

Contents

List of Acronyms and Abbreviations	XV
List of Symbols	XVII
1 Introduction	1
1.1 Motivation	6
1.2 Focus of the Work	7
1.3 Structure and Format	8
2 Scientific State of the Art	11
2.1 Information Fusion	11
2.1.1 Uncertainty	15
2.1.2 Conflict	17
2.2 Information Models	18
2.2.1 Probability Theory Fusion Approaches	19
2.2.2 Dempster-Shafer Theory of Evidence Fusion Approaches	22
2.2.3 Fuzzy Set Theory Fusion Approaches	26
2.2.4 Possibility Theory Fusion Approaches	29
2.2.5 Hybrid Information Fusion Approaches	30
2.2.6 Further Information Models	31
2.3 Human Group Decision-Making	32
2.4 Scientific Gap	33
2.5 Chapter Summary	35
3 Preliminaries	37
3.1 Modified-Fuzzy-Pattern-Classifer Membership Function Training	37
3.2 An Interconnection Between Dempster-Shafer, Fuzzy Set, and Possibility Theory	40
3.3 Two-Layer Conflict Solving	43
3.3.1 Conflict-Modified-DST	44
3.3.2 Group-Conflict-Redistribution	45
3.4 Fuzzy Aggregation	47
3.4.1 Ordered Weighted Averaging	48
Construction of OWA Operators with Desired Andness	49
3.4.2 Implicative Importance Weighted Ordered Weighted Averaging	50
3.5 Truncated Triangular Probability-Possibility Transform	51
3.6 Monitoring of Sensor Reliability	52
3.7 Chapter Summary	55

4	Multilayer Attribute-based Conflict-reducing Observation	57
4.1	The MACRO Architecture	58
4.2	Information Source Signal Conditioning	61
4.3	System State Representation	62
4.4	Fuzzy Basic Belief Assignment	65
4.5	Attribute Layer Fusion	67
4.5.1	Analysis of Two-Layer Conflict Solving	69
	Conflict	70
	Conflict Modified DST	72
	Group-Conflict-Redistribution	73
	Numerical Examples	76
	Numerical Stability	76
	Conclusions on Two-Layer Conflict Solving	80
4.5.2	Balanced Two-Layer Conflict Solving	80
	Non-conflicting Part	81
	Conflicting Part	82
	Balanced Group Conflict Redistribution	83
	Numerical Examples	85
	Numerical Stability	87
	Conclusions on Balanced Two-Layer Conflict Solving	88
4.5.3	Fuzzified Balanced Two-Layer Conflict Solving	88
4.5.4	MACRO Attribute Layer Fusion	90
4.5.5	Conflicting Coefficient Behaviour	92
4.5.6	Conflict as a Measure of Importance	94
4.5.7	MACRO Attribute Structure	95
4.6	System Layer Fusion	95
4.6.1	Degree of Optimism	96
4.6.2	Attribute Importance	98
4.7	Sensor Defect Detection	99
4.7.1	Sensor Observation Determination	100
4.7.2	Measurement Scale Fuzzification	100
4.7.3	Majority Consistency Measure Adaptation	102
4.7.4	Groupwise Sensor Reliability Determination	103
4.7.5	Sensor Defect Decision Rule	104
4.8	Implementation Aspects	104
4.8.1	Matrix Notation	105
4.8.2	Matrix Decomposition	107
4.8.3	Computational Complexity	110
4.9	Chapter Summary	111
5	Evaluation	113
5.1	Implementations	114
5.2	Human Activity Recognition	114
5.2.1	Experiment Setup	116
	Error Types	118

Confusion Matrix	118
Evaluation Metrics	119
5.2.2 Experiment Results	120
MACRO Results	120
Benchmark Results	124
5.2.3 Discussion of the Results	126
5.3 Condition Monitoring Under Laboratory Conditions	127
5.3.1 Experiment Setup	130
Benchmark Algorithms	131
5.3.2 PU _{static} Data Set Results	133
Benchmark Results	137
5.3.3 PU _{manip} Data Set Results	138
Benchmark Results	143
5.3.4 Discussion of the Results	145
5.4 Information Fusion Robustness Towards Noise	146
5.5 Sensor Defect Detection	149
5.5.1 PU _{static} Data Set Results	150
5.5.2 PU _{manip} Data Set Results	151
5.6 Chapter Summary	152
6 Summary	153
6.1 Conclusion	155
6.2 Future Work	157
6.2.1 Information Fusion System Design	158
6.2.2 Information Fusion System Composition and Adaptation	159
A Foundations of Probability Theory	163
B Foundations of Dempster-Shafer Theory of Evidence	167
C Foundations of Fuzzy Set Theory	171
D Proofs	173
D.1 Proofs of Section 4.4	173
D.2 Proofs of Section 4.5.1	174
D.3 Proofs of Section 4.5.2	177
D.4 Proofs of Section 4.5.3	177
D.5 Proofs of Section 4.8	182
E Compliance of the μBBA Approach with DST	187
F Features Involved in Condition Monitoring Evaluation	191
F1 Static Printing Unit Demonstrator Operation (PU _{static})	191
F2 Manipulated Printing Unit Demonstrator Operation (PU _{manip})	193
F3 Noisy Manipulated Printing Unit Demonstrator Operation (PU _{manip})	195
G Determination of OWA Weights with Desired Andness	201

H	Brief Historical Background	203
H.1	Information Fusion	203
H.2	Fuzzy Set Theory	204
	Bibliography	207
	List of Figures	231
	List of Tables	235
	Theses	239

Information Fusion Under Consideration of Conflicting
Input Signals

Mönks, U.

2017, XIX, 240 p. 58 illus., 35 illus. in color., Softcover

ISBN: 978-3-662-53751-0