5 Omnibus Model	20
2.1.2 Fusion Architectures	21
2.1.2.1 Centralized Fusion	21
2.1.2.2 Distributed Fusion	21
2.1.2.3 Hybrid Fusion	22
2.2 Unified Estimation Fusion Models and Other Methods	23
2.2.1 Definition of the Estimation Fusion Process	24
2.2.2 Unified Fusion Models Methodology	25
2.2.2.1 Special Cases of the Unified Fusion Models	25
2.2.2.2 Correlation in the Unified Fusion Models	26
2.2.3 Unified Optimal Fusion Rules	27
2.2.3.1 Best Linear Unbiased Estimation Fusion Rules with Complete Prior Knowledge	27
2.2.3.2 Best Linear Unbiased Estimation Fusion Rules without Prior Knowledge	28
2.2.3.3 Best Linear Unbiased Estimation Fusion Rules with Incomplete Prior Knowledge	28
2.2.3.4 Optimal-Weighted Least Squares Fusion Rule	28
2.2.3.5 Optimal Generalized Weighted Least Squares Fusion Rule	29

2.2.4	Kalman Filter Technique as a Data Fuser	29
2.2.4.1	Data Update Algorithm.....	30
2.2.4.2	State-Propagation Algorithm	31
2.2.5	Inference Methods.....	32
2.2.6	Perception, Sensing, and Fusion.....	32
2.3	Bayesian and Dempster-Shafer Fusion Methods	33
2.3.1	Bayesian Method.....	34
2.3.1.1	Bayesian Method for Fusion of Data from Two Sensors	36
2.3.2	Dempster-Shafer Method	38
2.3.3	Comparison of the Bayesian Inference Method and the Dempster-Shafer Method	40
2.4	Entropy-Based Sensor Data Fusion Approach	41
2.4.1	Definition of Information	41
2.4.2	Mutual Information.....	43
2.4.3	Entropy in the Context of an Image	44
2.4.4	Image-Noise Index.....	44
2.5	Sensor Modeling, Sensor Management, and Information Pooling.....	45
2.5.1	Sensor Types and Classification	45
2.5.1.1	Sensor Technology	46
2.5.1.2	Other Sensors and their Important Features and Usages	48
2.5.1.3	Features of Sensors	51
2.5.1.4	Sensor Characteristics	52
2.5.2	Sensor Management.....	53
2.5.2.1	Sensor Modeling	55
2.5.2.2	Bayesian Network Model.....	58
2.5.2.3	Situation Assessment Process	58
2.5.3	Information-Pooling Methods	60
2.5.3.1	Linear Opinion Pool	60
2.5.3.2	Independent Opinion Pool	61
2.5.3.3	Independent Likelihood Pool.....	61
3.	Strategies and Algorithms for Target Tracking and Data Fusion	63
3.1	State-Vector and Measurement-Level Fusion	69
3.1.1	State-Vector Fusion	70
3.1.2	Measurement Data-Level Fusion	71
3.1.3	Results with Simulated and Real Data Trajectories.....	71
3.1.4	Results for Data from a Remote Sensing Agency with Measurement Data-Level Fusion	72
3.2	Factorization Kalman Filters for Sensor Data Characterization and Fusion.....	73
3.2.1	Sensor Bias Errors	73

