

Principles Of Wireless Sensor Networks Ebook

This book focuses on the principles of wireless sensor networks (WSNs), their applications, and their analysis tools, with meticulous attention paid to definitions and terminology. This book presents the adopted technologies and their manufacturers in detail, making WSNs tangible for the reader. In introductory computer networking books, chapter sequencing follows the bottom-up or top-down architecture of the 7-layer protocol. This book addresses subsequent steps in this process, both horizontally and vertically, thus fostering a clearer and deeper understanding through chapters that elaborate on WSN concepts and issues. With such depth, this book is intended for a wide audience; it is meant to be a helper and motivator for senior undergraduates, postgraduates, researchers, and practitioners. It lays out important concepts and WSN-related applications; uses appropriate literature to back research and practical issues; and focuses on new trends. Senior undergraduate students can use it to familiarize themselves with conceptual foundations and practical project implementations. For graduate students and researchers, test beds and simulators provide vital insights into analysis methods and tools for WSNs. Lastly, in addition to applications and deployment, practitioners will be able to learn more about WSN manufacturers and components within several platforms and test beds. This book provides the basics needed to develop sensor network software and supplements it with many case studies covering network applications. It also examines how to develop onboard applications on individual sensors, how to interconnect these sensors, and how to form networks of sensors, although the major aim of this book is to provide foundational principles of developing sensor networking software and critically examine sensor network

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applications.

Written by award-winning engineers whose research has been sponsored by the U.S. National Science Foundation (NSF), IBM, and Cisco's University Research Program, *Wireless Sensor Networks: Principles and Practice* addresses everything product developers and technicians need to know to navigate the field. It provides an all-inclusive examina

Wireless sensor networks are an emerging technology with a wide range of applications in military and civilian domains. This book begins by detailing the basic principles and concepts of wireless sensor networks, including information gathering, energy management and the structure of sensory nodes. It proceeds to examine advanced topics, covering localisation, topology, security and evaluation of wireless sensor networks, highlighting international research being carried out in this area. Finally, it features numerous examples of applications of this technology to a range of domains, such as wireless, multimedia, underwater and underground wireless sensor networks. --

Wireless sensor networks (WSNs) have emerged as a phenomenon of the twenty-first century with numerous kinds of sensor being developed for specific applications. The origins of WSNs can, however, be traced back to the early days of connectivity between computers and their peripherals. Work with distributed sensor networks is evidenced in the literature during the latter part of the 1970s, continuing in functionality increases in the 1980s and 1990s. As a configuration of independent devices in a data communications network, WSNs are now pre-eminent as working solutions to numerous precision data collection situations where software control of instruments and routing protocols are needed. In this book, the authors have chosen a selection of specific topics relating to WSNs: their design, development, implementation and

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function. Some operating topics are addressed such as power management, data interchange protocols, instrument reliability and system security. Other topics are more application oriented, where particular hardware and software configurations are described to deliver system solutions for specific needs. All are clearly written with considerable detail relating to each of the issues addressed by the authors. Each of the chapters provides a rationale for the topic being covered and some general WSN details where appropriate. The citations used in the chapters are comprehensively referred to, which adds depth to the information being presented.

RFID (radio-frequency identification) is an emerging communication system technology and one of the most rapidly growing segments of today's automatic identification data collection industry. This cutting-edge resource offers you a solid understanding of the basic technical principles and applications of RFID-enabled sensor systems. The book provides you with a detailed description of RFID and its operation, along with a fundamental overview of sensors and wireless sensor networks. Moreover, this practical reference gives you step-by-step guidance on how to design RFID-enabled sensors that form a wireless sensor network. You also find detailed coverage of state-of-the-art RFID/sensor technology and worldwide applications.

Wireless sensor networks consist of small, mostly battery powered computers. Despite their simplicity, each sensor node is equipped with its own memory, CPU and radio transceiver. A typical application is to scatter many of them over a large area. Some sensor nodes can take measurements like temperature, air pressure and humidity. The latest models can also capture audio and images. But even the simplest capabilities like monitoring the temperature can be

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used e.g., to detect and fight forest fires at an early stage. The strength of this new paradigm comes from the mere number of nodes. Messages are forwarded over long distances from node to node. However, a sensor network does not only provide its own communication infrastructure. Within this book, it will also be shown how it can be used like a massively distributed database or as a compute cluster which filters and analyzes its data prior to transmission. A key-factor to the success of a sensor network is its longevity. Communication algorithms for medium access, routing but also for encryption and time synchronization have to be redesigned carefully with energy efficiency in mind.

