Advances In Statistical Multisource Multitarget Information Fusion

This book features the outcomes of the 16th International Conference on Distributed Computing and Artificial Intelligence 2019 (DCAI 2019), which is a forum to present applications of innovative techniques for studying and solving complex problems in artificial intelligence and computing. The exchange of ideas between scientists and technicians from both the academic and industrial sectors is essential to facilitate the development of systems that can meet the ever-increasing demands of today's society. This book brings together lessons learned, current work and promising future trends associated with distributed computing, artificial intelligence and their application to provide efficient solutions to real-world problems. The book includes 29 high-quality and diverse contributions in established and emerging areas of research presented at the symposium organized by the Osaka Institute of Technology, Hiroshima University, University of Granada and University of Salamanca, which was held in Ávila, Spain, from 26th–28th June 2019

Session 1 includes 109 papers selected from 2011 3rd International Asia Conference on Informatics in Control, Automation and Robotics (CAR 2011), held on December 24-25, 2011, Shenzhen, China. This session will act as an international forum for researchers and practitioners interested in the advances in and applications of Intelligent Control Systems. It is an opportunity to present and observe the latest research, results, and ideas in these areas. Intelligent control is a rapidly developing, complex, and challenging field of increasing practical importance and still greater potential. Its applications have a solid core in robotics and mechatronics but branch out into areas as diverse as process control, automotive industry, medical equipment, renewable energy and air conditioning. So, this session will aim to strengthen relationships between industry, research laboratories and universities. All papers published in session 1 will be peer evaluated by at least two conference reviewers. Acceptance will be based primarily on originality and contribution.

Multisensor Data Fusion: From Algorithms and Architectural Design to Applications covers the contemporary theory and practice of multisensor data fusion, from fundamental concepts to cutting-edge techniques drawn from a broad array of disciplines. Featuring contributions from the world's leading data fusion researchers and academicians, this authoritative book: Presents state-of-the-art advances in the design of multisensor data fusion algorithms, addressing issues related to the nature, location, and computational ability of the sensors Describes new materials and achievements in optimal fusion and multisensor filters Discusses the advantages and challenges associated with multisensor data fusion, from extended spatial and temporal coverage to imperfection and diversity in sensor technologies Explores the topology, communication structure, computational resources, fusion level, goals, and optimization of multisensor data fusion system architectures Showcases applications of multisensor data fusion in fields such as medicine, transportation's traffic, defense, and navigation Multisensor Data Fusion: From Algorithms and Architectural Design to Applications is a robust collection of modern multisensor data fusion methodologies. The book instills a deeper understanding of the basics of multisensor data fusion as well as a practical knowledge of the problems that can be faced during its execution.

The book presents some of the most efficient statistical and deterministic methods for information processing and applications in order to extract targeted information and find hidden patterns. The techniques presented range from Bayesian approaches and their variations such as sequential Monte Carlo methods, Markov Chain Monte Carlo filters, Rao Blackwellization, to the biologically inspired paradigm of Neural Networks and decomposition techniques such as Empirical Mode Decomposition, Independent Component Analysis and Singular Spectrum Analysis. The book is directed to the research students, professors, researchers and practitioners interested in exploring the advanced techniques in intelligent signal processing and data mining paradigms.

Advances in Statistical Multisource-Multitarget Information FusionArtech House

This book discusses state estimation of stochastic dynamic systems from noisy measurements, specifically sequential Bayesian estimation and nonlinear or stochastic filtering. The class of solutions presented in this book is based on the Monte Carlo statistical method. Although the resulting algorithms, known as particle filters, have been around for more than a decade, the recent theoretical developments of sequential Bayesian estimation in the framework of random set theory have provided new opportunities which are not widely known and are covered in this book. This book is ideal for graduate students, researchers, scientists and engineers interested in Bayesian estimation.

Time-Frequency Signal Analysis and Processing (TFSAP) is a collection of theory, techniques and algorithms used for the analysis and processing of non-stationary signals, as found in a wide range of applications including telecommunications, radar, and biomedical engineering. This book gives the university researcher and R&D engineer insights into how to use TFSAP methods to develop and implement the engineering application systems they require. New to this edition: New sections on Efficient and Fast Algorithms; a "Getting Started" chapter enabling readers to start using the algorithms on simulated and real examples with the TFSAP toolbox, compare the results with the ones presented in the book and then insert the algorithms in their own applications and adapt them as needed. Two new chapters and twenty three new sections, including updated references. New topics including: efficient algorithms for optimal TFDs (with source code), the enhanced spectrogram, time-frequency modelling, more mathematical foundations, the relationships between QTFDs and Wavelet Transforms, new advanced applications such as cognitive radio, watermarking, noise reduction in the time-frequency domain, algorithms for Time-Frequency Image Processing, and Time-Frequency applications in neuroscience (new chapter). A comprehensive tutorial introduction to Time-Frequency Signal Analysis and Processing (TFSAP), accessible to anyone who has taken a first course in signals Key advances in theory, methodology and algorithms, are concisely presented by some of the leading authorities on the respective topics Applications written by leading researchers showing how to use TFSAP methods

