Recommended Papers

IR Sensors and Systems


Dazzling and damage to helicopters and aircrafts pilots eye and/or goggles, from laser pointers and other lasers, is a well-known problem nowadays. One proposed solution is to use a notch filter to allow only a narrow band of wavelength. However, these types of filters block power at a specific wavelength regardless of the power level and the available wavelength-agile lasers make this strategy useless. KiloLambda developed an Optical Power Control (OPC) device that reduces laser power threat to a safe level for a variety of optical systems. The talk presents wideband dazzling protection goggles that uses a novel technology for air-force pilot, eye safety, applications.

8354-14: **Thermographic imaging of the space shuttle during re-entry using a near-infrared sensor**
Author(s): Joseph N. Zalameda, Thomas J. Horvath, Robert V. Kerns, NASA Langley Research Ctr. (United States); Jeff C. Taylor, Thomas S. Spisz, David M. Gibson, The Johns Hopkins Univ. Applied Physics Lab. (United States); Edward J. Shea, Futron Corp. (United States); David Mercer, Stinger Graffarian Technologies, Inc. (United States); Richard J. Schwartz, Analytical Mechanics Associates, Inc. (United States); Steve Tack, Naval Air Warfare Ctr. Weapons Div. (United States); Brett C. Bush, Photon Research Associates Inc. (United States); Ronald F. Dantowitz, Celestial Computing, Inc. (United States)

High resolution calibrated infrared imagery of the Space Shuttle was obtained during hypervelocity atmospheric re-entry of the STS-119, STS-125, STS-128, STS-131, STS-132, and STS-133 missions. This data has provided information on the distribution of surface temperature and the state of the airflow over the windward surface of the Orbiter during descent. In this paper we provide details of the NIR imaging system used on both land and air based imaging assets. The paper will discuss calibrations performed on the NIR imaging systems that permitted conversion of captured radiant intensity (counts) to temperature values. Image processing techniques including image registration and averaging, image histogram analysis, and 3-dimensional mapping will also be presented.

8354-24: **Infrared evaluation of insulated pipelines to detect water that could cause corrosion under insulation (CUI)**
Author(s): Douglas Burleigh, La Jolla Cove Consulting (United States); H. Allen Sanders, Kakivik Asset Management, LLC (United States)
IR is being used to evaluate Pipelines in the Arctic zone. Pipelines are insulated with foam and covered with a metal sheath. By various means, water can enter the sheath and become trapped in the insulation. If the water comes into contact with the steel pipe, it can cause corrosion, which can ultimately cause a pipeline leak. This is called Corrosion Under Insulation (CUI). In addition to a loss of oil, a leak will cause environmental contamination. IR is being used to detect water in the insulation before it causes leaks.

8353-29: **Advanced imaging R&D at DARPA-MTO** (Keynote Presentation); Author(s): Nibir K. Dhar, Defense Advanced Research Projects Agency (United States)

No abstract available

8354-29: **Using aerial infrared thermography to detect utility theft of service**
Author(s): Gregory R. Stockton, RecoverIR, Inc. (United States) and United Infrared, Inc. (United States) and Stockton Infrared Thermographic Services, Inc. (United States); R. Gillem Lucas, RecoverIR, Inc. (United States)

Natural gas and electric utility companies, public utility commissions, consumer advocacy groups, and cities across United States continue to turn a blind eye towards energy theft of service, which is in excess of $10 billion. This paper will define the problem and present successful techniques for finding energy theft using thermal infrared from the air, computer algorithms and analysis. These techniques can be used successfully to stop theft, but only if the stakeholders across America admit the problem, and are willing to not just pass the cost of theft on to the bill-paying public.

8354-31: **Breast cancer in tough economic times, new paradigms emerging**, Phillip Bretz, Desert Breast and Osteoporosis Institute and Desert Breast Foundation; Richard Lynch, Desert Breast and Osteoporosis Institute.