The new edition of this popular book has been transformed into a hands-on textbook, focusing on the principles of wireless sensor networks (WSNs), their applications, their protocols and standards, and their analysis and test tools; a meticulous care has been accorded to the definitions and terminology. To make WSNs felt and seen, the adopted technologies as well as their manufacturers are presented in detail. In introductory computer networking books, chapters sequencing follows the bottom up or top down architecture of the seven layers protocol. This book starts some steps later, with chapters ordered based on a topic's significance to the elaboration of wireless sensor networks (WSNs) concepts and issues. With such a depth, this book is intended for a wide audience, it is meant to be a helper and motivator, for both the senior undergraduates, postgraduates, researchers, and practitioners; concepts and WSNs related applications are laid out, research and practical issues are backed by appropriate literature, and new trends are put under focus. For senior undergraduate students, it familiarizes readers with conceptual foundations, applications, and practical project implementations. For graduate students and researchers, transport layer protocols and cross-

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layering protocols are presented and testbeds and simulators provide a must follow emphasis on the analysis methods and tools for WSNs. For practitioners, besides applications and deployment, the manufacturers and components of WSNs at several platforms and testbeds are fully explored.

A Beginners Guide to Data Agglomeration and Intelligent Sensing provides an overview of the Sensor Cloud Platform, Converge-casting, and Data Aggregation in support of intelligent sensing and relaying of information. The book begins with a brief introduction on sensors and transducers, giving readers insight into the various types of sensors and how one can work with them. In addition, it gives several real-life examples to help readers properly understand concepts. An overview of concepts such as wireless sensor networks, cloud platforms, and device-to-cloud and sensor cloud architecture are explained briefly, as is data gathering in wireless sensor networks and aggregation procedures. Final sections explore how to process gathered data and relay the data in an intelligent way, including concepts such as supervised and unsupervised learning, software defined networks, sensor data mining and smart systems. Presents the latest advances in data agglomeration for intelligent sensing Discusses the basic concepts of sensors, real-life applications of sensors and systems, the protocols and applications of wireless sensor networks, the methodology of sensor data accumulation, and real-life applications of Intelligent Sensor Networks Provides readers with an easy-to-learn and understand introduction to the concepts of the cloud platform, Sensor Cloud and Machine Learning

In this book, the authors describe the fundamental concepts and practical aspects of wireless sensor networks. The book provides a comprehensive view to this rapidly evolving field,

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including its many novel applications, ranging from protecting civil infrastructure to pervasive health monitoring. Using detailed examples and illustrations, this book provides an inside track on the current state of the technology. The book is divided into three parts. In Part I, several node architectures, applications and operating systems are discussed. In Part II, the basic architectural frameworks, including the key building blocks required for constructing large-scale, energy-efficient sensor networks are presented. In Part III, the challenges and approaches pertaining to local and global management strategies are presented – this includes topics on power management, sensor node localization, time synchronization, and security. At the end of each chapter, the authors provide practical exercises to help students strengthen their grip on the subject. There are more than 200 exercises altogether. Key Features: Offers a comprehensive introduction to the theoretical and practical concepts pertaining to wireless sensor networks Explains the constraints and challenges of wireless sensor network design; and discusses the most promising solutions Provides an in-depth treatment of the most critical technologies for sensor network communications, power management, security, and programming Reviews the latest research results in sensor network design, and demonstrates how the individual components fit together to build complex sensing systems for a variety of application scenarios Includes an accompanying website containing solutions to exercises (http://www.wiley.com/go/dargie_fundamentals) This book serves as an introductory text to the field of wireless sensor networks at both graduate and advanced undergraduate level, but it will also appeal to researchers and practitioners wishing to learn about sensor network technologies and their application areas, including environmental monitoring, protection of civil infrastructure, health care, precision agriculture, traffic control, and homeland security.