This exciting new resource investigates the function of RF communication in electronic warfare systems. The book provides in-depth coverage of how RF signals must be constructed to perform jamming missions, which prevent a receiver from properly extracting a target signal. Technical descriptions of oscillators and modulators, which generate the RF signals, are presented and explored. Power supplies that generate adequate power for fueling high power amplifiers are also described and their

operations investigated. Oscillator basics, including principles of oscillator operation, phase locked loop synthesizers and direct digital synthesis are examined. Fundamentals of RF communications, including power supplies for RF power amplifiers, are included, making it useful for both novice and advanced practitioners. Written by a prominent expert in the field, this authoritative book is the first available that combines the topics of electronic warfare and oscillator design and analysis.

The adaptive configuration of nodes in a sensor network has the potential to improve sequential estimation performance by intelligently allocating limited sensor network resources. In addition, the use of heterogeneous sensing nodes provides a diversity of information that also enhances estimation performance. This work reviews cognitive systems and presents a cognitive fusion framework for sequential state estimation using adaptive configuration of heterogeneous sensing nodes and heterogeneous data fusion. This work also provides an application of cognitive fusion to the sequential estimation problem of target tracking using foveal and radar sensors.

A unique guide to the state of the art of tracking, classification, and sensor management This book addresses the tremendous progress made over the last few decades in algorithm development and mathematical analysis for filtering, multi-target multi-sensor tracking, sensor management and control, and target classification. It provides for the first time an integrated treatment of these advanced topics, complete with careful mathematical formulation, clear description of the theory, and real-world applications. Written by experts in the field, Integrated Tracking, Classification, and Sensor Management provides readers with easy access to key Bayesian modeling and filtering methods, multi-target tracking approaches, target classification procedures, and large scale sensor management problem-solving techniques. Features include: An accessible coverage of random finite set based multi-target filtering algorithms such as the Probability Hypothesis Density filters and multi-Bernoulli filters with focus on problem solving A succinct overview of the track-oriented MHT that comprehensively collates all significant developments in filtering and tracking A state-of-the-art algorithm for hybrid Bayesian network (BN) inference that is efficient and scalable for complex classification models New structural results in stochastic sensor scheduling and algorithms for dynamic sensor scheduling and management Coverage of the posterior Cramer-Rao lower bound (PCRLB) for target tracking and sensor management Insight into cutting-edge military and civilian applications, including intelligence, surveillance, and reconnaissance (ISR) With its emphasis on the latest research results, Integrated Tracking, Classification, and Sensor Management is an invaluable guide for researchers and practitioners in statistical signal processing, radar systems, operations research, and control theory.

This text reviews the fundamental theory and latest methods for including contextual information in fusion process design and implementation. Chapters are contributed by the foremost international experts, spanning numerous

developments and applications. The book highlights high- and low-level information fusion problems, performance evaluation under highly demanding conditions, and design principles. A particular focus is placed on approaches that integrate research from different communities, emphasizing the benefit of combining different techniques to overcome the limitations of a single perspective. Features: introduces the terminology and core elements in information fusion and context; presents key themes for context-enhanced information fusion; discusses design issues in developing context-aware fusion systems; provides mathematical grounds for modeling the contextual influences in representative fusion problems; describes the fusion of hard and soft data; reviews a diverse range of applications.

This book provides a modern introductory tutorial on specialized theoretical aspects of spatial and temporal modeling. The areas covered involve a range of topics which reflect the diversity of this domain of research across a number of quantitative disciplines. For instance, the first chapter provides up-to-date coverage of particle association measures that underpin the theoretical properties of recently developed random set methods in space and time otherwise known as the class of probability hypothesis density framework (PHD filters). The second chapter gives an overview of recent advances in Monte Carlo methods for Bayesian filtering in high-dimensional spaces. In particular, the chapter explains how one may extend classical sequential Monte Carlo methods for filtering and static inference problems to high dimensions and big-data applications. The third chapter presents an overview of generalized families of processes that extend the class of Gaussian process models to heavy-tailed families known as alpha-stable processes. In particular, it covers aspects of characterization via the spectral measure of heavy-tailed distributions and then provides an overview of their applications in wireless communications channel modeling. The final chapter concludes with an overview of analysis for probabilistic spatial percolation methods that are relevant in the modeling of graphical networks and connectivity applications in sensor networks, which also incorporate stochastic geometry features.

