Studies of Radio Frequency Interference Detection Methods in Microwave Radiometry This second edition of an Artech House classic title describes in detail the relationship between radiometry and photometry. It covers information needed to solve problems in radiation transfer and detection, detectors, measuring instruments, and concepts in colorimetry. This revised second edition presents an updated treatment of modern radiometry and photometry, including brand new sections on applications and developments in light sources and scientific instruments for measuring radiation and light. Engineers are also provided with an exciting new chapter on the use of computerized optical ray tracing for “virtual” experiments on optical systems.

Passive Infrared Detection Two years of research have been conducted to determine the feasibility of using microwave radiometry for the detection, identification, and surveillance of oil pollution. Theoretical studies consisted of a review of contemporary theory concerning parameters that influence microwave emission from both unpolluted and oil-covered seas. Laboratory investigations confirm results obtained from earlier studies and established the response characteristics of the 3.2-mm sensor to continuous oil films. Airborne measurements of controlled spills off the Southern California Coast were performed with dual-polarized 3.2- and 8.1-mm sensors oriented with a forward antenna viewing angle 45 deg above nadir. Four sets of oil spills, or missions,
were performed to obtain data over a variety of sea-surface conditions. Pollutants used for the tests included No. 2 diesel fuel, 26.1 and 21.6 API gravity crude oils, and 9.7 API gravity fuel oil. Significant microwave brightness temperature oil slick signatures were noted for a wide range of ocean conditions (sea states 1-4) and oil film thickness (thickness)

Advances in Radiometry Research This workshop on ‘Advanced Technology for Radiometry and the Detection of Optical Radiation’ represents the seventh of a series of intensive academic / government interactions in the field of advanced electro-optics, as part of the Army sponsored University Research Initiative. By documenting the associated technology status and dialogue it is hoped that this baseline will serve all interested parties towards providing a solution to high priority Army requirements. Responsible for program and program execution are Dr. Nicholas George, University of Rochester (ARO-URI) and Dr. Rudy Buser, CCNVEO.

Detection and Assessment of Dental Caries

Microwave and Millimeter-wave Remote Sensing for Security Applications Classical detection theory is used to provide a framework for the study of the potential of passive detection of metallic targets by millimeter wave radiometry. The target is assumed to be embedded in a foliage environment. The problem is characterized as a two-class detection problem. Class C sub 1 denotes the class of measurements obtained when the field of view V of the radiometer contains some target elements, and C sub 2 represents the class of measurements obtained when V contains no target elements. Each of the measurement sets is characterized by probability density functions. These functions are used to obtain operating characteristic curves relating alpha and beta errors and to determine discriminant functions for the detection problem. The alpha error is the probability of assigning an observation to class C sub 1 when it belongs to C sub 2, and the beta error is the probability of assigning an observation to class C sub 2 when it belongs to C sub 1. Operating characteristic curves are useful in determining the amount of target obscuration for various alpha and beta errors. (Author).

Non-Imaging Microwave and Millimetre-Wave Sensors for Concealed Object Detection The latest EM techniques for detecting concealed targets, whether explosives, weapons, or people Extensively illustrated from basic principles to system design, the fundamental concepts of RF, microwave, millimeter wave, and terahertz detection systems and techniques to find concealed targets are explained in this publication. These concealed targets may be explosive devices or weapons, which can be buried in the ground, concealed in building structures, hidden under clothing, or inside luggage. Concealed targets may also be people who are stowaways or victims of an avalanche or earthquake. Although much information is available in conference proceedings and professional society publications, this book brings all the relevant information in a single, expertly written and organized volume. Readers gain an understanding of the physics underlying electromagnetic (EM) detection methods, as well as the factors that affect the performance of EM detection equipment, helping them choose the right type of equipment and techniques to meet the demands of particular tasks. Among the topics covered are: Ultra-wideband radar and ground-penetrating radar Millimeter, sub-millimeter, and terahertz systems Radar systems including Doppler, harmonic, impulse, FMCW, and holographic Radiometric systems Nuclear quadrupole resonance systems Author David Daniels has many years of experience designing and deploying EM systems to detect concealed targets. As a result, this publication is essential for scientists and engineers who are developing or using EM equipment and techniques for a diverse range of purposes, including homeland security, crime prevention, or the detection of persons.

