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Chenggen Quan
Anand Asundi
Editors

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Introduction

The 9th International Symposium on Laser Metrology (LM2008) in conjunction with IMEKO TC14 – Technical Committee on the Measurement of Geometric Quantities was successfully held from 30 June to 2 July 2008 at SMU Conference Centre, Singapore. The symposium was attended by 124 delegates from 23 countries.

The symposium program included three keynote and three invited presentations given by eminent experts in their respective fields. Professor James C. Wyant of University of Arizona (USA) delivered a lecture entitled "Dynamic interferometry." Professor Wolfgang Osten of University of Stuttgart (Germany) presented the second keynote lecture, entitled "Some answers to new challenges in optical metrology." The third keynote lecture was presented by Professor Christian Depeursinge of Ecole Polytechnique Federale de Lausanne (Switzerland) on "Digital holographic microscopy: a new perspective in 3D imaging at nanoscale." Three invited presentations were given by SPIE President (2008) Kevin Harding of GE Global Research (USA), Professor Francois Polack of Synchrotron Soleil (France) and Professor Toru Yoshizawa of Saitama Medical University (Japan).

Apart from the above, 89 papers were presented in 21 oral sessions and 33 papers were presented in two poster sessions. The SPIE-sponsored best student paper competition was also held during the symposium to encourage and acknowledge excellence in oral and poster student paper presentations. The SPIE Women in Optics Lunch provided attendees with an opportunity to network with other optics professionals. Dr Rachel Won, Associate Editor of Nature Photonics presented a talk on "Communicating photonics with the public" and shared her experiences on bridging the gap between university and industry, and science publishing and editing. Students with Experts Lunch provided a chance to promote personal and professional growth through networking and encourage students to choose optics as a career. This symposium covered topics ranging from dimensional measurements to precision metrology as well as high resolution metrology with applications ranging from shape measurement to laser spectroscopy for semiconductor applications to thin film metrology.

We take this opportunity to thank all speakers and authors for contributing to the success of the symposium, to members of the international advisory committee for their assistance and enthusiastic support, to the session chairs, to our sponsors, and to the organizing committee for ensuring the efficient execution of the symposium program.

Chenggen Quan

Abstract Only

Dynamic Interferometry

James C. WYANT
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Professor of Optical Sciences
University of Arizona

A major limitation of precision interferometry is the sensitivity to the environment. This talk discusses different techniques for reducing the effects of vibration and atmospheric turbulence on interferometric measurements enabling precision interferometric measurements in uncontrolled environments. The application of these techniques for the measurement of surface vibration, the testing of optical components, the phasing of segmented optical components, and the measurement of deformations of diffuse structures will be described.

Abstract Only

Digital Holographic Microscopy: A New Perspective In 3D Imaging at the Nanoscale

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Ecole Polytechnique Federale de Lausanne

DHM belongs to the larger family of "Coherent Imaging (CI) techniques in microscopy" (CIM), which includes also Interferometric Microscopy (IM). By the recourse to reduced coherence lengths, the so-called "Optical Coherence Microscopy" OCM imaging technique has been proposed, which is traditionally based on the exploitation of the coherence in the time domain (coherence gating), whereas DHM exploits coherence in the space domain, by providing a simple mean to reconstruct from the hologram data the wavefront scattered by the specimen. It is demonstrated in this talk how the new concept of "Digital Optics" (DO) can be useful by opening the way to a new kind of microscopy performing well down to the nanoscale. The DO concept can be applied to Digital Holographic Microscopy (DHM) in order to provide aberration- and distortion-free amplitude and phase images: Ultimately, wavefronts corrected by DO techniques can be combined to provide the reconstructed scattering potential by diffraction tomography (synthetic aperture). The 3D arrangement of the dielectric properties of the specimen can be directly derived from these data. Many new applications of DHM can be found in biology where longitudinal accuracies of a few nanometers and resolutions of a few hundreds of nanometers are achievable, provided that optical signals diffracted by the object are or can be made sufficiently large, eventually by tagging. Living biological cells in culture, including their intracellular structures, have been observed with accuracies far beyond that of confocal microscopy. New developments permit now to exploit fully the measurement of absolute phase contrast, and to derive quantitatively physiological parameters with DHM such as cell refractive index and morphology. DHM offers real time observations of very small movements and deformations (nanometers), which are produced, in particular, by stimulation of excitable cells like neurons or occurring naturally in red blood cells in connection with their metabolic activities. Direct imaging of living cells and tissues by DHM is deemed to offer henceforth unique investigation means in biology and medicine.