Future technical systems will be companion systems, competent assistants that provide their functionality in a completely individualized way, adapting to a user's capabilities, preferences, requirements, and current needs, and taking into account both the emotional state and the situation of the individual user. This book presents the enabling technology for such systems. It introduces a variety of methods and techniques to implement an individualized, adaptive, flexible, and robust behavior for technical systems by means of cognitive processes, including perception, cognition, interaction, planning, and reasoning. The technological developments are complemented by empirical studies from psychological and neurobiological perspectives.

Advances in digital signal processing algorithms and computer technology have combined to produce real-time systems with capabilities far beyond those of just

few years ago. Nonlinear, adaptive methods for signal processing have emerged to provide better array gain performance, however, they lack the robustness of conventional algorithms. The challenge remains to develop a concept that exploits the advantages of both-a scheme that integrates these methods in practical, real-time systems. The Advanced Signal Processing Handbook helps you meet that challenge. Beyond offering an outstanding introduction to the principles and applications of advanced signal processing, it develops a generic processing structure that takes advantage of the similarities that exist among radar, sonar, and medical imaging systems and integrates conventional and nonlinear processing schemes.

This book is a printed edition of the Special Issue "UAV-Based Remote Sensing" that was published in Sensors

Information fusion refers to the merging of information from disparate sources with differing conceptual, contextual and typographical representations. Rather than focusing on traditional data fusion applications which have been mainly concerned with physical military targets, this unique resource explores new human-centered trends, such as locations, identity, and interactions of individuals and groups (social networks). Moreover, the book discusses two new major sources of information: human observations and web-based information.This cutting-edge volume presents a new view of multi-sensor data fusion that seeks to address these new developments, explicitly considering the active role of a human user/analyst. Professionals become knowledgeable about the key inputs into this innovative information fusion process, including traditional sensing resources (S-space), dynamic communities of human observers (H-space), and resources such as archived sensor data, blogs, and dynamic news reports from citizen reporters via the Internet (I-space).

In the human quest for scientific knowledge, empirical evidence is collected by visual perception. Tracking with computer vision takes on the important role to reveal complex patterns of motion that exist in the world we live in. Multi-object tracking algorithms provide new information on how groups and individual group members move through three-dimensional space. They enable us to study in depth the relationships between individuals in moving groups. These may be interactions of pedestrians on a crowded sidewalk, living cells under a microscope, or bats emerging in large numbers from a cave. Being able to track pedestrians is important for urban planning; analysis of cell interactions supports research on biomaterial design; and the study of bat and bird flight can guide the engineering of aircraft. We were inspired by this multitude of applications to consider the crucial component needed to advance a single-object tracking system to a multi-object tracking system—data association. Data association in the most general sense is the process of matching information about newly observed objects with information that was previously observed about them. This information may be about their identities, positions, or trajectories. Algorithms for data association search for matches that optimize certain match criteria and are

subject to physical conditions. They can therefore be formulated as solving a "constrained optimization problem"—the problem of optimizing an objective function of some variables in the presence of constraints on these variables. As such, data association methods have a strong mathematical grounding and are valuable general tools for computer vision researchers. This book serves as a tutorial on data association methods, intended for both students and experts in computer vision. We describe the basic research problems, review the current state of the art, and present some recently developed approaches. The book covers multi-object tracking in two and three dimensions. We consider two imaging scenarios involving either single cameras or multiple cameras with overlapping fields of view, and requiring across-time and across-view data association methods. In addition to methods that match new measurements to already established tracks, we describe methods that match trajectory segments, also called tracklets. The book presents a principled application of data association to solve two interesting tasks: first, analyzing the movements of groups of free-flying animals and second, reconstructing the movements of groups of pedestrians. We conclude by discussing exciting directions for future research.

By exploiting the synergies among available data, information fusion can reduce data traffic, filter noisy measurements, and make predictions and inferences about a monitored entity. Networked Filtering and Fusion in Wireless Sensor Networks introduces the subject of multi-sensor fusion as the method of choice for implementing distributed systems. The book examines the state of the art in information fusion. It presents the known methods, algorithms, architectures, and models of information fusion and discusses their applicability in the context of wireless sensor networks (WSNs). Paying particular attention to the wide range of topics that have been covered in recent literature, the text presents the results of a number of typical case studies. Complete with research supported elements and comprehensive references, this teaching-oriented volume uses standard scientific terminology, conventions, and notations throughout. It applies recently developed convex optimization theory and highly efficient algorithms in estimation fusion to open up discussion and provide researchers with an ideal starting point for further research on distributed estimation and fusion for WSNs.

