



<http://www.phei.com.cn>

# 信息融合理论及应用

Information Fusion Theory With Applications

何友 王国宏 关欣 等著

HE You WANG Guohong GUAN Xin

-----01000101000101001010101001-----



電子工業出版社

PUBLISHING HOUSE OF ELECTRONICS INDUSTRY

国家科学技术学术著作出版基金资助出版  
电子信息科技专著出版专项资金资助出版

# 信息融合理论与应用

**Information Fusion Theory With Applications**

何 友 王国宏 关 欣 等著

HE You WANG Guohong GUAN Xin

电子工业出版社

**Publishing House of Electronics Industry**

北京 · BEIJING

## 内 容 简 介

本书是关于信息融合理论及应用的一部专著,是著者对该领域 20 多年来研究成果系统的、全面的总结。全书由 19 章组成,主要内容有:信息融合概述、信息融合中的数学基础、信源分类与特性、信息融合系统功能和结构模型、分布式检测融合、目标跟踪融合、统计航迹关联算法、模糊与灰色航迹关联算法、状态估计融合、图像融合、目标识别融合、态势估计、威胁估计、知识融合、信息融合中的传感器管理、信息融合中的数据库技术、信息融合中的性能评估,以及信息融合在民事和军事中的应用。最后是本书的回顾、建议与展望。本书可供从事信息工程、C<sup>4</sup>ISR 系统、信息融合、模式识别、人工智能、信息处理、电子对抗、军事指挥等专业的科技人员阅读和参考,也可作为上述专业的研究生教材。同时还可供从事雷达、红外、声呐、激光、机器人、组合导航、智能交通、医学、金融、安保、互联网、遥感、遥测、无线传感器网络等领域的科技工作者学习参考。

未经许可,不得以任何方式复制或抄袭本书之部分或全部内容。  
版权所有,侵权必究。

### 图书在版编目(CIP)数据

信息融合理论及应用 / 何友等著. —北京: 电子工业出版社, 2010.3

ISBN 978-7-121-10323-0

I. 信… II. 何… III. 信息处理 IV.G202

中国版本图书馆 CIP 数据核字(2010)第 022666 号

责任编辑: 王春宁

印 刷: 涿州市京南印刷厂

装 订: 涿州市桃园装订有限公司

出版发行: 电子工业出版社

北京市海淀区万寿路 173 信箱 邮编 100036

开 本: 787×1092 1/16 印张: 37.5 字数: 900 千字

印 次: 2010 年 3 月第 1 次印刷

印 数: 4 000 册 定价: 89.00 元

凡所购买电子工业出版社图书有缺损问题, 请向购买书店调换。若书店售缺, 请与本社发行部联系, 联系及邮购电话: (010) 88254888。

质量投诉请发邮件至 [zltz@phei.com.cn](mailto:zltz@phei.com.cn), 盗版侵权举报请发邮件至 [dbqq@phei.com.cn](mailto:dbqq@phei.com.cn)。

服务热线: (010) 88258888。

# 前 言

信息融合作为多学科交叉融合的新学科和高层次的共性关键技术，由于可以将各信源采集的不完整信息加以综合，减少多源信息间可能存在的冗余和矛盾信息，降低其不确定性，提高智能系统决策、规划、反应的快速性和正确性，自 20 世纪 70 年代以来得到了国内外的广泛重视，并在军事和国民经济各领域得到了广泛应用。

我们在国家自然科学基金、全国百篇优秀博士学位论文作者专项基金（No.200036、No.200443）、教育部高等院校骨干教师项目、国防预研、预研基金、863 计划等的支持下，开展信息融合领域的研究已经 20 多年，形成了一个专门从事信息融合研究的科研团队，在基础理论研究和工程实践方面取得了重要进展。本书第一、第二著者所著的《多传感器信息融合及应用》自 2000 年出版以来，受到广大读者的厚爱和关怀，已印刷了 2 次，并在修改补充新内容的基础上于 2007 年出版了第二版。