3.2.2	Error State-Space Kalman Filter	75
3.2.3	Measurement and Process Noise Covariance Estimation	76
3.2.4	Time Stamp and Time Delay Errors.....	77
3.2.5	Multisensor Data Fusion Scheme	77
3.2.5.1	UD Filters for Trajectory Estimation	80
3.2.5.2	Measurement Fusion	81
3.2.5.3	State-Vector Fusion.....	82
3.2.5.4	Fusion Philosophy.....	82
3.3	Square-Root Information Filtering and Fusion in Decentralized Architecture	86
3.3.1	Information Filter.....	87
3.3.1.1	Information Filter Concept	87
3.3.1.2	Square Root Information Filter Algorithm	88
3.3.2	Square Root Information Filter Sensor Data Fusion Algorithm.....	88
3.3.3	Decentralized Square Root Information Filter	89
3.3.4	Numerical Simulation Results	91
3.4	Nearest Neighbor and Probabilistic Data Association Filter Algorithms.....	93
3.4.1	Nearest Neighborhood Kalman Filter	94
3.4.2	Probabilistic Data Association Filter.....	96
3.4.3	Tracking and Data Association Program for Multisensor, Multitarget Sensors	97
3.4.3.1	Sensor Attributes.....	99
3.4.3.2	Data Set Conversion.....	99
3.4.3.3	Gating in Multisensor, Multitarget.....	100
3.4.3.4	Measurement-to-Track Association	100
3.4.3.5	Initiation of Track and Extrapolation of Track.....	101
3.4.3.6	Extrapolation of Tracks into Next Sensor Field of View	101
3.4.3.7	Extrapolation of Tracks into Next Scan.....	102
3.4.3.8	Track Management Process	102
3.4.4	Numerical Simulation	103
3.5	Interacting Multiple Model Algorithm for Maneuvering Target Tracking	106
3.5.1	Interacting Multiple Model Kalman Filter Algorithm	106
3.5.1.1	Interaction and Mixing	108
3.5.1.2	Kalman Filtering	108
3.5.1.3	Mode Probability Update.....	109
3.5.1.4	State Estimate and Covariance Combiner.....	109
3.5.2	Target Motion Models.....	110
3.5.2.1	Constant Velocity Model.....	110
3.5.2.2	Constant Acceleration Model	110

3.5.3	Interacting Multiple Model Kalman Filter Implementation.....	111
3.5.3.1	Validation with Simulated Data.....	112
3.6	Joint Probabilistic Data Association Filter.....	116
3.6.1	General Version of a Joint Probabilistic Data Association Filter	117
3.6.2	Particle Filter Sample-Based Joint Probabilistic Data Association Filter	119
3.7	Out-of-Sequence Measurement Processing for Tracking.....	120
3.7.1	Bayesian Approach to the Out-of-Sequence Measurement Problem	120
3.7.2	Out-of-Sequence Measurement with Single Delay and No Clutter	121
3.7.2.1	Y Algorithm	121
3.7.2.2	Augmented State Kalman Filters.....	122
3.8	Data Sharing and Gain Fusion Algorithm for Fusion.....	124
3.8.1	Kalman Filter-Based Fusion Algorithm.....	124
3.8.2	Gain Fusion-Based Algorithm	125
3.8.3	Performance Evaluation	126
3.9	Global Fusion and H-Infinity Filter-Based Data Fusion.....	127
3.9.1	Sensor Data Fusion using H-Infinity Filters	127
3.9.2	H-Infinity a Posteriori Filter-Based Fusion Algorithm.....	130
3.9.3	H-Infinity Global Fusion Algorithm	131
3.9.4	Numerical Simulation Results	132
3.10	Derivative-Free Kalman Filters for Fusion.....	134
3.10.1	Derivative-Free Kalman Filters.....	136
3.10.2	Numerical Simulation	137
3.10.2.1	Initialization of the Data Fusion-Derivative Free Kalman Filter Algorithm.....	140
3.10.2.2	Computation of the Sigma Points	140
3.10.2.3	State and Covariance Propagation.....	141
3.10.2.4	State and Covariance Update	141
3.11	Missile Seeker Estimator.....	143
3.11.1	Interacting Multiple Model-Augmented Extended Kalman Filter Algorithm	143
3.11.1.1	State Model.....	144
3.11.1.2	Measurement Model.....	145
3.11.2	Interceptor-Evader Engagement Simulation.....	146
3.11.2.1	Evader Data Simulation.....	147
3.11.3	Performance Evaluation of Interacting Multiple Model-Augmented Extended Kalman Filter	147
3.12	Illustrative Examples.....	151