Introduction to Radiometry and Photometry, Second Edition Acid drainage produced by abandoned coal mines continues to cause serious water pollution problems. Without knowing the exact location of the concealed openings and the extent of the mine, source abatement techniques are virtually impossible. Drilling is the only known method for accurately determining the location and extent of the mine voids, but this is extremely expensive. This project attacks the problem through field studies of the following geophysical methods: electrical resistivity, self-potential, infrared radiometry, total field and differential magnetometry, seismic refraction and reflection, very low frequency electromagnetic and induced polarization over well-documented, drift, coal mines. Airborne infrared radiometry proved to be an excellent tool for detecting and mapping acid mine/fresh water sources, acid mine/fresh water drainage, and
Optical Radiation Measurements: Grum, F. C., Becherer, R. Radiometry Radiometric sensors for aviation hazards have the potential for widespread and inexpensive deployment on aircraft. This report contains discussions of three aviation hazards - icing, turbulence, and volcanic ash - as well as candidate radiometric detection techniques for each hazard. Dual-polarization microwave radiometry is the only viable radiometric technique for detection of icing conditions, but more research will be required to assess its usefulness to the aviation community. Passive infrared techniques are being developed for detection of turbulence and volcanic ash by researchers in this country and also in Australia. Further investigation of the infrared airborne radiometric hazard detection approaches will also be required in order to develop reliable detection/discrimination techniques.

Microwave Radiometric Studies in Relation to Mine Detection

Microwave Radiometry and Remote Sensing of the Earth’s Surface and Atmosphere The problem of passive detection by millimeter wave radiometry of metallic targets obscured by foliage and other vegetation is defined and discussed. A model of the foliage obscuration situation is presented and evaluated on the basis of data collected in a field measurement program. Results obtained show the millimeter wave radiometric obscuration to be greater than the optical obscuration. Curve fitting techniques indicate a quadratic relationship between radiometric and optical obscuration; hence, the maximum range of a radiometric system will be reduced linearly with optical obscuration instead of theoretically with a square root relationship. Further refinements of the model are discussed and are to be included in a general foliage penetration model to be evaluated at a later date.

MILLIMETER WAVE RADIOMETRIC DETECTION OF TARGETS OBSCURED BY FOLIAGE.

Applied Photometry, Radiometry, and Measurements of Optical Losses reviews and analyzes physical concepts of radiation transfer, providing quantitative foundation for the means of measurements of optical losses, which affect propagation and distribution of light waves in various media and in diverse optical systems and components. The comprehensive analysis of advanced methodologies for low-loss detection is outlined in comparison with the classic photometric and radiometric observations, having a broad range of techniques examined and summarized: from interferometric and calorimetric, resonator and polarization, phase-shift and ring-down decay, wavelength and frequency modulation to pulse separation and resonant, acousto-optic and emissive - subsequently compared to direct and balancing methods for studying free-space and polarization optics, fibers and waveguides. The material is focused on applying optical methods and procedures for evaluation of transparent, reflecting, scattering, absorbing, and aggregated objects, and for determination of power and energy parameters of radiation and color properties of light.

Passive Standoff Detection of Chemical Vapors by Differential FTIR Radiometry This second edition of an Artech House classic title describes in detail the relationship between radiometry and photometry. It covers information needed to solve problems in radiation transfer and detection, detectors, measuring instruments, and concepts in colorimetry. This revised second edition presents an updated treatment of modern radiometry and photometry, including brand new sections on applications and developments in light sources and scientific instruments for measuring radiation and light. Engineers are also provided with an exciting new chapter on the use of computerized optical ray tracing for "virtual" experiments on optical systems.