自《多传感器信息融合及应用》出版的近十年来，信息融合理论、技术和应用又得到了迅速的发展。基于著者们的研究工作，并借鉴其他学者的成果，本书力图较全面、系统地向读者介绍信息融合理论及在各领域应用的发展与最新研究成果。本书除对《多传感器信息融合及应用》一书中的信息融合系统功能和结构模型、分布式检测与融合、集中式多传感器综合跟踪算法、统计和模糊航迹关联算法、状态估计、目标识别融合模型等内容进行了系统的扩充、完善及发展外，重点增加了信息融合中的数学基础、信源分类与特性、图像融合、知识融合、态势估计、威胁估计、传感器管理、数据库技术、性能评估和实际应用等许多关键理论和新技术，并进行了详细的研究、分析和探讨。本书在三年多的著书过程中历经数次修改、完善，目的是为从事这一领域的读者提供一部较全面、实用的研究和应用参考书。

全书共分 19 章。第 1 章介绍了信息融合定义及其新进展、基本原理、应用领域、研究历史与现状；第 2 章介绍了信息融合中有关数学工具的基础知识，包括线性和非线性系统的状态估计技术、模糊集合理论基础、灰色系统理论基础、粗糙集理论基础、基本的不确定推理方法等；第 3 章讨论了信息融合系统中信源的特性，包括雷达、红外、电子支援措施、激光传感器、声呐以及电子情报，第 2 章和第 3 章是本书的一个重要特点，这些知识对从事该领域理论研究和工程应用的专业人员具有较好的参考价值；第 4 章讨论了融合系统的功能和各融合层次的结构模型；第 5 章描述了分布检测融合理论，包括局部判决融合规则设计、并行结构、串行结构和带反馈并行结构的分布式检测与融合，以及模糊环境下和仅有决策信息时的分布式检测融合；第 6 章研究了各种多传感器多目标跟踪融合算法，主要介绍基本的多传感器联合概率数据互联算法，经典的集中式多传感器联合概率数据互联算法，研究扩展的集中式多传感器联合概率数据互联算法，讨论基于多假设的多传感器多目标跟踪融合算法和基于广义 S-维分配的多传感器多目标跟踪融合算法，并对各种算法进行了仿真比较与分析；第 7 章研究了用于分布式信息融合的统计航迹关联算法，主要讨论加权法、修正法、序贯、统计双门限、最近邻域、K 近邻域、多局部节点情况下和不等样本容量下的航迹关联算法，以及统计航迹关联算法的性能分析和应用等，作为第 7 章的继续，第 8 章提出了分布式融合

中的模糊与灰色航迹关联算法，其中包括模糊双门限、模糊综合函数、模糊综合评判、灰色航迹关联、多局部节点情况下的模糊航迹关联算法和不等样本容量下的模糊、灰色航迹关联算法及其性能分析等；第 9 章讨论了集中式、分布式、混合式和多级式多传感器信息融合系统中的状态估计模型，带反馈信息的分布和多层估计算法等；第 10 章是图像融合，包括简单加权融合算法，基于 IHS 和小波变换的融合算法，基于区域分割和最大期望的图像融合算法，基于特征融合的线状目标提取算法，基于模糊集的决策级图像目标识别算法和融合图像质量的评价方法；第 11 章讨论了目标识别融合，包括基于最大后验概率准则的目标识别融合，基于 D-S 证据理论和 DS<sub>m</sub> 理论的目标识别融合，基于灰色系统理论的融合，基于模糊集合理论的融合和基于属性测度理论，粗糙集理论的融合算法等；第 12 章讨论了信息融合中的态势估计，主要包括基于群的态势表示方法、态势预测、态势关联和态势评估；第 13 章讨论了信息融合中的威胁估计，主要包括威胁估计的分类和内容，威胁估计知识库，基于层次分析法的威胁估计，基于多因子综合加权的威胁估计，基于模糊多属性决策的威胁估计，以及基于神经网络和遗传算法的威胁估计等；第 14 章讨论了知识融合定义和体系结构，不确定知识的数据挖掘方法以及具体的知识融合算法；第 15 章讨论了信息融合中的传感器管理技术，包括传感器的微管理和宏管理，被动传感器对主动传感器的指示和引导，机载多传感器系统中的雷达辐射控制，多传感器组网系统中的地理位置优化配置等；第 16 章介绍了信息融合中的数据库技术，描述了应用于信息融合系统的数据库模型，并对如何设计数据库进行了讨论；第 17 章讨论了信息融合中的性能评估，主要包括信息融合性能评估指标体系和信息融合性能评估的方法；第 18 章介绍了信息融合在民事和军事上的实际应用；第 19 章回顾和总结了本著作的研究成果，并对某些问题提出进一步的研究建议，同时指出了信息融合领域未来的发展方向。