Osteoporosis Institute. To investigate the efficacy of melding two emerging technologies: pharmacogenomics and modified military digital infrared to establish their capability in diagnosing ultra-small breast cancers as well as other cancers.

**Defense, Homeland Security, and Law Enforcement**

8357-43: **Findings from the landmine ageing study**, Colin King, C King Associates Ltd.

Based on the recovery and breakdown of live mines from minefields in several countries, this study offers some important insights into the effects of ageing on landmines. There are implications for virtually every aspect of mine action, ranging from funding and management through to military operations and humanitarian demining. Many of the findings may also be applicable to other types of ammunition.
Design of a diffuse reflectance spectrometer explosive detector with Risley, Elizabeth Schundler, Julia Rentz Dupuis, David Carlson, Robert Vaillancourt, Craig Schwarze, OPTRA, Inc.

OPTRA is developing a compact, wide field diffuse reflectance spectrometer for trace explosive detection from a safe standoff. This system is comprised of three key components: a quantum cascade laser, a cooled detector, and a Risley scanner. The quantum cascade laser provides broad spectral tuning across the long wave infrared region. The detector provides the required sensitivity to detect signal changes due to the absorption of trace explosives. The Risley scanner enables spatial scanning of the field. By pairing these components with algorithms, an explosive map of the scene can be generated. This paper presents OPTRA’s prototype design.

Real-time quantitative hydrocarbon gas imaging with the gas cloud imager (GCI), Nathan Hagen, Robert Kester, Rebellion Photonics.

The gas cloud imager (GCI) is a passive uncooled multispectral camera capable of unprecedented sensitivity for analyzing hydrocarbon gas mixtures in a scene. The GCI obtains a 250x250 image of gas concentrations at 30 frames/sec, allowing for real-time display in a compact instrument without moving parts. We summarize the instrument design and present experimental data demonstrating its performance.

The future of biosurveillance-biosensing strategies (Keynote Presentation)

Dr. Franca Jones, from the Executive Office of the President - Office for Science and Technology Policy (OSTP), will be giving a talk on the future of Biosensing. Based on recent policy changes in Biosecurity, this talk aims to help the RDT&E community understand future biological sensing needs. ~ Augustus W. Fountain III, Ph.D.

3D vision system for enhanced robotic tele-operation for the homeland security mission, Richard Edmondson, Polaris Sensor Technologies, Inc. Polaris Sensor Technologies has developed a stereo vision upgrade for TALON comprised of a replacement cameras on the robot, and a replacement display in the Operator Control Unit. Polaris has also recently collaborated with Harris Corporation to integrate the 3D vision system onto a prototype seven degree of freedom haptic arm. In studies done at Fort Leonard Wood it has been shown that 3D vision, and 3D vision combined with haptics, provides intuitive perception, allowing for improved performance and the potential for reduced time on target. We discuss the potential benefits of these enhancements to robots used for homeland security.

Indoor imagery with a 3D through-wall synthetic aperture radar, Pascale Sevigny, David DiFilippo, Defence Research and Development Canada, Ottawa; Jonathan Fournier, Defence Research and Development Canada, Valcartier; Tony Laneve, Defence Research and Development Canada, Ottawa.
Through-wall radar imaging is an emerging technology with great interest to military forces operating in an urban battlefield. In this paper, we present our through-wall radar system mounted on the side of a vehicle and driven along a path in front of a building of interest. The vehicle is equipped with a LiDAR (Light Detection and Ranging) and motion sensors that provide auxiliary information. We present experimental results that demonstrate the 3D capability of the radar. We further demonstrate target detection behind challenging walls, and imagery of internal wall features. Finally, we discuss future work.

