Progress In Electromagnetics Research Symposium
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Short Course SC004

Optical Sensors

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Tuition Fee: (USD 150)

Course Objective:

The field of optical sensors has experienced rapid growth over the past two decades. Different types of sensors have been commercialized with a market growth rate of over 50% per year in recent years. At the same time, researches are continuing in developing photonic sensors with better performance, lower cost, smaller size and multiple functionalities. In this short course, an overview of various optical sensing technologies and applications will be presented and the state-of the-art as well as future techniques for higher-performance optical sensor systems will be introduced.

Who Should Attend:

The course is designed for graduate students and young researchers who are interested in optical sensors/instrumentation and for professionals who need to develop advanced methodologies for solving engineering problems.

Course Outline:

1. **Fundamentals of optical sensing methods**
2. **Active and passive components for optical sensors**
3. **Optical fiber sensors for physical and chemical measurands**
4. **Multiplexed and distributed sensors**
5. **Micro/nano structured optical sensors**
6. **Novel sensing methodologies for next-generation high performance sensors**
7. **Industrial application of optical sensors**

PART I. BASICS OF OPTICAL SENSORS

This section reviews the basic optical methods and components for optical sensors. An optical sensor typically consists of a light transmitter, a light receiver, and other optical components that deliver light to and collect light from the sensing region. Light-measurand interaction takes place in the sensing region and the properties of light is modulated via one of the optical effects such as length, refraction, absorption, fluorescence, electro-optic, magneto-optic, Doppler, and photothermal/photoacoustic. The modulated light signal is the demodulated and measurand information recovered at the receiver end. I will discuss, by use of examples of free-space systems, the various optical effects, the common optical components and demodulation techniques. This also forms the basis for the advanced sensors to be discussed in the next two parts.

PART II. OPTICAL FIBER SENSORS

Optical fiber sensors have evolved successfully from laboratory curiosities to practical sensing technologies. They have now been widely used in a number of industrial areas with a competing edge over the traditional electric sensors. This section discusses some popular and important types of optical fiber sensors, including optical fiber gyroscopes, fibre gratings, acoustic sensors, current sensors, and chemical and gas sensors. Their applications in aerospace, structural and environmental monitoring, and in railway and power industry will also be reported. Experiences and knowledge on design of various

fiber optic sensors, and on the use of alternative technologies to realize similar functionalities can be gained though the use of examples discussed in this section.

PART III. RECENT ADVANCES IN OPTICAL SENSING TECHNOLOGIES

This section will introduce some recent developments in optical sensors, including photonic crystal sensors, cavity ring down sensors, micro/nano resonator sensors, plasmonic sensors, and optofluidic sensors. These advanced sensing concepts are still in the stage of research and development but could become the enabling technologies for the next generation of high performance optical sensors. These novel sensors could provide ultra-sensitive means for detections at molecular and atomic levels and would find applications in future environmental and biological sensing.

Instructor(s) Biography:

Prof. Wei Jin received a PhD degree in optoelectronics from Strathclyde University, Scotland, in 1991. He joined the Department of Electrical Engineering, the Hong Kong Polytechnic University in 1996 and is currently a Professor and Director of the Photonic Sensors Research laboratory. Prof. Jin made several important contributions to the field of optical sensors including the first experimental demonstration of photonic crystal fiber (PCF) gas sensors, discovery of endlessly dual-mode operation of PCF, development of ultra-sensitive fiber-tip pressure/acoustic sensors, and fabrication of the first long period gratings in air-core PCFs. He edited 2 books, published 250 Journal papers and delivered >50 invited/plenary talks. His papers were cited >3000 times (SCI, excluding self-citations). He organized the 22nd International Conference on Optical Fiber Sensors (OFS-22) and served as the TPC chair. He received PolyU's President Award for Outstanding Research Performance and Scholarly Activities, PTeC's Award for Successful Technology Transfer, NSFC's Distinguished Young Scholar Award (Category-B), and the Chiang Jiang Guest Professor Award from Chinese Ministry of Education.

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