本书由何友教授、王国宏教授、关欣副教授、柴勇博士、熊伟副教授、衣晓副教授执笔，并由何友教授对全书进行了统稿。在成书的过程中，得到了张晶炜博士、宋强博士生、白晶博士生和胡丽芳博士生的帮助。同时，修建娟副教授、王海鹏博士生、王本才博士生、王娜博士生等参加了本书的校对工作。

信息融合理论与应用正处在迅速发展的阶段，本书也难以对这些发展做出统揽无余的介绍。为此，我们在每章的最后都给出了全章的小结，指出一些重要的新发展和相应的参考文献。我们热切地希望这本专著能够帮助学生和专业技术人员学习、应用和喜欢信息融合。

本书获得国家科学技术学术著作出版基金资助。本书在撰写和出版过程中，得到了国内著名电子学专家郭桂蓉院士、沈昌祥院士、钟山院士的推荐和帮助，著者在此向他们表示衷心感谢。书中引用了一些同行作者的论著及研究成果，在此向他们表示深深的谢意。著者同样要感谢海军航空工程学院同仁和电子工业出版社，特别是电子工业出版社的王春宁编辑，正是由于他们的大力支持才保证了本书按期高质量出版。

恳请广大读者热诚地关注、支持本书，并提出宝贵的意见和建议。

联系人：关欣；E-mail: gxtongwin@163.com；联系地址：山东烟台海军航空工程学院信息融合研究所（264001）。

何友 王国宏 关欣

二〇〇九年十一月于烟台海军航空工程学院

# Abstract

This book is a monograph about information fusion theory and its applications, which presents a systematic and comprehensive summation of the research highlights produced by the authors in this field during the last two decades. The book comprises 19 chapters, focusing on an introduction of information fusion, mathematic bases in information fusion, classifications and characteristics of sensors and information source, functional and architectural models of information fusion system, distributed detection fusion, target tracking fusion algorithms, statistical track association algorithms for distributed data fusion, fuzzy and gray track association algorithms, state estimate fusion, image fusion, target identification fusion, situation estimation, threat assessment, knowledge fusion, sensor management in information fusion, database techniques in information fusion, performance evaluation of information fusion, and civil and military applications of information fusion. The final part of the book provides a review of this book, puts forth suggestions for further research, and presents some prospects for information fusion theory.

This book can serve as reference for scientific and technical staffs engaged in information engineering, C<sup>4</sup>ISR system, information fusion, pattern identification, artificial intelligence, signal processing, electronic countermeasure, and military command, and can also serve as a textbook for technological personnel and graduate students of the professions mentioned above. It will also be of value to engineering staffs in such fields as radar, infrared, sonar, laser, robot, integrated navigation, intelligent traffic, medicine, finance, public security, internet, remote sensing and measure, and wireless sensor network.

# Foreword

As a high-level and commonly applicable key technology and a new subject of study that crosses and fuses many different disciplines, information fusion can integrate partial information collected from different sources, and decrease potential redundant and incompatible information between multisource information, thus reducing uncertainties and enhancing the speediness and correctness of decision-making, planning and reaction of high intelligence systems. Therefore, it has drawn wide attention both at home and abroad since the 1970s and has found wide applications in military as well as civil domains.

We have carried on the research in this domain for more than 20 years with the support of National Natural Science Foundation of China, Excellent Ph.D Paper Author Foundation of China (Grant No.200036、 Grant No. 200443), Foundation for University Key Teacher by the Ministry of Education, National Defence Budgetary Foundation of China, Budgetary Fund, and the 863 Program. We have set up a research team specializing in information fusion research, and have gained important progress in basic theoretical research and engineering application. *Multisensor Information Fusion with Applications*, written by the first and second authors of this book, has won great favor among many readers since it was published in 2000, and has since been printed twice. The authors revised the book and supplemented it with some new contents in order to satisfy the keen needs of many readers, and the second edition was published in 2007.