8363-17: Recent advances in room temperature semiconductor terahertz sources (Keynote Presentation), Author(s): Manijeh Razeghi, Northwestern Univ. (United States)

The terahertz (THz) spectral range offers promising applications in science, industry, and military. THz penetration through nonconductors (fabrics, wood, plastic) enables a more efficient way of performing security checks (for example at airports), as illegal drugs and explosives could be detected. Being a non-ionizing radiation, THz radiation is environment-friendly enabling a safer analysis environment than conventional X-ray based techniques. However, the lack of a compact room temperature THz laser source greatly hinders mass deployment of THz systems in security check points and medical centers. In the past decade, tremendous development has been made in THz Quantum Cascade Laser (QCLs), however, room temperature operation is still lacking mainly due to rapidly increasing LO-phonon scattering rate. Alternatively, recent demonstration of InP based mid-infrared QCLs with unprecedented performances at room temperature opens up the possibility of producing high power THz emission with difference frequency generation (DFB) through two mid-infrared wavelengths. Given a much larger LO-phonon energy, III-Nitrides are also promising candidates for room temperature THz lasers. However, realizing high quality material for GaN-based intersubband devices presents a significant challenge. Advances with this approach will be presented.

8364-16: Image processing: digital vs. polarization-based enhancement encoding techniques, Aed El-Saba, Univ. of South Alabama. Image processing is a field of great interest for many applications.

Nowadays it is very hard to name an application where image processing is not involved. Digital techniques remains the dominant ones applied to digital image processing with significant automation approaches that are built in image display, as in most digital cameras and digital TVs, to name few. Depending on the application, digital image processing techniques produces satisfactory accurate results. However, their main constraint is the processing time, an inherited problem associated with any digital image processing technique. On the other hand optical image enhancement techniques are polarization-based ones that simultaneously produce satisfactory accurate results and overcome the processing time constraint associated with their digital counter ones.

Sensing for Industry, Environment, and Health

8366-7: Laser photoacoustic sensor for air toxic measurements, Coorg Prasad, Jie Lei, Science & Engineering Services, Inc.; Wenhui Shi, Guangkun Li, MassTech Inc.
The detection and measurement of the concentration of various environmental pollutants such as Hazardous Air Pollutants (HAPs) and toxic gases is of increasing importance. Most of the sensors for measuring these toxic compounds are specific to a single gas or able to measure only a few of them. We describe a Laser photo acoustic spectroscopy gas analyzer equipped with a continuous wave, room temperature IR Quantum Cascade Laser (QCL) for continuous real-time measurements of multiple gases/chemical components. We have measured various HAPs such as Benzene, Formaldehyde, and Acetaldehyde in the presence of multiple atmospheric interferents.

8369-14: **3D imaging of tomato seeds using frequency domain optical coherence tomography**, Gang Yao, Chuanmao Fan, Univ. of Missouri-Columbia.

A frequency domain OCT system was used to image tomato seeds. The system has a central wavelength of 845nm with a 47 nm bandwidth. The requirement for depth scan was eliminated by using a Fourier domain implementation. The B-scan imaging speed was limited by the spectroscopic imaging CCD at 52 kHz. The calibrated system has a 9µm depth resolution and a 30 µm lateral resolution. Our results show that major seed structures can be clearly visualized in OCT images. Potential issues and future development are also discussed.

8371A-1: **New imaging and sensing architectures for telemedicine and global healthcare**, Aydogan Ozcan, Univ. of California, Los Angeles.

We present an on-chip cytometry platform that utilizes cost-effective and compact components to enable digital recognition and microscopic imaging of cells with sub-cellular resolution over a large field of view without the need for any lenses, bulky optical components or coherent sources such as lasers. This holographic imaging and diagnostic modality has orders of magnitude improved light collection efficiency and is very robust to misalignments which eliminates potential imaging artifacts or the need for realignment, making it highly suitable for field use. We demonstrate the performance of this platform for microscopic imaging and automated counting of whole blood cells with minimal sample preparation steps yielding spatial information at the sub-cellular level. Because this platform utilizes compact and cost-effective components that are also misalignment tolerant it may provide an important toolset for telemedicine based cytometry and diagnostics applications especially in resource poor settings for various global health problems such as malaria, HIV and tuberculosis.