The book supplies a cohesive overview of the key results of theory and applications of information-fusion-related problems in networked systems in a unified framework. Providing advanced mathematical treatment of fundamental problems with information fusion, it will help you broaden your understanding of prospective applications and how to address such problems in practice. After reading the book, you will gain the understanding required to model parts of dynamic systems and use those models to develop distributed fusion control algorithms that are based on feedback control theory.

With the recent proliferation of service-oriented architectures (SOA), cloud computing technologies, and distributed-interconnected systems, distributed

fusion is taking on a larger role in a variety of applications—from environmental monitoring and crisis management to intelligent buildings and defense. Drawing on the work of leading experts around the world, Distributed Data Fusion for Network-Centric Operations examines the state of the art of data fusion in a distributed sensing, communications, and computing environment. Get Insight into Designing and Implementing Data Fusion in a Distributed Network Addressing the entirety of information fusion, the contributors cover everything from signal and image processing, through estimation, to situation awareness. In particular, the work offers a timely look at the issues and solutions involving fusion within a distributed network enterprise. These include critical design problems, such as how to maintain a pedigree of agents or nodes that receive information, provide their contribution to the dataset, and pass to other network components. The book also tackles dynamic data sharing within a network-centric enterprise, distributed fusion effects on state estimation, graph-theoretic methods to optimize fusion performance, human engineering factors, and computer ontologies for higher levels of situation assessment. A comprehensive introduction to this emerging field and its challenges, the book explores how data fusion can be used within grid, distributed, and cloud computing architectures. Bringing together both theoretical and applied research perspectives, this is a valuable reference for fusion researchers and practitioners. It offers guidance and insight for those working on the complex issues of designing and implementing distributed, decentralized information fusion.

Data fusion or information fusion are names which have been primarily assigned to military-oriented problems. In military applications, typical data fusion problems are: multisensor, multitarget detection, object identification, tracking, threat assessment, mission assessment and mission planning, among many others. However, it is clear that the basic underlying concepts underlying such fusion procedures can often be used in nonmilitary applications as well. The purpose of this book is twofold: First, to point out present gaps in the way data fusion problems are conceptually treated. Second, to address this issue by exhibiting mathematical tools which treat combination of evidence in the presence of uncertainty in a more systematic and comprehensive way. These techniques are based essentially on two novel ideas relating to probability theory: the newly developed fields of random set theory and conditional and relational event algebra. This volume is intended to be both an update on research progress on data fusion and an introduction to potentially powerful new techniques: fuzzy logic, random set theory, and conditional and relational event algebra. Audience: This volume can be used as a reference book for researchers and practitioners in data fusion or expert systems theory, or for graduate students as text for a research seminar or graduate level course.

Many practical applications, such as search and rescue operations and environmental monitoring, involve the use of mobile sensor platforms. The workload of the sensor operators is becoming overwhelming, as both the number

of sensors and their complexity are increasing. This thesis addresses the problem of automating sensor systems to support the operators. This is often referred to as sensor management. By planning trajectories for the sensor platforms and exploiting sensor characteristics, the accuracy of the resulting state estimates can be improved. The considered sensor management problems are formulated in the framework of stochastic optimal control, where prior knowledge, sensor models, and environment models can be incorporated. The core challenge lies in making decisions based on the predicted utility of future measurements. In the special case of linear Gaussian measurement and motion models, the estimation performance is independent of the actual measurements. This reduces the problem of computing sensing trajectories to a deterministic optimal control problem, for which standard numerical optimization techniques can be applied. A theorem is formulated that makes it possible to reformulate a class of nonconvex optimization problems with matrix-valued variables as convex optimization problems. This theorem is then used to prove that globally optimal sensing trajectories can be computed using off-the-shelf optimization tools. As in many other fields, nonlinearities make sensor management problems more complicated. Two approaches are derived to handle the randomness inherent in the nonlinear problem of tracking a maneuvering target using a mobile range-bearing sensor with limited field of view. The first approach uses deterministic sampling to predict several candidates of future target trajectories that are taken into account when planning the sensing trajectory. This significantly increases the tracking performance compared to a conventional approach that neglects the uncertainty in the future target trajectory. The second approach is a method to find the optimal range between the sensor and the target. Given the size of the sensor's field of view and an assumption of the maximum acceleration of the target, the optimal range is determined as the one that minimizes the tracking error while satisfying a user-defined constraint on the probability of losing track of the target. While optimization for tracking of a single target may be difficult, planning for jointly maintaining track of discovered targets and searching for yet undetected targets is even more challenging. Conventional approaches are typically based on a traditional tracking method with separate handling of undetected targets. Here, it is shown that the Poisson multi-Bernoulli mixture (PMBM) filter provides a theoretical foundation for a unified search and track method, as it not only provides state estimates of discovered targets, but also maintains an explicit representation of where undetected targets may be located. Furthermore, in an effort to decrease the computational complexity, a version of the PMBM filter which uses a grid-based intensity to represent undetected targets is derived.