Abstract Only

Banknote Verification Using Optical Techniques

Toru YOSHIZAWA
Saitama Medical University
Japan

Today, in the high-technology world, one of the crucial social problems is counterfeiting of currency. The situation is the same with a high-tech country such as Japan. Counterfeit currency of all kinds of notes found in 1998 was 807, but more than 20,000 notes were detedcted in 2002, and 25,000 notes in 2004. This means total amount of detected banknotes increased 32 times during these six years. The main reason is attributed to the rapid widespread use of color copying and printing machines. At the same time, the fact that vending machines and bill validators are too popular in Japan caused this result. Consequently, the Bank of Japan issued the three new bank notes in November 2004. Some of the former features were 1) Watermark, 2) Ultrafine-line printing, 3) Intaglio printing, 4) Microprinting, 5) Luminescent ink. In addition, the following security features have been added:1) Hologram, 2) Watermark-bar-pattern, 3) Latent image, 4) Pearl ink, 5) Luminescent ink, 6) Intaglio printing. Because of newly incorporated techniques, the amount of forged bills of new type notes seems to have reduced. Most of the false notes found recently are old type of notes still in circulation. However, measures have to be taken to meet the demand for discrimination of a legitimate bill from a fake because forging techniques are becoming more skillful. Moreover, most of false notes are found in the vending machines or bill validators for drinks and game machines such as ?Pachinko? which are counted to be more than 5.5 million in Japan. To cope with the situation, a project team was set up two years ago by members from two universities, an institure and an industrial company. This team succeeded in developing sensors for checking hologram pattern, fluorescence of ink, microprinting pattern, and watermark. One group focused on checking the microprinting. Microprinting technique has been adopted to draw a portrait on the front surface using fine and thin lines. When the reference pattern is overlapped on the note, distinct moire pattern is produced, whereas, in the case of a copied note, blurred poor pattern appears. Another group weighed three-dimensional information as well as two-dimensional pattern. In printing banknotes higher technique such as intaglio printing has been used. In this case, the ink is raised much higher than by conventional anastatic printing. Such high raise is impossible to duplicate or produce by using letter press, an office printer or a copying machine. To detect this raising of ink, they applied newly improved structured-light-method which has been used in industrial applications to car industry and/or semiconductor industry for measurement of 3D profile of bodies, dies, bumps, etc. The proto-type apparatus incorporating these detection principles is now undertesting, and a bill validator equipped with new sensors is expected to be commercialized.

Multi-Sensor Target Recognition Fusion Based On Fuzzy Evidence Theory

Feng HAN, WanHai YANG and XiaoGuang YUAN
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It is important to situation and threat assessment that targets in battle field are identified timely and exactly, which is the key element of victory in the war. D-S evidence theory is an important method and is widely used in automatic target recognition system. However, modern wars have the trait of air-surface integration and electronic counter measures are taken by both hostile sides, which makes battlefield more complex increasingly. As a result, the data measured by different sensors are imprecise, half-baked, fallibility and the attributes of targets in the model database may be fuzzy too. So, multi-sensor target recognition is not carried off in a state of normal in this condition. In this situation, how to finish multi-sensor target recognition is an open issue. In order to solve this problem, a multi-sensor target recognition fusion model based on fuzzy evidence theory was set up. Firstly, each factor that has influence on target recognition was analyzed in the model, and then different weights are selected in each sensor according to the fuzzy membership function. The degree of membership of the measured target relative to the reference target in the target-base is gained, and then the decision results are sent to the fusion center. In the fusion center, D-S evidence theory was used to implement data fusion, and the target recognition decision results were obtained finally. The simulation experiment shows that it can identify the target accurately and is an effective and feasible multi-sensors target recognition fusion method.

Abstract Only

Optical Fiber Sensors Analysis By In-Line Digital Holographic Microscopy

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In this paper in-line digital holographic microscopy is presented to study splicing point of optical fiber sensors. A diverging beam is used to illuminate the object to get desired magnification. The amplitude and phase information of the object is recorded digitally and then numerically reconstruct. The amplitude contrast image shows the amplitude distribution of the object however the phase image shows the information about refractive index. The profile of the refractive index distribution of optical fibers is studied by reconstructed phase contrast image. This method is extended for the analysis of splicing point of optical fibers. Two optical fibers are spliced together and their refractive index distribution is studied. The fibers are joined together by heat created by an electrical spark. We conclude that this analysis helps to calculate the loss in the light during in spliced optical fibers and can found promising applications in optical MEMS.