8371B-58: **Full-hand, 3D, non-contact scanner using sub-window-based, structured-light-illumination technique**, Veeraganesh Yalla, Flashscan3D LLC ; Laurence Hassebrook, Univ. of Kentucky ; Ray Daley, Colby Boles, Mike Troy, Flashscan3D LLC.

Fingerprint identification is a well-regarded and widely accepted modality in the field of biometrics for its high recognition rates. Legacy 2D contact based methods, though highly evolved in terms of technology suffer from certain drawbacks. Being contact based, there are many known issues which affect the recognition rates. Flashscan3D/University of Kentucky (UKY) developed state of the art 3D non-contact fingerprint scanners using different structured light illumination (SLI) techniques namely SLI single Point Of View (POV) and the SLI Sub-windowing techniques. Capturing the fingerprints by non-contact means in 3D gives much higher quality fingerprint data which ultimately improves matching rates over a traditional 2D approach. In this paper, we present a full hand 3D non-contact scanner using
the SLI Sub-windowing technique. Sample fingerprint data and experimental results for fingerprint matching based on a sample 3D fingerprint test set are presented.

8372-30: Development of new fusion products using satellite infrared, visible, synthetic aperture radar and altimetry data during the Deepwater Horizon oil spill in the Gulf of Mexico, 2010, Mitchell Roffer, Gregory Gawlickowski, Mathew Upton, Roffer’s Ocean Fishing Forecasting Service, Inc.; Frank Muller-Karger, Univ. of South Florida; Gustavo Goni, Joaquin Trinanes, National Oceanic and Atmospheric Administration.

The development of new satellite visualization products for mapping the oil + dispersant + water mixtures during the Deepwater Horizon oil spill in 2010 is presented. Due to the differing spatial and temporal resolution of satellite derived infrared (AVHRR and MODIS), visible (MODIS and MERIS), synthetic aperture radar and altimetry, as well as, the type of information provided and needed it was necessary to merge the different data. The fusion facilitated mapping the oil and dispersant mixture and the surface current flow fields in the near field and far field over a variety of spatial and temporal scales.

Emerging Technologies

8378-1: Past, present, and future of BSE imaging in the SEM (Invited Paper) (Keynote Presentation)  
Author(s): Oliver C. Wells, Lynne M. Gignac, Michael S. Gordon, IBM Thomas J. Watson Research Ctr.  
(United States)

In this talk, we will describe developments in backscattered electron (BSE) imaging in the scanning electron microscope (SEM) since the pioneering work of Charles Oatley, Dennis McMullan, and Kenneth Smith in the 1950's. Recent work on BSE imaging with very high energy (100's of KeV) electron beams, such as the inspection of voids in metallurgy under thick dielectrics in semiconductor packaging will be presented. Finally, we will look toward the future of BSE imaging in terms of the SEM's, detectors, and application areas.

From conference chair Michael T. Postek: In this session, the opening invited paper of the conference is presented by Dr. Oliver Wells entitled “Past, present, and future of BSE imaging in the SEM” (8378-1). At the end of the presentation Dr. Wells will be recognized with the first Professor Sir Charles Oatley Memorial Award: “in recognition for his pioneering work in the field of scanning electron microscopy and his over 60 years of dedication to microscopy education and research.” This provided an opportunity for both conferences to see and meet a true pioneer in the field of scanning electron microscopy.

8380-28: The mitigation of cloud impacts on free-space optical communications, Randall Alliss, Billy Felton, Michael Mason, Northrop Grumman Corp. The mitigation of clouds is a key driver in the performance of free space optical communication (FSOC) systems.

The Lasercom Network Optimization Tool (LNOT) is used along with a mission CONOPS and a long duration, high resolution cloud database to find configurations of geographically diverse ground sites which provide a high availability system. Examples of LNOT trade studies will be shown for various free space scenarios such as optical communications from the Moon to Earth and from Deep Space to Earth.
Speckle signatures of articulating humans, Dallis Conrad III, Univ. of Dayton; Edward Watson, Air Force Research Lab.