A rigorous introduction to the theory and applications of state estimation and association, an important area in aerospace, electronics, and defense industries. Applied state estimation and association is an important area for practicing engineers in aerospace, electronics, and defense industries, used in such tasks

as signal processing, tracking, and navigation. This book offers a rigorous introduction to both theory and application of state estimation and association. It takes a unified approach to problem formulation and solution development that helps students and junior engineers build a sound theoretical foundation for their work and develop skills and tools for practical applications. Chapters 1 through 6 focus on solving the problem of estimation with a single sensor observing a single object, and cover such topics as parameter estimation, state estimation for linear and nonlinear systems, and multiple model estimation algorithms. Chapters 7 through 10 expand the discussion to consider multiple sensors and multiple objects. The book can be used in a first-year graduate course in control or system engineering or as a reference for professionals. Each chapter ends with problems that will help readers to develop derivation skills that can be applied to new problems and to build computer models that offer a useful set of tools for problem solving. Readers must be familiar with state-variable representation of systems and basic probability theory including random and stochastic processes.
The LNCS series reports state-of-the-art results in computer science research, development, and education, at a high level and in both printed and electronic form. Enjoying tight cooperation with the R&D community, with numerous individuals, as well as with prestigious organizations and societies, LNCS has grown into the most comprehensive computer science research forum available. The scope of LNCS, including its subseries LNAI and LNBI, spans the whole range of computer science and information technology including interdisciplinary topics in a variety of application fields. In parallel to the printed book, each new volume is published electronically in LNCS Online.
Target tracking is a mature topic with over half a century of mainly military and aviation research. The field has lately expanded into a range of civilian applications due to the development of cheap sensors and improved computational power. With the rise of new applications, new challenges emerge, and with better hardware there is an opportunity to employ more elaborated algorithms. There are five main contributions to the field of target tracking in this thesis. Contributions I-IV concern the development of non-conventional models for target tracking and the resulting estimation methods. Contribution V concerns a reformulation for improved performance. To show the functionality and applicability of the contributions, all proposed methods are applied to and verified on experimental data related to tracking of animals or other objects in nature. In Contribution I, sparse Gaussian processes are proposed to model behaviours of targets that are caused by influences from the environment, such as wind or obstacles. The influences are learned online as a part of the state estimation using an extended Kalman filter. The method is also adapted to handle time-varying influences and to identify dynamic systems. It is shown to improve accuracy over the nearly constant velocity and acceleration models in simulation. The method is also evaluated in a sea ice tracking application using data from a radar on Svalbard. In Contribution II, a state-space model is derived that

incorporates observations with uncertain timestamps. An example of such observations could be traces left by a target. Estimation accuracy is shown to be better than the alternative of disregarding the observation. The position of an orienteering sprinter is improved using the control points as additional observations. In Contribution III, targets that are confined to a certain space, such as animals in captivity, are modelled to avoid collision with the boundaries by turning. The proposed model forces the predictions to remain inside the confined space compared to conventional models that may suffer from infeasible predictions. In particular the model improves robustness against occlusions. The model is successfully used to track dolphins in a dolphinarium as they swim in a basin with occluded sections. In Contribution IV, an extension to the jump Markov model is proposed that incorporates observations of the mode that are state-independent. Normally, the mode is estimated by comparing actual and predicted observations of the state. However, sensor signals may provide additional information directly dependent on the mode. Such information from a video recorded by biologists is used to estimate take-off times and directions of birds captured in circular cages. The method is shown to compare well with a more time-consuming manual method. In Contribution V, a reformulation of the labelled multi-Bernoulli filter is used to exploit a structure of the algorithm to attain a more efficient implementation.Modern target tracking algorithms are often very demanding, so sound approximations and clever implementations are needed to obtain reasonable computational performance. The filter is integrated in a full framework for tracking sea ice, from pre-processing to presentation of results. Målföljning (eng. target tracking) är ett välutforskat ämne med en historia som sträcker sig tillbaka till åtminstone 30-talet. Då tävlade en handfull nationer om att snabbast kunna upptäcka fienden innan det var för sent. Traditionellt sett har målföljning fortsatt att vara starkt förknippat med militära tillämpningar och flygfart. Det är först på senare år som billiga och kommersiellt tillgängliga sensorer har öppnat upp för en mängd betydligt fredligare användningsområden. Målföljning skulle kunna beskrivas som lokalisering av främmande objekt genom att samla in data från sensorer. Den här avhandlingen behandlar framförallt målföljning av olika sorters djur där data samlas in med videokameror. Det finns två bakomliggande syften. Det ena handlar om att underlätta forskning för biologer och det andra handlar om att skapa tekniska lösningar för att underlätta skyddet av sällsynta djur. Även målföljning av drivis där data samlas in med radar behandlas. Trots den vitt skilda tillämpningen är många metoder desamma. Syftet är att hantera drivis i norra ishavet där detektion och målföljning är viktiga komponenter för att undvika kollisioner. Biologer lägger ofta en ansenlig mängd tid på att samla in, annotera och sortera data. Det är tid som kan spenderas på mer givande forskningsaktiviteter. Med videokamera, bildbehandling och moderna algoritmer för målföljning är det möjligt att i viss mån automatisera datainsamlingen. Med automatisering kan mer information samlas in än med traditionella metoder och längre experiment kan ofta genomföras. Ytterligare en