Information fusion theory, technology and applications have been in rapid development since *Multisensor Information Fusion with Applications* was published nearly ten years ago. Based on the research work of the authors and the research results of other researchers, this book tries to present a comprehensive and systematic introduction of the development and latest research results on information fusion theory and its applications in various domains. In addition to the systematic expansion, perfection and updating of contents concerning functional and architectural models of information fusion systems, distributed detection fusion, centralized multisensor joint tracking fusion algorithms, statistical and fuzzy track association algorithms, state estimate fusion, and target identification fusion modes included in *Multisensor Information Fusion with Applications*, this book has been supplemented with relevant critical theories and technologies with detailed study, analyses and discussions. The supplemented contents include mathematic bases in information fusion, classifications and characteristics of information sources, image fusion, knowledge fusion, situation estimation, threat assessment, sensor management in information fusion, database techniques in information fusion, performance evaluation of information fusion, and practical applications of information fusion. It has taken more than three years to finish the book, during which time it was revised and modified time and again for consummation in order to provide readers working in this field with a comprehensive and practical research and reference book.

This book is composed of nineteen chapters. Chapter 1 defines information fusion and introduces new progress, basic principles, application domains, and history and current state of information fusion. Chapter 2 introduces basic knowledge of mathematic tools concerned in information fusion, including state estimate technology in linear and nonlinear system, the basics of fuzzy set theory, gray system theory and rough set theory, and uncertainty reasoning methods. Chapter 3 discusses the characteristics of information sources in information fusion system, including radar, infrared, electronics supporting measure(ESM), laser, sonar, and electronic intelligence. Chapter 2 and Chapter 3 are the good reference value to specialists in theoretical research and engineering application. Chapter 4 discusses the functional and architectural models of information fusion systems. Chapter 5 describes distributed detection fusion theory, including local decision fusion rule design, distributed detection fusion in parallel network, distributed detection fusion in serial network, distributed detection fusion in parallel network with feedback, and distributed detection fusion with only decision information and in fuzzy environment. Chapter 6 studies various multisensor multitarget tracking fusion algorithms, introducing mainly basic multisensor joint probabilistic data association algorithms, classical centralized multisensor joint probabilistic data association algorithms, extended centralized multisensor joint probabilistic data association algorithms, multisensor multitarget tracking fusion algorithms based on multiple hypothesis, multisensor multitarget tracking fusion algorithms based on generalized S-D assignment technique, and making simulation comparison among and analysis of various algorithms. Chapter 7 studies statistical track association algorithms for distributed data fusion, including weighted and modified track association algorithms, sequential track association algorithms, statistical binary track association algorithms, nearest neighbor and K-nearest neighbor track association algorithms, statistical track association algorithms in an environment of multiple local nodes, statistical track association for unequal sample size situation, and performance analysis and applications of statistical track association algorithms. As a continuation of Chapter 7, Chapter 8 puts forward fuzzy and gray track association algorithms for distributed data fusion, including fuzzy track association with dual thresholds, track association based on fuzzy synthetic functions, track association algorithms based on fuzzy synthetic decisions, gray track association algorithms, fuzzy track association algorithms for multiple local nodes, fuzzy and gray track association algorithms for unequal sample size situation, and performance analysis of them . Chapter 9 discusses state estimate fusion in centralized, distributed, hybrid, and multilevel multisensor systems. Chapter 10 is about image fusion, including weighted image fusion algorithms, image fusion algorithms based on IHS transform and wavelet transform, image fusion algorithms based on segmentation and maximum expectation, linear target extraction based on feature image fusion, decision level target identification based on fuzzy set, and performance evaluation of image fusion. Chapter 11 discusses target identification fusion, including target identification fusion algorithms based on maximum a posteriori probability criterion, D-S evidential theory, Dezert-Smarandache theory, gray system theory, target identification fusion algorithms based on fuzzy set theory, attribute measure theory, and rough set. Chapter 12 discusses situation estimation in information



fusion, including situation description based on group, situation forecast, situation association and situation evaluation. Chapter 13 discusses threat assessment in information fusion, including the classification and contents of threat assessment, knowledge base of threat assessment, threat assessment based on analytic hierarchy process, threat assessment based on fuzzy integrated evaluation with multiple elements, threat assessment based on fuzzy multiattribute decision, and threat assessment based on neural network and genetic algorithm. Chapter 14 discusses the definition and architecture of knowledge fusion, data mining methods of uncertain knowledge, and material knowledge fusion algorithms. Chapter 15 discusses sensor management in information fusion, which involves micro-management and macro-management for sensors, indication and cueing of passive sensor to active sensor, radar radiation control in multisensor systems, and optimum sensor deployment in radar network. Chapter 16 introduces database techniques in information fusion, and describes database models applied in information fusion systems, and then discusses how to design database. Chapter 17 discusses performance evaluation of information fusion, including performance index for information fusion evaluation and performance evaluation methods for information fusion. Chapter 18 introduces civil and military applications of information fusion. Chapter 19 reviews and summarizes research results of this book, and puts forward suggestions for further research about some problems, and points out the trends of future development of information fusion domain.