Speckle is a well-investigated interference phenomenon that is produced by coherent light scattering off a rough surface. While speckle is often considered a noise source, it can be used to obtain information about the object. We investigate a non-imaging technique using speckle statistics to estimate object articulation. It is anticipated that as an object articulates, perhaps periodically as in a person walking, the object illumination distribution, and therefore average speckle size in the far field, will vary in time. In this paper we investigate, through simulation and lab experiments, the effect of object articulation on speckle statistics.

Innovative Defense and Security Applications for Displays

3D visual systems using integral photography camera, camera array, and electronic holography display, Kenji Yamamoto, Yasuyuki Ichihashi, Takanori Senoh, Ryutaro Oi, Taiichiro Kurita, National Institute of Information and Communications Technology. This paper introduces two 3D visual systems toward ultra-realistic communication. The first system uses integral photography for the capture of ray information at slightly separated locations. The second system uses camera array that includes 300 cameras to capture ray information at more sparse locations than integral photography. Both systems use electronic holography as an ideal 3D display.

Is it worth using an array of cameras to capture the spatio-angular information of a 3D scene or is it enough with just two? Hector Navarro, Manuel Martinez-Corral, Genaro Saavedra-Tortosa, Univ. de València; Bahram Javidi, Univ. of Connecticut.

An analysis and comparison of the lateral and the depth resolution in the reconstruction of 3D scenes from images obtained either with a classical two view stereoscopic camera or with an Integral Imaging (InI) pickup setup is presented. We demonstrate that InI is the optimum system to sampling the spatio-angular information contained in a 3D scene.

Space Technologies and Operations


A concept of a compact device for analyzing key isotopic composition in surface materials without sample preparation will be presented. This design is based on an advanced modification of Laser Induced Breakdown Spectroscopy (LIBS). First, we developed a method, Laser Ablation Molecular Isotopic Spectrometry (LAMIS) that involves measuring isotope-resolved molecular emission, which exhibits significantly larger isotopic spectral shifts than atomic transitions. Second, we use laser induced plasma to vaporize the sample materials into a plume in which absorption spectra are measured using a tunable diode laser. The intrinsically high spectral resolution of the diode lasers enables accurate
measurement of isotopic ratios. The absorption sensitivity can be boosted using cavity enhanced spectroscopy.

8385-24: Multileader Stackelberg games for anti-jamming cognitive radio
Author(s): Zhi Tian, Michigan Technological Univ. (United States); Xin Tian, Dan Shen, I-Fusion Technologies, Inc. (United States); Khanh Pham, Erik Blasch, Air Force Research Lab. (United States); Genshe Chen, DCM Research Resources, LLC (United States)

During tactical operations, cognitive sensors continuously monitor and detect jammers via spectrum sensing and signal classification. Detected jammers will be treated as "target-leaders", whose information is known to cooperative sensors during the observation period and will be active mitigated through gaming strategies. Non-detected jammers will be treated as "interference", whose individual knowledge is unknown but the aggregate effects to sensors can be sensed and mitigated via properly imposed interference constraints. In anticipation of multiple active jammers, we develop a multi-leader Stackelberg game (MLSG) solution which requires new methods to characterize the sensor-to-jammer relations.

From conference chair Khanh D. Pham: As demonstrated in the paper, from the literature review, there was not a defined way to process correlated measurements from overlapping sliding windows. If we assume that we do a sliding window test (where we get all the data in a window), then we can process the data. To aid academic studies, we demonstrate the limitation of the sliding window test with the independence assumption. The paper can be used in classroom experiences for experimentation. For applications, the issue surrounds the needs of which communication devices (spectrum access) and space communications (long distance) can utilize the method. The detection problem is that all the data is collected and batted in a window; but maybe the data of relevance requires a different window size, varying window sizes, or a connection between data in different windows. This segmentation of the data into windows could relate to the exploitation of the data and spectrum access. The method supports increased detection for spectrum access. For the long-distance communication problem, if we have to wait for the data to be collected, it could cause spectrum and access management problems. Thus we need an overlapping sliding window method for communication timeliness.