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This book presents a comprehensive overview of wireless sensor networks (WSNs) with an emphasis on security, coverage, and localization. It offers a structural treatment of WSN building blocks including hardware and protocol architectures and also provides a systems-level view of how WSNs operate. These building blocks will allow readers to program specialized applications and conduct research in advanced topics. A brief introductory chapter covers common applications and communication protocols for WSNs. Next, the authors review basic mathematical models such as Voroni diagrams and Delaunay triangulations. Sensor principles, hardware structure, and medium access protocols are examined. Security challenges ranging from defense strategies to network robustness are explored, along with quality of service measures. Finally, this book discusses recent developments and future directions in WSN platforms. Each chapter concludes with classroom-tested exercises that reinforce key concepts. This book is suitable for researchers and for practitioners in industry. Advanced-level students in electrical engineering and computer science will also find the content helpful as a textbook or reference.

Smart Environments contains contributions from leading researchers, describing techniques and issues related to developing and living in intelligent environments. Reflecting the multidisciplinary nature of the design of smart environments, the topics covered include the latest research in smart environment philosophical and computational architecture considerations, network protocols for smart environments, intelligent sensor networks and powerline control of devices, and action prediction and identification.

Although governments worldwide have invested significantly in intelligent sensor network research and applications, few books cover intelligent sensor networks from a machine

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learning and signal processing perspective. Filling this void, *Intelligent Sensor Networks: The Integration of Sensor Networks, Signal Processing and Machine Learning* focuses on the close integration of sensing, networking, and smart signal processing via machine learning. Based on the world-class research of award-winning authors, the book provides a firm grounding in the fundamentals of intelligent sensor networks, including compressive sensing and sampling, distributed signal processing, and intelligent signal learning. Presenting recent research results of world-renowned sensing experts, the book is organized into three parts: Machine Learning—describes the application of machine learning and other AI principles in sensor network intelligence—covering smart sensor/transducer architecture and data representation for intelligent sensors Signal Processing—considers the optimization of sensor network performance based on digital signal processing techniques—including cross-layer integration of routing and application-specific signal processing as well as on-board image processing in wireless multimedia sensor networks for intelligent transportation systems Networking—focuses on network protocol design in order to achieve an intelligent sensor networking—covering energy-efficient opportunistic routing protocols for sensor networking and multi-agent-driven wireless sensor cooperation Maintaining a focus on "intelligent" designs, the book details signal processing principles in sensor networks. It elaborates on critical platforms for intelligent sensor networks and illustrates key applications—including target tracking, object identification, and structural health monitoring. It also includes a paradigm for validating the extent of spatiotemporal associations among data sources to enhance data cleaning in sensor networks, a sensor stream reduction application, and also considers the use of Kalman filters for attack detection in a water system sensor network that consists of water level sensors and velocity

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sensors.

With modern communication networks continuing to grow in traffic, size, complexity, and variety, control systems are critical to ensure quality and effectively manage network traffic. Providing a thorough and authoritative introduction, *Wireless Ad hoc and Sensor Networks: Protocols, Performance, and Control* examines the theory, architectures, and technologies needed to implement quality of service (QoS) in a wide variety of communication networks. Based on years of research and practical experience, this book examines the technical concepts underlying the design, implementation, research, and invention of both wired and wireless networks. The author builds a strong understanding of general concepts and common principles while also exploring issues that are specific to wired, cellular, wireless ad hoc, and sensor networks. Beginning with an overview of networks and QoS control, he systematically explores timely areas such as Lyapunov analysis, congestion control of high-speed networks, admission control based on hybrid system theory, distributed power control of various network types, link state routing using QoS parameters, and predictive congestion control. The book also provides a framework for implementing QoS control using mote hardware. Providing a deeply detailed yet conveniently practical guide to QoS implementation, *Wireless Ad hoc and Sensor Networks: Protocols, Performance, and Control* is the perfect introduction for anyone new to the field as well as an ideal reference guide for seasoned network practitioners. *Wireless Sensor Networks* presents the latest practical solutions to the design issues presented in wireless-sensor-network-based systems. Novel features of the text, distributed throughout, include workable solutions, demonstration systems and case studies of the design and application of wireless sensor networks (WSNs) based on the first-hand research and