fördel är att man kan minska påverkan på djuren. Parkvakterna i många nationalparker kämpar dagligen med intrång från tjuvjägare. De har ytterst begränsade resurser och utsätter sina liv för stor fara. Bestånden minskar fortfarande för många djurarter som går en mörk framtid till mötes. För att vända trenden behövs stora insatser på många fronter samtidigt. Målföljning kan bidra med att på ett kostnadseffektivt sätt tillhandahålla övervakning av nationalparker. Kännedom om var djuren befinner sig underlättar koordinering av parkvakternas insatser för att skydda djuren. Målföljning kan ske med ett flertal olika sensorer, såsom radarer, fast uppsatta och luftburna videokameror, mikrofoner som lyssnar efter djurläten och även vittnesmål från parkvakterna. All insamlad information bidrar till att skapa en helhetsbild av situationen i nationalparken om den används rätt. Ishantering är ett viktigt område för oljeindustrin för att garantera säkerhet och undvika allvarliga olyckor. Målet är att upptäcka och spåra is som flyter i havet och om nödvändigt vidta åtgärder för att undvika kollision. Målet är att i förlängningen sätta upp ett stort nätverk av olika sensorer och databaser för att få en heltäckande bild av det aktuella läget. Flera källor diskuteras, såsom mark- och fartygsradarer av olika slag, satelliter, drönare med kameror och väderdatabaser. Att skapa fullständiga och användbara lösningar för biologer, parkvakter och oljeindustrin är väldigt ambitiösa mål. I avhandlingen presenteras bakomliggande teori för målföljning varvat med författarens egna forskningsbidrag och lösningar för en handfull specifika problem och tillämpningar. Det första projektet som presenteras är ett samarbete med Kolmårdens djurpark. Biologer i djurparken studerar delfiners beteende i fångenskap. I dagsläget markerar studenter för hand i video var delfinerna befinner sig i bassängen. Med målföljning samlas djurens positioner in automatiskt utan mänsklig inblandning. Det främsta bidraget i forskningen är utvecklingen av en modell för hur delfinerna rör sig i bassängen. Det andra projektet som presenteras är ett samarbete med biologer vid Lunds universitet som studerar beteendet hos flyttfåglar. I en metod från 60-talet mäts fåglars rörelser i en tratt. Från repor i tratten som orsakats vid fåglarnas lyftförsök analyserar man riktningarna för lyftförsöken. Med videokamera och målföljning samlas djurens positioner in och enskilda lyftförsök detekteras automatiskt. Det främsta bidraget i forskningen är en metod för att bättre utnyttja information från videon till att detektera lyftförsöken. Det tredje projektet som presenteras är ett samarbete med Smarta Savanner. En idé som utforskas är möjligheten att använda parkvakternas vittnesmål om spår från noshörningar för att förbättra målföljningen. Å ena sidan är data från videokameror och radarer väldigt noggranna i tid, men relativt osäkra i de uppmätta positionerna. Å andra sidan kan positionen för ett spår mätas noggrant samtidigt som det ofta är svårt att avgöra när noshörningen var på platsen. Genom att utnyttja informationen från båda källorna kan noshörningars förflyttningar i parken kartläggas bättre. Den bakomliggande teorin för observationer med osäker tid inom målföljning är relativt outforskad. Det främsta bidraget i forskningen är utvecklingen av en

metod för att utnyttja sådana observationer. Enkla simulerade fall används för att analysera metoden. Metoden utvärderas även i en tillämpning för att förbättra den satellitbaserade positionsbestämningen av en orienterare genom att noggrant mäta positionen på kontrollerna. Det fjärde projektet som presenteras är ett samarbete med Norges teknisk-naturvitenskapelige universitet (NTNU) och Norut i Norge som samlat in radardata på Svalbard. Det främsta bidraget är utvecklandet av en metod som lär sig hur lokala strömmar och vindar påverkar drivisen för att bättre kunna förutspå rörelser.Ett annat bidrag i forskningen är en förenkling av formuleringen och implementationen av en modern algoritm för målföljning. Projekten, som alla har flera likheter och skillnader med varandra, kan gemensamt sammanfattas med att de spårar rörelser, eller vandringar, i naturen.