4.	Performance Evaluation of Data Fusion Systems, Software, and Tracking.....	157
4.1	Real-Time Flight Safety Expert System Strategy	160
4.1.1	Autodecision Criteria	161
4.1.2	Objective of a Flight Test Range	161
4.1.3	Scenario of the Test Range.....	161
4.1.3.1	Tracking Instruments.....	162
4.1.3.2	Data Acquisition.....	163
4.1.3.3	Decision Display System.....	163
4.1.4	Multisensor Data Fusion System	163
4.1.4.1	Sensor Fusion for Range Safety Computer	164
4.1.4.2	Algorithms for Fusion	164
4.1.4.3	Decision Fusion	165
4.2	Multisensor Single-Target Tracking	166
4.2.1	Hierarchical Multisensor Data Fusion Architecture and Fusion Scheme.....	166
4.2.2	Philosophy of Sensor Fusion.....	168
4.2.3	Data Fusion Software Structure	169
4.2.3.1	Fusion Module 1.....	169
4.2.3.2	Fusion Modules 2 and 3	169
4.2.4	Validation	170
4.3	Tracking of a Maneuvering Target—Multiple-Target Tracking Using Interacting Multiple Model Probability Data Association Filter and Fusion.....	171
4.3.1	Interacting Multiple Model Algorithm.....	171
4.3.1.1	Automatic Track Formation.....	171
4.3.1.2	Gating and Data Association.....	172
4.3.1.3	Interaction and Mixing in Interactive Multiple Model Probabilistic Data Association Filter.....	174
4.3.1.4	Mode-Conditioned Filtering.....	174
4.3.1.5	Probability Computations.....	175
4.3.1.6	Combined State and Covariance Prediction and Estimation	176
4.3.2	Simulation Validation.....	177
4.3.2.1	Constant Velocity Model.....	177
4.3.2.2	Constant Acceleration Model.....	178
4.3.2.3	Performance Evaluation and Discussions	179
4.4	Evaluation of Converted Measurement and Modified Extended Kalman Filters	183
4.4.1	Error Model Converted Measurement Kalman Filter and Error Model Modified Extended Kalman Filter Algorithms	184
4.4.1.1	Error Model Converted Measurement Kalman Filter Algorithm.....	185

4.4.1.2	Error Model Modified Extended Kalman Filter Algorithm	186
4.4.2	Discussion of Results.....	189
4.4.2.1	Sensitivity Study on Error Model Modified Extended Kalman Filter	191
4.4.2.2	Comparison of Debiased Converted Measurements Kalman Filter, Error Model Converted Measurement Kalman Filter, and Error Model Modified Extended Kalman Filter Algorithms	191
4.5	Estimation of Attitude Using Low-Cost Inertial Platforms and Kalman Filter Fusion.....	193
4.5.1	Hardware System.....	195
4.5.2	Sensor Modeling	195
4.5.2.1	Misalignment Error Model.....	196
4.5.2.2	Temperature Drift Model.....	196
4.5.2.3	CG Offset Model	196
4.5.3	MATLAB®/Simulink Implementation.....	196
4.5.3.1	State Model.....	197
4.5.3.2	Measurement Model.....	198
4.5.4	Microcontroller Implementation	200
	Epilogue.....	203
	Exercises	203
	References.....	206

Part II: Fuzzy Logic and Decision Fusion

(J. R. Raol and S. K. Kashyap)

5.	Introduction	215
6.	Theory of Fuzzy Logic	217
6.1	Interpretation and Unification of Fuzzy Logic Operations	218
6.1.1	Fuzzy Sets and Membership Functions	218
6.1.2	Types of Fuzzy Membership Functions	220
6.1.2.1	Sigmoid-Shaped Function.....	220
6.1.2.2	Gaussian-Shaped Function.....	220
6.1.2.3	Triangle-Shaped Function	222
6.1.2.4	Trapezoid-Shaped Function.....	222
6.1.2.5	S-Shaped Function.....	222
6.1.2.6	Π -Shaped Function.....	224
6.1.2.7	Z-Shaped Function.....	224
6.1.3	Fuzzy Set Operations	225
6.1.3.1	Fuzzy Logic Operators	226