Clinical Application of Microwave Radiometry Techniques in the Detection of Cancer Familiarization with the infrared world Thermal imaging systems extend human perception beyond the visible spectrum. Since their principle is based on the natural emission of energy by physical bodies, they represent today the subject of a great deal of interest in many fields, whether in the military field or in industry or in research laboratories. They can be employed to analyse physical properties of objects, such as their energy level or their surface appearance; they are also commonly used to observe scenes in particular conditions like night vision, or in order to increase the visibility range through haze and fogs. All of these applications exploit the properties of infrared
radiation whose characteristics are described in this book. This is achieved in a manner which differs from other publications on the same subject in that the book is governed by the intention to progressively lead the reader to a complete understanding of the infrared. The author intends to link physical theory to each specific aspect of the elements involved in the detection process, from their physical origin up to energy mapping in a two-dimensional picture. However we thought that it was unnecessary to demonstrate again that which the reader will easily find in scientific literature, nor to write another data book. Our aim is to fill the gap between theory and practical application. The subject is vast: infrared systems combines a wide variety of disciplines and image interpretation depends on the precise understanding of various phenomena.

Photometry, Radiometry, and Measurements of Optical Losses

Radiometry The revised 2nd edition of this practical book provides an expanded treatment and comparison of techniques used in advanced optical measurements, guiding its reader from fundamental radiometric and photometric concepts to the state-of-the-art in highly sensitive measurements of optical losses and in spectroscopic detection using coherent laser light and spontaneous radiation. The book describes and compares a broad array of high-sensitivity methods and techniques – from interferometric and/or calorimetric, acousto-optic and resonator or polarization to wavelength- and frequency-modulation, phase-shift and decay time studies, and direct-loss measurements for free-space, fiber- or waveguide-based systems and devices. Updated throughout, the new edition describes novel trends in spectral interferometry, frequency-comb and laser-excitation spectroscopy, reflected in the developments of Raman, Brillouin and FTIR (Fourier Transform Infra-Red) techniques for biomedical research, biotech sensing and detection. It also covers broad practical implementations of time- and frequency-domain terahertz spectroscopy measurements. This book reviews the physical concepts of radiation transfer, providing a quantitative foundation for the means of measurements of optical losses, which affect propagation and distribution of light waves in various media and in diverse optical systems and components. It focuses on the application of optical methods and procedures for the evaluation of transparent, reflecting, scattering, absorbing, and aggregated objects, and for determining the power and energy parameters of radiation and color properties of light. This updated new edition will serve as an up-to-date reference source and practical guide for those using photometric and radiometric techniques.

Ice/frost Detection Using Millimeter Wave Radiometry A novel method of human presence detection using passive millimeter-wave sensors is presented. The method focuses on detecting a standing human from a moving platform in a cluttered outdoor environment using millimeter-wave radiometry, which has not been attempted before. Ka-band radiometers are used in total power mode as well as correlation mode, which ideally responds well to self-luminous objects such as humans. The intrinsic radiative power from a human is derived as well as the responses of the total power and correlation mode. The application of correlation radiometer theory to the detection of self-luminous objects at close range is presented in the context of human presence detection. Modifications and additions to techniques developed in radio astronomy and remote sensing for close range terrestrial situations are developed and discussed. The correlation radiometer fringe frequency is analyzed in the context of the scanning beam detection system and is estimated using MUSIC and ESPRIT. Detection and classification of humans is accomplished using a Naïve Bayesian classifier. The performance of the classifier is measured using the F1-measure and the receiver operating characteristic.

Feasibility Study of Radiometry for Airborne Detection of Aviation Hazards This book contains a selection of refereed papers presented at the 6 Specialist Meeting on Microwave Radiometry and Remote Sensing of the Environment held in Florence, Italy on March 15-18, 1999. Over the last two decades, passive microwave remote sensing has made considerable progress, and has achieved significant results in the study of the Earth's surface and atmosphere. Many years of observations with ground-based and satellite-borne sensors have made an important contribution to improving our knowledge of many geophysical processes of the Earth's environment and of global changes. The evolution in microwave radiometers aboard satellites has increased steadily over recent years. At the same time, many investigations have been carried out both to improve the algorithms for the retrieval of geophysical parameters and to develop new technologies. The book is divided into four main sections: three of these are devoted to the observation of the Earth's surface and atmosphere, and the fourth, to future missions and new technologies. The first section deals with the study of sea and land surfaces, and reports recent advances in remote
sensing of ocean wind, sea ice, soil moisture and vegetation biomass, including electromagnetic modelling and the assimilation of radiometric data in models of land surface processes. The following two sections are devoted to the measurement of atmospheric quantities which are of fundamental importance in climatology and meteorology, and, since they influence radio-wave propagation, they also impact on several other fields, including geodesy, navigational satellite and radioastronomy. The last section presents an overview of new technologies and plans for future missions.