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development experience of the author, and the chapters on real applications: building fire safety protection; smart home automation; and logistics resource management. Case studies and applications illustrate the practical perspectives of: · sensor node design; · embedded software design; · routing algorithms; · sink node positioning; · co-existence with other wireless systems; · data fusion; · security; · indoor location tracking; · integrating with radio-frequency identification; and · Internet of things Wireless Sensor Networks brings together multiple strands of research in the design of WSNs, mainly from software engineering, electronic engineering, and wireless communication perspectives, into an over-arching examination of the subject, benefiting students, field engineers, system developers and IT professionals. The contents have been well used as the teaching material of a course taught at postgraduate level in several universities making it suitable as an advanced text book and a reference book for final-year undergraduate and postgraduate students.

This book provides comprehensive coverage of the major aspects in designing, implementing, and deploying wireless sensor networks by discussing present research on WSNs and their applications in various disciplines. It familiarizes readers with the current state of WSNs and how such networks can be improved to achieve effectiveness and efficiency. It starts with a detailed introduction of wireless sensor networks and their applications and proceeds with layered architecture of WSNs. It also addresses prominent issues such as mobility, heterogeneity, fault-tolerance, intermittent connectivity, and cross layer optimization along with a number of existing solutions to stimulate future research.

Embedded network systems (ENS) provide a set of technologies that can link the physical world to large-scale networks in applications such as monitoring of borders, infrastructure,

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health, the environment, automated production, supply chains, homes and places of business. This book details the fundamentals for this interdisciplinary and fast-moving field. The book begins with mathematical foundations and the relevant background topics in signal propagation, sensors, detection and estimation theory, and communications. Key component technologies in ENS are discussed: synchronization and position localization, energy and data management, actuation, and node architecture. Ethical, legal and social implications are addressed. The final chapter summarizes some of the lessons learned in producing multiple ENS generations. A focus on fundamental principles together with extensive examples and problem sets make this text ideal for use on graduate courses in electrical engineering and computer science. It will also appeal to engineers involved in the design of ENS.

Wireless sensor networks are penetrating our daily lives, and they are starting to be deployed even in an industrial environment. The research on such industrial wireless sensor networks (IWSNs) considers more stringent requirements of robustness, reliability, and timeliness in each network layer. This Special Issue presents the recent research result on industrial wireless sensor networks. Each paper in this Special Issue has unique contributions in the advancements of industrial wireless sensor network research and we expect each paper to promote the relevant research and the deployment of IWSNs.

This book will have a broad appeal in the area of Wireless Networking-Based Control. Various engineering disciplines, control and communication science organizations will be interested in purchasing the book with a new, emerging, and important theme. Also, industry such as Honeywell and those (e.g. power industry, automotive industry, aerospace industry) interested in implementing wireless network control to express interest in purchasing this book.

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Infrastructure for Homeland Security Environments Wireless Sensor Networks helps readers discover the emerging field of low-cost standards-based sensors that promise a high order of spatial and temporal resolution and accuracy in an ever-increasing universe of applications. It shares the latest advances in science and engineering paving the way towards a large plethora of new applications in such areas as infrastructure protection and security, healthcare, energy, food safety, RFID, ZigBee, and processing. Unlike other books on wireless sensor networks that focus on limited topics in the field, this book is a broad introduction that covers all the major technology, standards, and application topics. It contains everything readers need to know to enter this burgeoning field, including current applications and promising research and development; communication and networking protocols; middleware architecture for wireless sensor networks; and security and management. The straightforward and engaging writing style of this book makes even complex concepts and processes easy to follow and understand. In addition, it offers several features that help readers grasp the material and then apply their knowledge in designing their own wireless sensor network systems:

- * Examples illustrate how concepts are applied to the development and application of * wireless sensor networks *
- Detailed case studies set forth all the steps of design and implementation needed to solve real-world problems *
- Chapter conclusions that serve as an excellent review by stressing the chapter's key concepts *
- References in each chapter guide readers to in-depth discussions of individual topics

This book is ideal for networking designers and engineers who want to fully exploit this new technology and for government employees who are concerned about homeland security. With its examples, it is appropriate for use as a coursebook for upper-level undergraduates and graduate students.