Potential or future applications of research: For the case of the military communications applications, there are long distances between some communications platforms and thus, the wait time for a sliding window analysis (with non-overlapping sliding windows) would challenge the spectrum allocation of data between entities of varying distances. Finally, we feel the documentation (packaged in SPIE proceedings) aids the general DOD community by providing a textbook example of issues to consider in a preferred cognitive radio method of independent sliding window assumptions.

Unmanned, Robotic, and Layered Systems


Nearly all explosive ordnance disposal robots in use today employ monoscopic standard-definition video cameras to relay imagery from the robot to the operator. We recently completed a Joint-Ground-Robotics-Enterprise-sponsored study in which head-aimed high-definition (HD) and stereoscopic video
cameras were used in addition to conventional cameras in order to determine if higher resolutions and/or stereoscopic depth cues improve operators' overall performance of various unmanned ground vehicle (UGV) tasks. In general, the study results support the expectation that higher resolution and stereoscopic vision aid UGV teleoperation, but the degree of improvement was found to depend notably on the specific task being performed.

8387-52: Design and development of a revolutionary VTOL micro-air vehicle: the cyclocopter, Moble Benedict, Inderjit Chopra, Univ. of Maryland, College Park.

The cyclocopter or a cycloidal-rotor aircraft is a revolutionary flying concept which has not been systematically studied in the past. Even though there have been many attempts from various researchers to build cyclorotor-based aircrafts, none of them have been successful in building a stable flight-capable vehicle until recently, when an MAV-scale cyclocopter was successfully built and flight tested at the University of Maryland. This paper would discuss the design and development of this vehicle. The paper would also include the systematic experimental and computational studies that have been conducted at the University of Maryland on the cycloidal rotor concept over the past 5 years which has been the key to the success of this vehicle.


A key challenge of sentry and monitoring duties is detection of approaching people. We are exploring smartphones as easily available, easily portable, and less expensive alternatives to traditional military sensors for this task, where sensors are already integrated into the package. An application was developed that uses the sensors of the Android Smartphone to look for people passing nearby and take their pictures. We got best results with the microphone (looking for footsteps) and light sensor (looking for abrupt changes in light). We ran a variety of tests with subjects walking at various distances from the smartphone under different environmental conditions, and report on these.

Sensor Data and Information Exploitation

8395-6: The Airborne Aero-Optics Laboratory (AAOL) (Invited Paper), Author(s): Eric J. Jumper, Stanislav Gordeyev, Michael A. Zenk, David A. Cavalieri, Univ. of Notre Dame (United States)

This paper will give a brief overview of aero-optic phenomenon and then describe the Airborne Aero-Optics laboratory (AAOL) program as an affordable research tool to measure aero-optical distortions in ground facilities and in flight. The AAOL program includes components in computational and theoretical modeling of aero-optical phenomena, wind-tunnel testing and, most uniquely, flight testing on two, transonic jet aircraft. The paper will briefly mention all aspects of the program but then go more deeply into of aircraft systems, their engineering development and of the various hardware needed to make the program possible and, finally, the evolution of the instrumentation suite used in the main laboratory aircraft. Also included will be a brief review of the type of data that we are now routinely collecting both in the wind tunnel and in flight, with some discussion of the future of the program.
8395-7: **Recent data from the AAOL (Invited Paper)**
Author(s): Nicholas DeLucca, Stanislav Gordeyev, Eric J. Jumper, Michael A. Zenk, David A. Cavalieri, Univ. of Notre Dame (United States)

In this talk recent in-flight aero-optical measurements on Airborne Aero-Optics Laboratory (AAOL) will be given. Instrumentation and experimental set-up will be presented. Results of extensive survey of aero-optical environment at different viewing angles for both flat-window and conformal-window turrets at different subsonic and low transonic speeds, below M = 0.65, will be presented, compared and extensively discussed. Statistical analysis of wavefronts at different viewing angles will be presented and discussed. A possible extension of subsonic scaling laws to low transonic speeds will be proposed and discussed.