EM Detection of Concealed Targets This book explains how to optimize clinical conditions for detection of the earliest visible signs of dental caries and how best to assess caries activity as a basis for effective management. The available evidence from the literature on detection criteria and methods is distilled and placed in a clinical context to facilitate implementation in clinical practice. Guidance is offered on removal of the dental biofilm and the potential impact of various factors on the performance of different caries detection devices. The histological changes that occur during the caries process and their effect on the clinical appearance of caries lesions are explained. In addition, several caries classification systems based on visual detection criteria and designed to allow staging are presented. Consideration is also given to currently marketed detection aids, including methods involving light fluorescence, transillumination, and radiography. In each case, a summary of the detection performance, based on available supporting evidence, is tabulated together with advice on appropriate clinical application. The reader will find the text to be clearly written and informative, with many supporting clinical images.

Laser Photothermal Radiometry for the Detection of Early Enamel Demineralization

Radio Frequency Radiometry for the Remote Airborne Detection of Small Forest Fir


An Application of Pattern Recognition to Radiometric Target Detection

Theory of Broadband Autocorrelation Radiometry for Spectral Line Detection Infrared Detectors and Systems offers a deep and detailed examination of the optical detection process and the electronics of mimicking the eye. It further explores recent research in new detector materials and the latest advances in optical detectors. This text covers the range of subjects necessary for the understanding of modern infrared-imaging systems at a level appropriate for seniors or first-year graduate students in physics or electrical engineering. The first six chapters focus on fundamental background issues of radiation detection, beginning with the basics of geometrical optics and finishing with a discussion of the figures of merit used for describing the signal-to-noise performance of a detector system. Other topics include radiometry and flux-transfer issues, basic radiation-detector mechanisms, and random-process mathematics. The book concludes with a close look at infrared detection systems and related issues. In the discussion of infrared search systems, the range equation is developed in terms of the optical and detector parameters of the system. A separate chapter is devoted to modulation transfer function, a spatial-frequency-domain description of image quality. The final chapter describes the design equations for thermal-imager systems in terms of noise-equivalent temperature difference and minimum resolvable temperature. Supported and clarified by 470 illustrations and accompanied by an extensive glossary of the nomenclature, this is an excellent text for graduate and senior level courses in radiometry and infrared detectors. It is also a valuable reference for practicing engineers involved in the use, design, analysis, and testing of infrared detector-based systems.

Infrared Detectors and Systems

Radiometry Detection of Acoustic Signals
Detection of Greenbug Infestation Using Ground-based Radiometry Radiometric sensors for aviation hazards have the potential for widespread and inexpensive deployment on aircraft. This report contains discussions of three aviation hazards - icing, turbulence, and volcanic ash - as well as candidate radiometric detection techniques for each hazard. Dual-polarization microwave radiometry is the only viable radiometric technique for detection of icing conditions, but more research will be required to assess its usefulness to the aviation community. Passive infrared techniques are being developed for detection of turbulence and volcanic ash by researchers in this country and also in Australia. Further investigation of the infrared airborne radiometric hazard detection approaches will also be required in order to develop reliable detection/discrimination techniques. This report includes a description of a commercial hyperspectral imager for investigating the infrared detection techniques for turbulence and volcanic ash.