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Wireless sensor networks promise an unprecedented fine-grained interface between the virtual and physical worlds. They are one of the most rapidly developing information technologies, with applications in a wide range of fields including industrial process control, security and surveillance, environmental sensing, and structural health monitoring. Originally published in 2005, this book provides a detailed and organized survey of the field. It shows how the core challenges of energy efficiency, robustness, and autonomy are addressed in these systems by networking techniques across multiple layers. The topics covered include network deployment, localization, time synchronization, wireless radio characteristics, medium-access, topology control, routing, data-centric techniques, and transport protocols. Ideal for researchers and designers seeking to create algorithms and protocols and engineers implementing integrated solutions, it also contains many exercises and can be used by graduate students taking courses in networks.

Learn all you need to know about wireless sensor networks! *Protocols and Architectures for Wireless Sensor Networks* provides a thorough description of the nuts and bolts of wireless sensor networks. The authors give an overview of the state-of-the-art, putting all the individual solutions into perspective with one and other. Numerous practical examples, case studies and illustrations demonstrate the theory, techniques and results presented. The clear chapter structure, listing learning objectives, outline and summarizing key points, help guide the reader expertly through the material. *Protocols and Architectures for Wireless Sensor Networks: Covers architecture and communications protocols in detail with practical implementation examples and case studies. Provides an understanding of mutual relationships and dependencies between different protocols and architectural decisions. Offers an in-depth*

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investigation of relevant protocol mechanisms. Shows which protocols are suitable for which tasks within a wireless sensor network and in which circumstances they perform efficiently. Features an extensive website with the bibliography, PowerPoint slides, additional exercises and worked solutions. This text provides academic researchers, graduate students in computer science, computer engineering, and electrical engineering, as well as practitioners in industry and research engineers with an understanding of the specific design challenges and solutions for wireless sensor networks. Check out www.wiley.com/go/wsn for accompanying course material! "I am deeply impressed by the book of Karl & Willig. It is by far the most complete source for wireless sensor networks...The book covers almost all topics related to sensor networks, gives an amazing number of references, and, thus, is the perfect source for students, teachers, and researchers. Throughout the book the reader will find high quality text, figures, formulas, comparisons etc. - all you need for a sound basis to start sensor network research." Prof. Jochen Schiller, Institute of Computer Science, Freie Universität Berlin

Mobile computing technology has come a long way in recent years—providing anytime, anywhere communication and access to information. Bringing students up to date on important technological and industry developments, *Principles of Mobile Computing and Communications* examines mobile networks and relevant standards, highlighting issues unique to the mobile computing environment and exploring the differences between conventional and mobile applications. Going beyond discussions on wireless network infrastructure and how to develop enterprise mobile applications, this textbook considers pervasive computing and smart environments, the complexity of designing and developing such applications, and how issues are dependent on the context of the applications. Following an overview of what mobile

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computing has to offer and how its applications affect both our professional and personal lives, it focuses on the technologies and the infrastructure of all mobile and wireless networks, cellular networks, WLANs, WPANs, and sensor and mobile ad hoc networks. The textbook then discusses the Mobile IP, adaptive behavior, power management, resource constraints, interface design, seamless mobility support, and locating sensing techniques and systems. It also discusses important security issues that concern all users regardless of applications employed.

This book incorporates a selection of research and development papers. Its scope is on history and background, underlying design methodology, application domains and recent developments. The readers will be able to understand the underlying technology, philosophy, concepts, ideas, and principles, with regard to broader areas of sensor network. Aspects of sensor network and experimental results have been presented in proper order.

The military, the research community, emergency services, and industrial environments all rely on ad hoc mobile wireless networks because of their simple infrastructure and minimal central administration. Now in its second edition, *Ad Hoc Mobile Wireless Networks: Principles, Protocols, and Applications* explains the concepts, mechanism, design, and

Wireless sensor networks (WSNs) consist of tiny sensors capable of sensing, computing, and communicating. Due to advances in semiconductors, networking, and material science technologies, it is now possible to deploy large-scale

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WSNs. The advancement in these technologies has not only decreased the deployment and maintenance costs of networks but has also increased the life of networks and made them more rugged. As WSNs become more reliable with lower maintenance costs, they are being deployed and used across various sectors for multiple applications. This book discusses the applications, challenges, and design and deployment techniques of WSNs.