This book has been written by Professor He You, Professor Wang Guohōng, Associate Professor Guan Xin, Doctor Chai Yong, Associate Professor Xiong Wei and Associate Professor Yi Xiao. Professor He You has compiled and revised the full book rigorously and carefully. Doctor Zhang Jingwei, Ph.D. candidate Song Qiang, Ph.D. candidate Bai Jing and Ph.D. candidate Hu Lifang offered their help in the course of writing this book. Associate Professor Xiu Jianjuan, Ph.D. candidate Wang Haipeng, Ph.D. candidate Wang Bencai, Ph.D. candidate Wang Na, et al. proof-readed this book.

Information fusion theory with applications is in rapid development, and it is hard to make a very detailed introduction of these developments in one book. For this reason, we provide a summary at the end of each chapter, and point out some new important developments and related references. We hope this book can help students and professional personnel to study and apply information fusion.

This book is supported by the National Scientific and Technological Academic Writing Publish Foundation. The authors would like to extend their thanks to Academician Guo Guirong, Academician Shen Changxiang and Academician Zhong Shan for their recommendation and help in the course of writing the books. The authors would also like to give their thanks to those authors who gave their permission to reproduce copyright material. The authors would like to acknowledge the contributions of fellow teachers in Naval Aeronautical and Astronautical University and the Electronics Industry Publishing House, especially Editor Wang Chuning from the Electronics Industry Publishing House. Thanks to their energetic support, this book can be published in high quality.

The authors sincerely hope readers can support this book, and put forward their valuable suggestions.

Contact: Guan Xin.

E-mail: [gxtongwin@163.com](mailto:gxtongwin@163.com).

Contact address: Research Inst. of Information Fusion, Naval Aeronautical Astronautical University (264001) .

HE You, WANG Guohong, GUAN Xin

Naval Aeronautical and Astronautical University, Yantai, China, November, 2009

# 主要作者简历

**何友**生于1956年10月，男，吉林磐石人，1982年毕业于海军工程大学指控系统专业，获学士学位，1988年在该校火力控制系统专业获硕士学位，1991年10月至1992年11月在德国不伦瑞克工业大学作高级访问学者，1997年在清华大学通信与信息系统专业获博士学位。现为烟台海军航空工程学院院长、教授、博士生导师，清华大学兼职教授，中国航空学会常务理事，中国电子学会会士，首届全国信息融合学术年会大会主席，中国电子学会无线电定位技术分会副主任委员、信号处理分会委员，中国造船学会电子技术委员会委员，国家“863”专家，总装备部专业组成员，山东省学位委员会委员，《雷达科学与技术》、《舰船电子工程》编委会副主任委员，《现代雷达》、《数据采集与处理》、《火力与指挥控制》等杂志编委。主要研究领域有雷达自适应检测方法、信息融合、多目标跟踪、分布检测理论及应用、系统仿真与作战模拟等。在国内外核心期刊和重要国际会议上发表论文200余篇，有150余篇论文被SCI、EI和ISTP等国际检索收录，出版专著6部。科研成果获国家科技进步二等奖2项，获军队科技进步一等奖5项，二等奖5项，三等奖20项，国防发明专利6项。获国家级教学成果二等奖1项，省部级教学成果一等奖2项、二等奖1项。荣立二等功4次、三等功2次。1999年入选国家“百千万人才工程”第一、二层次，2000年获“全国优秀博士学位论文奖”和中国科协“求是杰出青年实用工程奖”，2001年被教育部授予“全国优秀教师”称号，享受政府特殊津贴，2003年被授予“全国留学回国人员先进个人”荣誉称号，并获“全国留学回国人员成就奖”。2006年获中国人民解放军专业技术重大贡献奖。2007年当选“十七大”党代表。被评为全军和山东省优秀研究生指导教师。