6.1.4	Fuzzy Inference System	227
6.1.4.1	Triangular Norm or T-norm	228
6.1.4.2	Fuzzy Implication Process Using T-norm	232
6.1.4.3	Triangular Conorm or S-norm.....	239
6.1.4.4	Fuzzy Inference Process Using S-norm.....	240
6.1.5	Relationships between Fuzzy Logic Operators.....	247
6.1.6	Sup (max)-Star (T-norm) Composition.....	248
6.1.6.1	Maximum-Minimum Composition (Mamdani).....	249
6.1.6.2	Maximum Product Composition (Larsen)	250
6.1.7	Interpretation of the Connective "and"	250
6.1.8	Defuzzification.....	251
6.1.8.1	Centroid Method, or Center of Gravity or Center of Area.....	251
6.1.8.2	Maximum Decomposition Method	252
6.1.8.3	Center of Maxima or Mean of Maximum.....	252
6.1.8.4	Smallest of Maximum	253
6.1.8.5	Largest of Maximum	253
6.1.8.6	Height Defuzzification	253
6.1.9	Steps of the Fuzzy Inference Process	253
6.2	Fuzzy Implication Functions	255
6.2.1	Fuzzy Implication Methods	255
6.2.2	Comparative Evaluation of the Various Fuzzy Implication Methods with Numerical Data	264
6.2.3	Properties of Fuzzy If-Then-Rule Interpretations	265
6.3	Forward- and Backward-Chain Logic Criteria	266
6.3.1	Generalization of <i>Modus Ponens</i> Rule	266
6.3.2	Generalization of <i>Modus Tollens</i> Rule.....	267
6.4	Tool for the Evaluation of Fuzzy Implication Functions.....	268
6.4.1	Study of Criteria Satisfaction Using MATLAB® Graphics	268
6.5	Development of New Implication Functions.....	275
6.5.1	Study of Criteria Satisfaction by New Implication Function Using MATLAB and GUI Tools	278
6.6	Fuzzy Logic Algorithms and Final Composition Operations.....	281
6.7	Fuzzy Logic and Fuzzy Integrals in Multiple Network Fusion	289
7.	Decision Fusion	293
7.1	Symbol- or Decision-Level Fusion.....	293
7.2	Soft Decisions in Kalman Filtering	296
7.3	Fuzzy Logic-Based Kalman Filter and Fusion Filters.....	297
7.3.1	Fuzzy Logic-Based Process and Design	298

7.3.2	Comparison of Kalman Filter and Fuzzy Kalman Filter	299
7.3.3	Comparison of Kalman Filter and Fuzzy Kalman Filter for Maneuvering Target Tracking	301
7.3.3.1	Training Set and Check-Set Data	301
7.3.3.2	Mild and Evasive Maneuver Data	302
7.3.4	Fuzzy Logic-Based Sensor Data Fusion	303
7.3.4.1	Kalman Filter Fuzzification	304
7.3.4.2	Fuzzy Kalman Filter Fuzzification	306
7.3.4.3	Numerical Simulation Results	307
7.4	Fuzzy Logic in Decision Fusion	308
7.4.1	Methods Available to Perform Situation Assessments	310
7.4.2	Comparison between Bayesian Network and Fuzzy Logic	310
7.4.2.1	Situation Assessment Using Fuzzy Logic	311
7.4.3	Level-3 Threat Refinement and Level-4 Process Refinement	312
7.4.4	Fuzzy Logic-Based Decision Fusion Systems	313
7.4.4.1	Various Attributes and Aspects of Fuzzy Logic-Based Decision Fusion Systems	314
7.5	Fuzzy Logic Bayesian Network for Situation Assessment	316
7.5.1	Description of Situation Assessment in Air Combat	317
7.5.1.1	Exercise Controller	317
7.5.1.2	Integrated Sensor Model	318
7.5.1.3	Data Processor	318
7.5.1.4	Pilot Mental Model	318
7.5.2	Bayesian Mental Model	318
7.5.2.1	Pair Agent Bayesian Network	319
7.5.2.2	Along Agent Bayesian Network	320
7.5.2.3	Attack Agent Bayesian Network	320
7.5.3	Results and Discussions	320
7.6	Fuzzy Logic-Based Decision Fusion in a Biometric System	321
7.6.1	Fusion in Biometric Systems	322
7.6.2	Fuzzy Logic Fusion	322
8.	Performance Evaluation of Fuzzy Logic-Based Decision Systems	325
8.1	Evaluation of Existing Fuzzy Implication Functions	325
8.2	Decision Fusion System 1—Formation Flight	328
8.2.1	Membership Functions	329
8.2.2	Fuzzy Rules and the Fuzzy Implication Method	330
8.2.3	Aggregation and Defuzzification Method	330
8.2.4	Fuzzy Logic-Based Decision Software Realization	330