Principles of Wireless Sensor Networks Cambridge University Press

A comprehensive, encompassing and accessible text examining a wide range of key Wireless Networking and Localization technologies This book provides a unified treatment of issues related to all wireless access and wireless localization techniques. The book reflects principles of design and deployment of infrastructure for wireless access and localization for wide, local, and personal networking. Description of wireless access methods includes design and deployment of traditional TDMA and CDMA technologies and emerging Long Term Evolution (LTE) techniques for wide area cellular networks, the IEEE 802.11/WiFi wireless local area networks as well as IEEE 802.15 Bluetooth, ZigBee, Ultra Wideband (UWB), RF Microwave and body area networks used for sensor and ad hoc networks. The principles of wireless localization techniques using time-of-arrival and received-signal-strength of the wireless signal used in

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military and commercial applications in smart devices operating in urban, indoor and inside the human body localization are explained and compared. Questions, problem sets and hands-on projects enhances the learning experience for students to understand and appreciate the subject. These include analytical and practical examples with software projects to challenge students in practically important simulation problems, and problem sets that use MatLab. Key features: Provides a broad coverage of main wireless technologies including emerging technical developments such as body area networking and cyber physical systems Written in a tutorial form that can be used by students and researchers in the field Includes practical examples and software projects to challenge students in practically important simulation problems

Wireless sensor networks are an emerging technology with a wide range of applications in military and civilian domains. The book begins by detailing the basic principles and concepts of wireless sensor networks, including information gathering, energy management and the structure of sensory nodes. It proceeds to examine advanced topics, covering localisation, topology, security and evaluation of wireless sensor networks, highlighting international research being carried out in this area. Finally, it features numerous examples of applications of this technology to a range of domains, such as wireless, multimedia, underwater

and underground wireless sensor networks. The concise but clear presentation of the important principles, techniques and applications of wireless sensor networks makes this guide an excellent introduction for anyone new to the subject, as well as an ideal reference for practitioners and researchers.

Wireless sensor network is a group of dedicated and spatially distributed sensors used to monitor and record the physical conditions of the environment. It also organizes the collected data at a central location. It helps in measuring the environmental conditions such as temperature, pollution levels, sound, humidity, and wind. They rely on wireless connectivity and spontaneously form a network to ensure the wireless transportation of sensor data. Modern wireless sensor networks are bi-directional that enable the control of sensor activity. It plays an important role in military applications such as battlefield surveillance. Such networks are also used in many industrial and consumer applications such as industrial process monitoring and control and machine health monitoring. This book elucidates the concepts and innovative models around prospective developments with respect to wireless sensors network. Some of the diverse topics covered herein book address the varied branches that fall under this category. The book is appropriate for those seeking detailed information in this area.

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Advances such as 3-G mobile communications networks demonstrate the increasing capability of high-quality data transmission over wireless media. Adapting wireless functionality into instrument and sensor systems endows them with unmatched flexibility, robustness, and intelligence. *Wireless Sensors and Instruments: Networks, Design, and Applications* explains the principles, state-of-the-art technologies, and modern applications of this burgeoning field. From underlying concepts to practical applications, this book outlines all the necessary information to plan, design, and implement wireless instrumentation and sensor networks effectively and efficiently. The author covers the basics of instruments, measurement, sensor technology, communication systems, and networks along with the theory, methods, and components involved in digital and wireless instruments. Placing these technologies in context, the book also examines the principles, components, and techniques of modern communication systems followed by network standards, protocols, topologies, and security. Building on these discussions, the book uses examples to illustrate the practical aspects of constructing sensors and instruments. Finally, the author devotes the closing chapter to applications in a broad array of fields, including commercial, human health, and consumer products applications. Filled with up-to-date information and thorough coverage of fundamentals, *Wireless Sensors and Instruments:*

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Networks, Design, and Applications supplies critical, hands-on tools for efficiently, effectively, and immediately implementing advanced wireless systems. A concise and clear guide to the concepts and applications of wireless sensor networks, ideal for students, practitioners and researchers.