**王国宏**生于1963年10月，男，山西沁水人。分别于海军航空工程学院、西安电子科技大学和北京航空航天大学获学士、硕士和博士学位，2002-2004年在中电集团公司第十四研究所博士后工作站做博士后研究。现任海军航空工程学院电子信息工程系副主任、教授、博士生导师、中国电子学会无线电定位分会委员、国家自然科学基金委员会第十二届评审专家、海军第二届电子信息预研专家组成员。先后荣立二等功、三等功各1次。2004年获第六届百篇“全国优秀博士学位论文”奖；2005年被国家人事部和全国博士后管委会授予“全国优秀博士后”称号；2006年获国务院政府特殊津贴、军队优秀专业技术人才一类岗位津贴；2007年被山东省人民政府确定为“泰山学者”特聘教授；2009年被评为“山东省研究生教育管理与学科建设先进个人”。获国家科技进步二等奖1项、军队科技进步一等奖3项、二等奖2项、三等奖6项，省部级教学成果一等奖1项、二等奖1项、三等奖1项。出版专著4部，其中2部获国家科学技术学术著作出版基金资助，1部获全国优秀博士学位论文出版基金资助。在国内外刊物及国际会议上发表学术论文160余篇，被国际三大检索收录70余篇，获发明专利2项。

**He You** was born in Panshi, Jilin Province, P.R. China, 1956. He received the B.S. degree in electronic engineering and the M.S. degree in computer science from Huazhong University of Science and Technology at Wuhan, P.R. China, in 1982 and 1988, respectively. From October 1991 to November 1992, he was with the Institute of Communication at Technical University of Braunschweig, Germany, where he carried out automatic radar detection theory and CFAR algorithm studies. From November 1992 to December 1994, he was an associate professor in the Department of Electronic Engineering at Technical University of Yantai, China. Then, he received the Ph.D. degree in communication and information systems from Tsinghua University in 1997. He is currently Chancellor, Professor, Doctor Tutor of Naval Aeronautical and Astronautical University, as well as Part-time Professor of Tsinghua University. He also served as a managing director of Chinese Aviation Society, a fellow member of Chinese Institute of Electronics and a member in a large range of professional and social organizations. Moreover, he was the founder of the National Conference on Information Fusion, and served as General Chairman in 2009.

His research interests include detection and estimation theory, digital signal processing, CFAR processing, distributed detection theory, pattern recognition, multiple target tracking and multisensor information fusion. Dr. He has published over two hundred research articles in various journals, conference proceedings and books. He was the coauthor of the books *Automatic radar detection and CFAR techniques* (Tsinghua University Press, 1999), *Multisensor Information Fusion with Applications* (Publishing House of Electronics Industry, 2000), *Radar Data Processing with Applications* (Publishing House of Electronics Industry, 2006) and other three books. He currently serves on the editorial boards of *Journal of Data Acquisition & Processing*, *Modern Radar*, *Fire Control & Command Control*, *Ship Electronic Engineering* and *Radar Science and Technology*.

**Wang Guohong** was born in Shanxi Province in 1963. He received his bachelor degree, master degree and PhD degree in 1983, 1991 and 2002, respectively. He is now a professor and has published over 160 papers. He gained the Award of the National Excellent Doctoral Dissertation in 2004 and the Special Allowance of the Chinese State Department in 2006. He was named as the Taishan Scholar Professor by the government of Shandong Province in 2007. His research areas include information fusion, target tracking and target identification.

# 目 录

<b>第 1 章 信息融合概述</b> .....	(1)
1.1 信息融合的定义 .....	(1)
1.2 信息融合的原理与级别 .....	(2)
1.3 信息融合的效益 .....	(7)
1.4 信息融合的应用 .....	(8)
1.5 信息融合研究的历史与现状 .....	(13)
1.6 本书的范围和概貌 .....	(16)
1.7 背景资料 .....	(18)
<b>第 2 章 信息融合中的数学基础</b> .....	(19)
2.1 引言 .....	(19)
2.2 统计数学理论基础 .....	(19)
2.3 模糊数学理论基础 .....	(44)
2.4 灰色系统理论基础 .....	(49)
2.5 粗糙集理论基础 .....	(52)
2.6 不确定性推理方法 .....	(55)
2.7 小结 .....	(68)
<b>第 3 章 信源分类与特性</b> .....	(69)
3.1 引言 .....	(69)
3.2 信源分类 .....	(69)
3.3 雷达及其特性 .....	(70)
3.4 双/多基地雷达及其特性 .....	(74)
3.5 合成孔径雷达 (SAR) 及其特性 .....	(77)
3.6 逆合成孔径雷达 (ISAR) 及其特性 .....	(78)
3.7 红外传感器及其特性 .....	(80)
3.8 电子支援措施 (ESM) 及其特性 .....	(83)
3.9 激光传感器及其特性 .....	(86)
3.10 声呐及其特性 .....	(87)
3.11 电子情报 (ELINT) 及其特性 .....	(88)
3.12 GPS 及其特性 .....	(89)
3.13 小结 .....	(90)
<b>第 4 章 信息融合系统功能和结构模型</b> .....	(91)
4.1 引言 .....	(91)
4.2 信息融合系统的功能模型 .....	(91)