Gimmestad, Gary G. and Papanicoloopoulos, Chris D. and Richards, Mark A. and Sherman, Donald L. and West, Leanne L. and Johnson, James W. (Technical Monitor)

Langley Research Center

FLIGHT SAFETY; MICROWAVE RADIOMETERS; REMOTE SENSING; AIRBORNE EQUIPMENT; AIRCRAFT SAFETY; FLIGHT HAZARDS; INFRARED DETECTORS; AVIATION METEOROLOGY; ICE FORMATION; TURBULENCE; VOLCANOES; AERIAL RECONNAISSANCE; INFRARED RADIATION

Radiometry and the Detection of Optical Radiation This report presents a novel method for the passive standoff detection of chemical vapors by differential Fourier Transform Infrared (FTIR) radiometry. The originality of the method lies on the use of a double-input beam FTIR interferometer optimized for optical subtraction. For implementing this method, a radiative transfer model is formulated for the general case of slant path scenarios containing any type of background scenes. A procedure of radiometric calibration adapted for differential detection with a double-input beam FTIR interferometer is developed. A detection algorithm (GASEM) that controls the interferometer data acquisition and performs the on-line monitoring of chemical vapor parameters is described and validated. The differential detection method has been successfully tested in the field on several chemical vapors.

W-band Radiometry for the Non-invasive Investigation of Materials Radiometry is a fascinating, fast growing research area, and there are many interesting real life applications. This book is intended to provide readers the theoretical background of radiometry, a resource of the latest radiometry technology, as well as the latest research in radiometry. It is aimed at university/college students, researchers and engineers. It assumes readers have basic knowledge and skills concerning electronics, physics and mathematics at the university level. This book is divided into three parts. Part I is the Introduction to Radiometry, which includes the theoretical background of radiometry, radiometry sources, radiometry detectors, and radiometry optical systems. This part also includes the latest technologies available, such as different Quantum Cascade Lasers, wavelength tuneable detectors, thermal electric cooled and Stirling cooled detectors, multispectral and hyperspectral thermal cameras, high resolution and high speed thermal cameras, and various radiometry optical detection systems. Part II is called the Advances in Radiometry Research, which contains the development of the latest research in areas of biomedical applications, industrial applications, non-destructive testing, astronomy and environmental applications. This is the core part of the book, and provides a review of the latest research trends in radiometry in different application areas. It also includes a chapter on prototyping low cost radiometry devices, which provides a list of low cost lasers and detectors, low cost and compact thermal cameras, low cost optics, low cost PCB making, and finally low cost 3D printers and CNC machines. Part III is the Appendices, which includes symbols used in the book, some MATLAB example codes including least squares fitting and the latest deep learning GoogLeNet, the introduction to WolframAlpha, a list of optical, infrared and laser components suppliers, and radiometry books. This book can be used as a textbook as well as a background reading textbook, or as a resource book.

Human Presence Detection Using Millimeter-wave Radiometry

Radiometry for Low Target Detection Field investigations over clay-type soils of the Fort Belvoir area indicated that microwave radiometry is highly unsuitable for mine detection for the following reasons: (1) Numerous strong and highly variable radiation signals from soils almost completely mask mine detection signals even under the most favorable summer conditions. (During moist soil and thermally neutral conditions which prevail during much of the spring, fall, and winter, detection performance can be expected to deteriorate even more.) (2) Microwave radiation originates in upper 2 in. to 4 in. of soil of moderate moisture content (13 to 20 percent) because of soil attenuation. When soil moisture approaches saturation conditions (30 to 40 percent), emitted
radiation is confined to surface. (3) Strong similarity exists between thermal responses of microwave radiometer and typical infrared detector to mine signals. Infrared detector offers greater potential promise because of image-forming capability obtainable with high inherent resolution of infrared compared to microwave frequencies. (Author).