Micro-Raman Mapping Of Ge Rich Sige-On-Insulator And Ge-On-Insulator Templates

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In this study, we report on the micro-Raman mapping studies on high Ge-content SiGe-on-insulator (SGOI) and Ge-on-insulator (GeOI) templates. These templates are prepared by Ge condensation techniques and we have successfully produced nearly-relaxed SGOI and GeOI layers of good crystalline quality. SGOI layers with varying Ge contents (20 to 100% Ge) are chosen for micro-Raman probing of in-plane strain distribution on the surface. Thick GeOI templates formed by thermal intermixing and subsequent condensation of epitaxially grown high Ge-content SiGe on Si-on-insulator (SOI) substrate reveal that phonon peak associated with the Ge-Ge optical vibration approaches the bulk Ge optical phonon peak. An additional cyclic annealing step has led to the reduction of the compressive strain on GeOI surface, which is confirmed by two-dimensional visible Raman mapping. The distribution of layer strain and the relaxation mechanism in thick GeOI templates are discussed based on the Raman mapping data.

Optical Properties Of AlGaN/GaN Multiple Quantum Wells Grown On Nano-Epitaxial GaN

K Y ZANG, X H ZHANG and S J CHUA
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AlGaN/GaN multiple quantum wells (MQWs) were grown on nano-epitaxial GaN template by metalorganic chemical vapor deposition. Hexagonal nanopore arrays in SiO_2 film are fabricated on the underlying GaN using anodic alumina (AAO) as etch masks, resulting in a nanoporous SiO_2 mask layer with an average nanopore diameter and interpore distance of 60 and 110nm, respectively. The photoluminescence measurement shows great increase in intensity on nano-epitaxy GaN compared to that of the MQWs grown on planar GaN. The improvement in photoluminescence of the AlGaN MQWs is benefited from the reduction of threading dislocation density in the nano-epitaxial GaN layer, revealed from cross-sectional transmission electron microscopy. It is also attributed to the improvement of light extraction efficiency by the periodic arrangement at the nanoporous SiO_2 mask. The nanoporous SiO_2 mask acts as both a threading dislocation reduction layer and a 2-dimentional (2D) photonic crystal layer to enhance both internal quantum efficiency and external light extraction efficiency. The use of nano-epitaxy method improves both internal quantum efficiency and external quantum efficiency for III-nitrides based optoelectronic devices.

CARS Spectra Measurements Of CO_2 In Nanopores

Sergey DUBYANSKIY
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Nonlinear optics are widely used for investigations of nanocomposite objects spectral properties. These properties are defined by individual contributions of both nano-porous matrix and filling molecular matter. The mechanism of molecular vibrations can be essentially modified due to molecular interaction with the wall surface of nanoporous matrix in comparison with the case of liquid in bulk volume. Therefore, the molecular spectra can be essentially deformed in comparison with molecular spectra in bulk volume and also they depend on pores size and topology. We studied the influence of nanoporous glass walls on spectral broadening of carbon dioxide Fermi dyad ν1/2ν2 Q-branches with CARS spectra measurements. The nanoporous glass sample with nanoporous average diameter about 40 nm and void-solid ratio ~30% was filled with liquid carbon dioxide in high-pressure cell. Spectral linewidth was investigated as a function of liquid density comparatively in a bulk volume and in nanoporous glass sample. Measurements were fulfilled at room (25 ^{o}C) and near-critical (30.5^{o}C) temperatures at density range 340÷450 Amagat. Non-resonant signal in the case of carbon dioxide in a bulk volume was negligible, whereas nano-porous glass cell provided considerable non-resonant contribution and special fitting procedure was used in order to separate resonant part.

An Application Of Stereo Vision In 3D Measurement Of Microstructures

Tao ZHANG and J J GUO
Xi'an Jiaotong University, China

This paper attempts to apply the stereo vision system into 3D coordinates measurement of microstructures. A conventional bridge-type coordinate measuring machine (CMM) with an opto-tactile fiber probe for the measurement of microstructures has been equipped with dual-camera vision system. Image of the fiber probe sphere during probing of the measured surface is captured by the cameras. Then, based on the principle of stereo vision measurement, the center of fiber probe sphere is deduced and the three-dimensional coordinates of the probing point are obtained. The arrangement of the dual cameras and the global calibration of the system are discussed in this paper.

Partial Differential Equation Based Denosing In Electronic Speckle Pattern Interferometry Fringe Patterns

Haixia WANG, Kemao QIAN and Wenjing GAO
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Fringe pattern produced by electronic speckle pattern interferometry (ESPI) are evaluated to measure the deformations on object surfaces. Noise in the fringe pattern is one of the key problems affecting the unwrapping result. This paper presents a partial differential equations (PDEs) based denoising filter to reduce the noise and improve the fringe pattern image quality. Experimental results show that this filter is flexible, fast and capable of removing most of the noise in ESPI fringe image.