8.3	Decision Fusion System 2—Air Lane	331
8.3.1	Membership Functions	332
8.3.2	Fuzzy Rules and Other Methods	333
8.3.3	Fuzzy Logic-Based Decision Software Realization for System 2	334
8.4	Evaluation of Some New Fuzzy Implication Functions	334
8.5	Illustrative Examples	337
	Epilogue	347
	Exercises	347
	References	351

Part III: Pixel- and Feature-Level Image Fusion

(J. R. Raol and V. P. S. Naidu)

9.	Introduction	357
10.	Pixel- and Feature-Level Image Fusion Concepts and Algorithms	361
10.1	Image Registration	361
10.1.1	Area-Based Matching	363
10.1.1.1	Correlation Method	364
10.1.1.2	Fourier Method	364
10.1.1.3	Mutual Information Method	365
10.1.2	Feature-Based Methods	365
10.1.2.1	Spatial Relation	366
10.1.2.2	Invariant Descriptors	366
10.1.2.3	Relaxation Technique	367
10.1.2.4	Pyramids and Wavelets	367
10.1.3	Transform Model	368
10.1.3.1	Global and Local Models	368
10.1.3.2	Radial Basis Functions	368
10.1.3.3	Elastic Registration	369
10.1.4	Resampling and Transformation	369
10.1.5	Image Registration Accuracy	369
10.2	Segmentation, Centroid Detection, and Target Tracking with Image Data	370
10.2.1	Image Noise	370
10.2.1.1	Spatial Filter	371
10.2.1.2	Linear Spatial Filters	372
10.2.1.3	Nonlinear Spatial Filters	372
10.2.2	Metrics for Performance Evaluation	373
10.2.2.1	Mean Square Error	373
10.2.2.2	Root Mean Square Error	373
10.2.2.3	Mean Absolute Error	373

10.2.2.4 Percentage Fit Error.....	373
10.2.2.5 Signal-to-Noise Ratio.....	374
10.2.2.6 Peak Signal-to-Noise Ratio	374
10.2.3 Segmentation and Centroid Detection Techniques	374
10.2.3.1 Segmentation.....	374
10.2.3.2 Centroid Detection.....	376
10.2.4 Data Generation and Results.....	377
10.2.5 Radar and Imaging Sensor Track Fusion	378
10.3 Pixel-Level Fusion Algorithms	380
10.3.1 Principal Component Analysis Method.....	380
10.3.1.1 Principal Component Analysis Coefficients	382
10.3.1.2 Image Fusion.....	382
10.3.2 Spatial Frequency.....	383
10.3.2.1 Image Fusion by Spatial Frequency	384
10.3.2.2 Majority Filter	384
10.3.3 Performance Evaluation.....	385
10.3.3.1 Results and Discussion	387
10.3.3.2 Performance Metrics When No Reference Image Is Available.....	390
10.3.4 Wavelet Transform.....	394
10.3.4.1 Fusion by Wavelet Transform.....	398
10.3.4.2 Wavelet Transforms for Similar Sensor Data Fusion.....	398
10.4 Fusion of Laser and Visual Data.....	400
10.4.1 3D Model Generation	400
10.4.2 Model Evaluation.....	402
10.5 Feature-Level Fusion Methods	402
10.5.1 Fusion of Appearance and Depth Information	403
10.5.2 Stereo Face Recognition System.....	404
10.5.2.1 Detection and Feature Extraction	405
10.5.2.2 Feature-Level Fusion Using Hand and Face Biometrics.....	406
10.5.3 Feature-Level Fusion	407
10.5.3.1 Feature Normalization.....	407
10.5.3.2 Feature Selection	407
10.5.3.3 Match Score Generation	408
10.6 Illustrative Examples.....	408
11. Performance Evaluation of Image-Based Data Fusion Systems...	415
11.1 Image Registration and Target Tracking.....	415
11.1.1 Image-Registration Algorithms.....	415
11.1.1.1 Sum of Absolute Differences.....	415
11.1.1.2 Normalized Cross Correlation.....	417
11.1.2 Interpolation	418
11.1.3 Data Simulation and Results.....	420