4.3	信息融合系统的结构模型 .....	(95)
4.4	小结 .....	(102)
<b>第 5 章</b>	<b>分布式检测融合 .....</b>	<b>(104)</b>
5.1	引言 .....	(104)
5.2	并行结构中的分布式检测融合 .....	(104)
5.3	串行结构中的分布检测与融合 .....	(116)
5.4	反馈并联网络中的分布检测与融合 .....	(121)
5.5	基于恒虚警率 (CFAR) 约束的分布检测 .....	(126)
5.6	小结 .....	(133)
<b>第 6 章</b>	<b>目标跟踪融合 .....</b>	<b>(135)</b>
6.1	引言 .....	(135)
6.2	集中式多传感器联合概率数据互联算法 .....	(135)
6.3	扩展的集中式多传感器联合概率数据互联算法 .....	(145)
6.4	基于多假设的多传感器多目标跟踪融合算法 .....	(150)
6.5	基于广义 S-维分配的多传感器多目标跟踪融合算法 .....	(160)
6.6	各种多传感器多目标跟踪融合算法仿真分析 .....	(168)
6.7	小结 .....	(177)
<b>第 7 章</b>	<b>分布式信息融合中的统计航迹关联 .....</b>	<b>(178)</b>
7.1	引言 .....	(178)
7.2	加权和修正航迹关联算法 .....	(179)
7.3	序贯航迹关联算法 .....	(180)
7.4	统计双门限航迹关联算法 .....	(189)
7.5	最近邻域和 K 近邻域航迹关联算法 .....	(194)
7.6	修正的 K 近邻域航迹关联算法 .....	(195)
7.7	多局部节点情况下的统计航迹关联算法 .....	(202)
7.8	不等样本容量下基于统计理论的航迹关联算法 .....	(220)
7.9	统计航迹关联算法性能分析 .....	(223)
7.10	在空中交通管制中的应用 .....	(232)
7.11	比较与结论 .....	(235)
<b>第 8 章</b>	<b>分布式信息融合中的模糊与灰色航迹关联 .....</b>	<b>(239)</b>
8.1	引言 .....	(239)
8.2	模糊因素集与隶属度函数 .....	(239)
8.3	模糊因素的确定与模糊集的动态分配 .....	(241)
8.4	模糊双门限航迹关联算法 .....	(242)
8.5	基于模糊综合函数的航迹关联算法 .....	(244)
8.6	多因素模糊综合决策航迹关联算法 .....	(248)
8.7	灰色航迹关联算法 .....	(251)
8.8	多局部节点情况下的模糊与灰色航迹关联 .....	(252)
8.9	不等样本容量下基于模糊综合分析的航迹关联 .....	(255)

8.10	不等样本容量下的灰色航迹关联 .....	(257)
8.11	模糊与灰色航迹关联算法的性能分析 .....	(260)
8.12	小结 .....	(265)
<b>第9章</b>	<b>状态估计融合 .....</b>	<b>(267)</b>
9.1	引言 .....	(267)
9.2	系统方程描述 .....	(268)
9.3	集中式状态估计融合 .....	(270)
9.4	分布式状态估计融合 .....	(275)
9.5	混合式状态估计融合 .....	(282)
9.6	多级式状态估计融合 .....	(285)
9.7	带反馈信息的分布估计融合 .....	(290)
9.8	带反馈信息的多层估计融合 .....	(297)
9.9	异步状态估计融合 .....	(300)
9.10	小结 .....	(307)
<b>第10章</b>	<b>图像融合 .....</b>	<b>(309)</b>
10.1	引言 .....	(309)
10.2	图像融合基础理论 .....	(310)
10.3	像素级图像融合 .....	(314)
10.4	特征级图像融合 .....	(321)
10.5	决策级图像融合 .....	(329)
10.6	图像融合效果评价 .....	(331)
10.7	小结 .....	(335)
<b>第11章</b>	<b>目标识别融合 .....</b>	<b>(336)</b>
11.1	引言 .....	(336)
11.2	基于灰色系统理论的目标识别融合算法 .....	(336)
11.3	基于模糊集合理论的目标识别融合算法 .....	(340)
11.4	基于属性测度理论的目标识别融合算法 .....	(350)
11.5	基于粗糙集理论的目标识别融合算法 .....	(357)
11.6	基于D-S证据理论的目标识别融合算法 .....	(360)
11.7	基于DSmT的目标识别融合算法 .....	(364)
11.8	基于最大后验概率准则的目标识别融合算法 .....	(368)
11.9	小结 .....	(369)
<b>第12章</b>	<b>态势估计 .....</b>	<b>(370)</b>
12.1	引言 .....	(370)
12.2	基于群的态势表示方法 .....	(371)
12.3	态势预测 .....	(374)
12.4	态势关联 .....	(379)
12.5	态势评估 .....	(380)
12.6	应用实例 .....	(389)