Nowadays, the technological advances allow developing many applications on different fields. In this book Motion Tracking and Gesture Recognition, two important fields are shown. Motion tracking is observed by a hand-tracking system for surgical training, an approach based on detection of dangerous situation by the prediction of moving objects, an approach based on human motion detection results and preliminary environmental information to build a long-term context model to describe and predict human activities, and a review about multispeaker tracking on different modalities. On the other hand, gesture recognition is shown by a gait recognition approach using Kinect sensor, a study of different methodologies for studying gesture recognition on depth images, and a review about human action recognition and the details about a particular technique based on a sensor of visible range and with depth information.

This IMA Volume in Mathematics and its Applications RANDOM SETS: THEORY AND APPLICATIONS is based on the proceedings of a very successful 1996 three-day Summer Program on "Application and Theory of Random Sets." We would like to thank the scientific organizers: John Goutsias (Johns Hopkins University), Ronald P.S. Mahler (Lockheed Martin), and Hung T. Nguyen (New Mexico State University) for their excellent work as organizers of the meeting and for editing the proceedings. We also take this opportunity to thank the Army Research Office (ARO), the Office ofNaval Research (0NR), and the Eagan, MinnesotaEngineering Center ofLockheed Martin Tactical Defense Systems, whose financial support made the summer program possible. Avner Friedman Robert Gulliver v PREFACE "Later generations will regard set theory as a disease from which one has recovered. " - Henri Poincare Random set theory was independently conceived by D.G. Kendall and G. Matheron in connection with stochastic geometry. It was however G.

Introduces object tracking algorithms from a unified, recursive Bayesian perspective, along with performance bounds and illustrative examples.

The book shows that the analytic combinatorics (AC) method encodes the combinatorial problems of multiple object tracking--without information loss--into the derivatives of a generating function (GF). The book lays out an easy-to-follow path from theory to practice and includes salient AC application examples. Since GFs are not widely utilized amongst the tracking community, the book takes the reader from the basics of the subject to applications of theory starting from the simplest problem of single object tracking, and advancing chapter by chapter to more challenging multi-

object tracking problems. Many established tracking filters (e.g., Bayes-Markov, PDA, JPDA, IPDA, JIPDA, CPHD, PHD, multi-Bernoulli, MBM, LMBM, and MHT) are derived in this manner with simplicity, economy, and considerable clarity. The AC method gives significant and fresh insights into the modeling assumptions of these filters and, thereby, also shows the potential utility of various approximation methods that are well established techniques in applied mathematics and physics, but are new to tracking. These unexplored possibilities are reviewed in the final chapter of the book.

This book is a printed edition of the Special Issue "Advances in Multi-Sensor Information Fusion: Theory and Applications 2017" that was published in Sensors

This comprehensive resource provides you with an in-depth understanding of finite-set statistics (FISST) ndash; a recently developed method which unifies much of information fusion under a single probabilistic, in fact Bayesian, paradigm. The book helps you master FISST concepts, techniques, and algorithms, so you can use FISST to address real-world challenges in the field. You learn how to model, fuse, and process highly disparate information sources, and detect and track non-cooperative individual/platform groups and conventional non-cooperative targets.

The International Symposium on Distributed Computing and Artificial Intelligence is an annual forum that brings together ideas, projects, lessons, etc. associated with distr- uted computing, artificial intelligence and its applications in different themes. This meeting has been held at the University of Salamanca from the 22th to the 24th of October 2008. This symposium has be organized by the Biomedicine, Intelligent S- tem and Educational Technology Research Group (http://bisite. usal. es/) of the Univ- sity of Salamanca. The technology transfer in this field is still a challenge and for that reason this type of contributions has been specially considered in this edition. This c- ference is the forum in which to present application of innovative techniques to complex problems. The artificial intelligence is changing our society. Its application in distr- uted environments, such as the Internet, electronic commerce, mobile communications, wireless devices, distributed computing, and so on is increasing and is becoming an element of high added value and economic potential, both industrial and research. These technologies are changing constantly as a result of the large research and technical effort being undertaken in both universities and businesses. The exchange of ideas between scientists and technicians from both academic and business areas is essential to facilitate the development of systems that meet the demands of today's society.