11.2 3D Target Tracking with Imaging and Radar Sensors.....	429
11.2.1 Passive Optical Sensor Mathematical Model.....	430
11.2.2 State-Vector Fusion for Fusing IRST and Radar Data	431
11.2.2.1 Application of Extended KF	432
11.2.2.2 State-Vector Fusion.....	433
11.2.3 Numerical Simulation	435
11.2.4 Measurement Fusion.....	437
11.2.4.1 Measurement Fusion 1 Scheme.....	437
11.2.4.2 Measurement Fusion 2 Scheme.....	439
11.2.5 Maneuvering Target Tracking	440
11.2.5.1 Motion Models.....	441
11.2.5.2 Measurement Model.....	442
11.2.5.3 Numerical Simulation	442
11.3 Target Tracking with Acoustic Sensor Arrays and Imaging Sensor Data	448
11.3.1 Tracking with Multiple Acoustic Sensor Arrays.....	448
11.3.2 Modeling of Acoustic Sensors.....	449
11.3.3 DoA Estimation.....	451
11.3.4 Target-Tracking Algorithms	453
11.3.4.1 Digital Filter.....	455
11.3.4.2 Triangulation	455
11.3.4.3 Results and Discussion	455
11.3.5 Target Tracking	457
11.3.5.1 Joint Acoustic-Image Target Tracking.....	459
11.3.5.2 Decentralized KF	460
11.3.5.3 3D Target Tracking.....	463
11.3.6 Numerical Simulation	465
Epilogue.....	471
Exercises	471
References.....	474

Part IV: A Brief on Data Fusion in Other Systems

(A. Gopal and S. Utete)

12. Introduction: Overview of Data Fusion in Mobile Intelligent Autonomous Systems.....	479
12.1 Mobile Intelligent Autonomous Systems	479
12.2 Need for Data Fusion in MIAS	481
12.3 Data Fusion Approaches in MIAS.....	482
13. Intelligent Monitoring and Fusion	485
13.1 The Monitoring Decision Problem	485
13.2 Command, Control, Communications, and Configuration.....	488

13.3 Proximity- and Condition-Monitoring Systems	488
Epilogue.....	491
Exercises	492
References.....	492
Appendix: Numerical, Statistical, and Estimation Methods	495
A.1 Some Definitions and Concepts.....	495
A.1.1 Autocorrelation Function.....	495
A.1.2 Bias in Estimate.....	496
A.1.3 Bayes' Theorem	496
A.1.4 Chi-Square Test	496
A.1.5 Consistency of Estimates Obtained from Data	496
A.1.6 Correlation Coefficients and Covariance	497
A.1.7 Mathematical Expectations	497
A.1.8 Efficient Estimators.....	498
A.1.9 Mean-Squared Error (MSE).....	498
A.1.10 Mode and Median.....	498
A.1.11 Monte Carlo Data Simulation.....	498
A.1.12 Probability.....	499
A.2 Decision Fusion Approaches.....	499
A.3 Classifier Fusion.....	500
A.3.1 Classifier Ensemble Combining Methods.....	501
A.3.1.1 Methods for Creating Ensemble Members	501
A.3.1.2 Methods for Combining Classifiers in Ensembles...	501
A.4 Wavelet Transforms.....	502
A.5 Type-2 Fuzzy Logic.....	504
A.6 Neural Networks	505
A.6.1 Feed-Forward Neural Networks	506
A.6.2 Recurrent Neural Networks.....	508
A.7 Genetic Algorithm	508
A.7.1 Chromosomes, Populations, and Fitness	509
A.7.2 Reproduction, Crossover, Mutation, and Generation.....	509
A.8 System Identification and Parameter Estimation.....	509
A.8.1 Least-Squares Method.....	510
A.8.2 Maximum Likelihood and Output Error Methods	511
A.9 Reliability in Information Fusion.....	516
A.9.1 Bayesian Method.....	518
A.9.1.1 Weighted Average Methods	518
A.9.2 Evidential Methods	518
A.9.3 Fuzzy Logic-Based Possibility Approach.....	519
A.10 Principal Component Analysis.....	519
A.11 Reliability	520
References.....	520
Index	523