12.7	小结 .....	(392)
<b>第 13 章</b>	<b>威胁估计</b> .....	(393)
13.1	引言 .....	(393)
13.2	威胁估计的应用和分类 .....	(393)
13.3	威胁估计中的知识库 .....	(395)
13.4	基于层次分析法的威胁估计 .....	(400)
13.5	基于多因子综合加权的威胁估计 .....	(404)
13.6	基于模糊多属性决策的威胁估计 .....	(411)
13.7	基于神经网络和遗传算法的威胁估计 .....	(415)
13.8	小结 .....	(418)
<b>第 14 章</b>	<b>知识融合</b> .....	(419)
14.1	引言 .....	(419)
14.2	信息融合中的知识融合 .....	(419)
14.3	知识融合的体系结构 .....	(422)
14.4	不确定知识的数据挖掘方法 .....	(424)
14.5	基于融合规则的知识融合算法 .....	(438)
14.6	基于粗糙集理论的知识融合算法 .....	(441)
14.7	小结 .....	(443)
<b>第 15 章</b>	<b>信息融合中的传感器管理</b> .....	(444)
15.1	引言 .....	(444)
15.2	传感器的微管理和宏管理 .....	(445)
15.3	被动传感器对主动传感器的指示和引导 .....	(448)
15.4	多传感器系统中的雷达辐射控制 .....	(449)
15.5	异类被动传感器的协同工作 .....	(452)
15.6	多传感器被动定位系统中的交会角优化控制 .....	(454)
15.7	基于 CRLB 的传感器位置优化配置 .....	(457)
15.8	基于最大期望效用的传感器管理 .....	(460)
15.9	基于市场架构的多传感器管理 (MASM) .....	(463)
15.10	小结 .....	(464)
<b>第 16 章</b>	<b>信息融合中的数据库技术</b> .....	(465)
16.1	引言 .....	(465)
16.2	数据库模型 .....	(466)
16.3	信息融合中的数据库要求 .....	(469)
16.4	数据库设计 .....	(473)
16.5	数据库应用举例 .....	(481)
16.6	小结 .....	(484)
<b>第 17 章</b>	<b>信息融合中的性能评估</b> .....	(485)
17.1	引言 .....	(485)
17.2	信息融合性能评估指标体系 .....	(485)



17.3	信息融合性能评估的方法 .....	(490)
17.4	信息融合性能评估举例 .....	(493)
17.5	小结 .....	(503)
<b>第 18 章</b>	<b>信息融合在民事和军事中的应用 .....</b>	<b>(504)</b>
18.1	引言 .....	(504)
18.2	智能驾驶系统 .....	(504)
18.3	网络中心战 .....	(505)
18.4	反潜战 .....	(507)
18.5	全源信息分析系统 .....	(510)
18.6	瑞典战术情报处理信息融合演示验证系统 .....	(514)
18.7	小结 .....	(518)
<b>第 19 章</b>	<b>回顾、建议与展望 .....</b>	<b>(519)</b>
19.1	引言 .....	(519)
19.2	研究成果回顾 .....	(519)
19.3	问题与建议 .....	(523)
19.4	研究方向展望 .....	(525)
<b>英文缩写对照表 .....</b>		<b>(530)</b>
<b>参考文献 .....</b>		<b>(535)</b>