This comprehensive resource provides readers with the tools necessary to perform analysis of various waveforms for use in radar systems. It provides information about how to produce synthetic aperture (SAR) images by giving a tomographic formulation and implementation for SAR imaging. Tracking filter fundamentals, and each parameter associated with the filter and how each affects tracking performance are also presented. Various radar cross section measurement techniques are covered, along with waveform selection analysis through the study of the ambiguity function for each particular waveform from simple linear frequency modulation (LFM) waveforms to more complicated coded waveforms. The text includes the Python tool suite, which allows the reader to analyze and predict radar performance for various scenarios and applications. Also provided are MATLAB® scripts corresponding to the Python tools. The software includes a user-friendly graphical user interface (GUI) that provides visualizations of the

concepts being covered. Users have full access to both the Python and MATLAB source code to modify for their application. With examples using the tool suite are given at the end of each chapter, this text gives readers a clear understanding of how important target scattering is in areas of target detection, target tracking, pulse integration, and target discrimination.

This book gives a concise and comprehensive overview of non-cooperative target tracking, fusion and control. Focusing on algorithms rather than theories for non-cooperative targets including air and space-borne targets, this work explores a number of advanced techniques, including Gaussian mixture cardinalized probability hypothesis density (CPHD) filter, optimization on manifold, construction of filter banks and tight frames, structured sparse representation, and others. Containing a variety of illustrative and computational examples, Non-cooperative Target Tracking, Fusion and Control will be useful for students as well as engineers with an interest in information fusion, aerospace applications, radar data processing and remote sensing.

The fourth volume on Advances and Applications of Dezert-Smarandache Theory (DSmT) for information fusion collects theoretical and applied contributions of researchers working in different fields of applications and in mathematics. The contributions (see List of Articles published in this book, at the end of the volume) have been published or presented after disseminating the third volume (2009, http://fs.gallup.unm.edu/DSmT-book3.pdf) ininternational conferences, seminars, workshops and journals.

This is the sequel to the 2007 Artech House bestselling title, Statistical Multisource-Multitarget Information Fusion. That earlier book was a comprehensive resource for an in-depth understanding of finite-set statistics (FISST), a unified, systematic, and Bayesian approach to information fusion. The cardinalized probability hypothesis density (CPHD) filter, which was first systematically described in the earlier book, has since become a standard multitarget detection and tracking technique, especially in research and development. Since 2007, FISST has inspired a considerable amount of research, conducted in more than a dozen nations, and reported in nearly a thousand publications. This sequel addresses the most intriguing practical and theoretical advances in FISST, for the first time aggregating and systematizing them into a coherent, integrated, and deep-dive picture. Special emphasis is given to computationally fast exact closed-form implementation approaches. The book also includes the first complete and systematic description of RFS-based sensor/platform management and situation assessment.

Sensor Data Fusion is the process of combining incomplete and imperfect pieces of mutually complementary sensor information in such a way that a better understanding of an underlying real-world phenomenon is achieved. Typically, this insight is either unobtainable otherwise or a fusion result exceeds what can be produced from a single sensor output in accuracy, reliability, or cost. This book provides an introduction Sensor Data Fusion, as an information technology as well as a branch of engineering science and informatics. Part I presents a coherent methodological framework, thus providing the prerequisites for discussing selected applications in Part II of the book. The presentation mirrors the author's views on the subject and emphasizes his own contributions to the development of particular aspects. With some delay, Sensor Data Fusion is likely to develop along lines similar to the evolution of another modern key

technology whose origin is in the military domain, the Internet. It is the author's firm conviction that until now, scientists and engineers have only scratched the surface of the vast range of opportunities for research, engineering, and product development that still waits to be explored: the Internet of the Sensors.

This book gathers high-quality papers presented at the International Conference on Smart Trends for Information Technology and Computer Communications (SmartCom 2020), organized by the Global Knowledge Research Foundation (GR Foundation) from 23 to 24 January 2020. It covers the state-of-the-art and emerging topics in information, computer communications, and effective strategies for their use in engineering and managerial applications. It also explores and discusses the latest technological advances in, and future directions for, information and knowledge computing and its applications.

The two-volume set (LNCS 6728 and 6729) constitutes the refereed proceedings of the International Conference on Swarm Intelligence, ICSI 2011, held in Chongqing, China, in June 2011. The 143 revised full papers presented were carefully reviewed and selected from 298 submissions. The papers are organized in topical sections on theoretical analysis of swarm intelligence algorithms, particle swarm optimization, applications of pso algorithms, ant colony optimization algorithms, bee colony algorithms, novel swarm-based optimization algorithms, artificial immune system, differential evolution, neural networks, genetic algorithms, evolutionary computation, fuzzy methods, and hybrid algorithms - for part I. Topics addressed in part II are such as multi-objective optimization algorithms, multi-robot, swarm-robot, and multi-agent systems, data mining methods, machine learning methods, feature selection algorithms, pattern recognition methods, intelligent control, other optimization algorithms and applications, data fusion and swarm intelligence, as well as fish school search - foundations and applications.