Use of Airborne Microwave Radiometry for the Detection and Investigation of Oil Slicks at Sea In response to the ever-increasing global threat of terrorist attacks, the personal screening industry has been growing at a rapid rate. Many methods have been developed for detecting concealed weapons and explosives on the human body. In this important new book, the authors discuss their experiences over the last decade designing and testing microwave and millimetre wave detection and screening systems. It includes examples of actual devices that they have built and tested, along with test results that were obtained in realistic scenarios. The book focuses on the development of non-imaging detection systems, which are similar to radar. These systems do not form a conventional image of the scene and the person(s) being screened. Instead, the sensors detect and analyze the effect that the body, and any concealed objects, has on a transmitted waveform. These systems allow remote detection of both metallic and dielectric devices concealed on the human body in both indoor and outdoor environments. The book discusses a number of sensor types, including active millimetre wave sensors using the direct detection and the heterodyne approach, active microwave sensors for CNR-based object detection, passive millimetre wave sensors, and the role of shielding effects in operating non-imaging MM-wave sensors. The goal of this book is to systematize the test results obtained by the authors, helping specialists to develop improved screening systems in the future. Another goal is to show how the use of non-imaging systems can reduce the cost of the screening process.

Feasibility Study of Radiometry for Airborne Detection of Aviation Hazards

Introduction to Radiometry and Photometry A novel method for RFI detection that uses the Shapiro-Wilk test of normality is also elucidated. Comparisons are made with another method based on the normality of thermal noise, the kurtosis detection technique, for the pulsed sinusoidal RFI case. Results prove that the Shapiro-Wilk technique is a viable alternative for RFI mitigation in actual systems. The thesis is concluded with a theoretical performance comparison against pulsed sinusoidal RFI using the three most commonly used RFI detection methods: Pulse detection, cross-frequency detection, and kurtosis detection. Particular emphasis is given to the cross-frequency detection method. It is shown that cross-frequency detection method provides good detection performance regardless of duty cycle for this important type of RFI.

Radio Frequency Interference Characterization and Detection in L-band Microwave Radiometry Radio Frequency Interference (RFI) is a major issue in microwave radiometry and prevents correct estimation of geophysical parameters via remote sensing. This problem is reported even in the protected portion of the L-band (1400-1427MHz) which is allocated for only remote sensing of Earth from space. RFI contamination in radiometric measurements and the methods to mitigate it have previously been discussed in the literature. On the other hand, a comprehensive characterization of the RFI environment and an optimal RFI detection procedure which combines multiple RFI detection algorithms to effectively operate in that environment have yet to be presented. This dissertation aims to fill this gap for L-band microwave remote sensing research efforts. First, the RFI problem in microwave radiometry and previously developed RFI detection algorithms and their applications in current microwave radiometers are reported. Then, the L-band RFI environment is characterized in terms of its temporal, spectral, spatial, and statistical properties using space-borne and air-borne measurements from European Space Agency (ESA) and National Aeronautics and Space Administration (NASA) missions as well as local air-borne campaigns. It is demonstrated that RFI is a global problem, and its temporal, spectral and statistical properties may change significantly. Thus, classical RFI detection algorithms based on certain assumptions on these properties are insufficient to resolve the RFI problem and a more sophisticated approach is needed. This dissertation introduces NASA’s Soil Moisture and Active Passive (SMAP) radiometer which was launched on January 31, 2015 as one of the first radiometers which implements such a multifaceted RFI detection technique. SMAP’s comprehensive multi-domain RFI detection approach is summarized and analyzed in terms of its performance under different RFI exposure scenarios using pre-launch and post-launch RFI studies. Finally, several improvements to the SMAP baseline algorithm, and future
investigations to obtain a more efficient RFI mitigation are discussed.

Detection of Abandoned Underground Coal Mines by Geophysical Methods Microwave and millimeter-wave remote sensing techniques are fast becoming a necessity in many aspects of security as detection and classification of objects or intruders becomes more difficult. This groundbreaking resource offers you expert guidance in this burgeoning area. It provides you with a thorough treatment of the principles of microwave and millimeter-wave remote sensing for security applications, as well as practical coverage of the design of radiometer, radar, and imaging systems. You learn how to design active and passive sensors for intruder detection, concealed object detection, and human activity classification. This detailed book presents the fundamental concepts practitioners need to understand, including electromagnetic wave propagation in free space and in media, antenna theory, and the principles of receiver design. You find in-depth discussions on the interactions of electromagnetic waves with human tissues, the atmosphere and various building and clothing materials. This timely volume explores recently developed detection techniques, such as micro-Doppler radar signatures and correlation radiometry. The book is supported with over 200 illustrations and 1,135 equations.

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