The collaborative nature of industrial wireless sensor networks (IWSNs) brings several advantages over traditional wired industrial monitoring and control systems, including self-organization, rapid deployment, flexibility, and inherent intelligent processing. In this regard, IWSNs play a vital role in creating more reliable, efficient, and productive industrial systems, thus improving companies' competitiveness in the marketplace. *Industrial Wireless Sensor Networks: Applications, Protocols, and Standards* examines the current state of the art in industrial wireless sensor networks and outlines future directions for research. *What Are the Main Challenges in Developing IWSN Systems?* Featuring contributions by researchers around the world, this book explores the software and hardware platforms, protocols, and standards that are needed to address the unique challenges posed by IWSN systems. It offers an in-depth review of emerging and already deployed IWSN applications and technologies, and outlines technical issues and design objectives. In particular, the book covers radio technologies, energy harvesting techniques, and network and resource management. It also discusses issues critical to industrial applications, such as latency, fault tolerance, synchronization, real-time constraints, network security, and cross-layer design. A

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chapter on standards highlights the need for specific wireless communication standards for industrial applications. A Starting Point for Further Research Delving into wireless sensor networks from an industrial perspective, this comprehensive work provides readers with a better understanding of the potential advantages and research challenges of IWSN applications. A contemporary reference for anyone working at the cutting edge of industrial automation, communication systems, and networks, it will inspire further exploration in this promising research area.

Applications which use wireless sensors are increasing in number. The emergence of wireless sensor networks has also motivated the integration of a large number of small and lightweight nodes which integrate sensors, processors, and wireless transceivers. Existing books on wireless sensor networks mainly focus on protocols and networks and pay little attention to the sensors themselves which the author believes is the main focus. Without adequate knowledge of sensors as well as how they can be designed, realized and used, books on wireless sensor networks become too theoretical and irrelevant. The purpose of this book is to intimately acquaint readers with the technique of sensing (resistive, capacitive, inductive, magnetic, inertial, etc.) and existing sensor technologies. It also discusses how the sensors are used in a wide application domain and how new sensors can be designed and used in a novel way.

Learn the fundamental concepts, major challenges, and effective solutions in wireless sensor networking This book provides a comprehensive and systematic introduction to

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the fundamental concepts, major challenges, and effective solutions in wireless sensor networking (WSN). Distinguished from other books, it focuses on the networking aspects of WSNs and covers the most important networking issues, including network architecture design, medium access control, routing and data dissemination, node clustering, node localization, query processing, data aggregation, transport and quality of service, time synchronization, network security, and sensor network standards. With contributions from internationally renowned researchers, *Wireless Sensor Networks* expertly strikes a balance between fundamental concepts and state-of-the-art technologies, providing readers with unprecedented insights into WSNs from a networking perspective. It is essential reading for a broad audience, including academic researchers, research engineers, and practitioners in industry. It is also suitable as a textbook or supplementary reading for electrical engineering, computer engineering, and computer science courses at the graduate level.

This book explores various challenging problems and applications areas of wireless sensor networks (WSNs), and identifies the current issues and future research challenges. Discussing the latest developments and advances, it covers all aspects of WSNs, from architecture to protocols design, and from algorithm development to synchronization issues. As such the book is an essential reference resource for undergraduate and postgraduate students as well as scholars and academics working in the field.

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Network security has always been an area of priority and extensive research. Recent years have seen a considerable growth in experimentation with biologically inspired techniques. This is a consequence of our increased understanding of living systems and the application of that understanding to machines and software. The mounting complexity of telecommunications networks and the need for increasing levels of security have been the driving factor. The human body can act as a great role model for its unique abilities in protecting itself from external, foreign entities. Many abnormalities in the human body are similar to that of the attacks in wireless sensor networks (WSN). This paper presents basic ideas drawn from human immune system analogies that can help modelling a system to counter the attacks on a WSN by monitoring parameters such as energy, frequency of data transfer, data sent and received. This is implemented by exploiting two immune concepts, namely danger theory and negative selection. Danger theory aggregates the anomalies based on the weights of the anomalous parameters. The objective is to design a cooperative intrusion detection system (IDS) based on danger theory. Negative selection differentiates between normal and anomalous strings and counters the impact of malicious nodes faster than danger theory. We also explore other human immune system concepts and their adaptability to Wireless Sensor Network Security.

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