8394-31: **Robust 3D reconstruction using lidar and polarized image**, Prakash Duraisamy, Univ. of North Texas; Mohammad Showkat Alam, Univ. of South Alabama.

3-D reconstruction plays vital role in many applications like city planning, heritage, video games and others. The accuracy of 3-D reconstruction is very important to maintain the high quality output. GPS or INS sensors are used to build the 3-D model, but it is a expensive approach. In this paper, we introduce a novel approach without using GPS or INS sensor to build the 3D model. We fuse polarized image with LiDAR data to build the camera matrix. We are introducing the polarized image instead of un-polarized image (regular visual image) to reduce the artifacts created by laser scanning which will refine the rough estimate of the camera matrix. This approach is inexpensive and results are promising compared to existing techniques.

8395-6: **The Airborne Aero-Optics Laboratory (AAOL)**, Eric Jumper, Stanislav Gordeyev, Michael Zenk, David Cavalieri, Univ. of Notre Dame.

This paper will give a brief overview of aero-optic phenomenon and then describe the Airborne Aero-Optics laboratory (AAOL) program as an affordable research tool to measure aero-optical distortions in ground facilities and in flight. The AAOL program includes components in computational and theoretical modeling of aero-optical phenomena, wind-tunnel testing and, most uniquely, flight testing on two, transonic jet aircraft. The paper will briefly mention all aspects of the program but then go more deeply into of aircraft systems, their engineering development and of the various hardware needed to make the program possible and, finally, the evolution of the instrumentation suite used in the main laboratory aircraft. Also included will be a brief review of the type of data that we are now routinely collecting both in the wind tunnel and in flight, with some discussion of the future of the program.

**Signal, Image, and Neural Net Processing**

8398-1: **Detection and identification of oil and oil-derived substances at the surface and subsurface levels via hyperspectral imaging**, Mohammad Showkat Alam, Ravi Gollapalli, Sidike Paheding, Univ. of South Alabama.

The BP Deepwater Horizon drilling rig accident in the Gulf of Mexico released 206 million gallons of crude oil contaminating the Gulf waters along with 665 mile stretch coastline of Texas, Louisiana, Mississippi, Alabama and Florida. Accurate detection and estimation of the oil at the surface, subsurface
and ocean floor is essential for the cleaning and mitigation efforts. It is critical to develop a quick-response technique to detect, identify and track the oil spills to facilitate efficient clean-up and minimize the impact of oil spills to the environment, economy, human life and other living organisms. The BP Deepwater Horizon drilling rig explosion in the Gulf of Mexico released 206 million gallons of crude oil contaminating the Gulf waters along with 665 mile stretch coastline of Texas, Louisiana, Mississippi, Alabama and Florida. Accurate detection and estimation of the oil at the surface, subsurface and ocean floor is essential for the cleaning and mitigation efforts. It is critical to develop a quick-response technique to detect, identify and track the oil spills to facilitate efficient clean-up and minimize the impact of oil spills to the environment, economy, human life and other living organisms. Existing techniques are limited in scope as they cover only small regions of interest (RoI). On the other hand, optical remote sensing based techniques, such as hyperspectral imaging can provide information over vast regions of interest. Hyperspectral imaging can provide information in minute details on the spread of the surface and subsurface oil and oil derived substances which can assist in the containment and mitigation efforts before the oil spill can become a full-blown catastrophe. Current techniques can detect and identify surface oil but fail to address the critical issue of detecting subsurface oil and estimate the depth where the oil is present. In this paper, we developed an algorithm for detecting both surface and subsurface oil using hyperspectral imagery. In this technique, a support vector machine (SVM) based classifier is trained using potential ROIs to classify the oil/oil-derived substances at the surface and subsurface levels using AVIRIS data available from the Jet Propulsion Laboratory. The proposed technique provides an efficient way for estimating the amount of oil as well as the depth of the subsurface oil location, which may provide crucial information in the containment, mitigation and clean-up efforts. Test results using AVIRIS data is presented to verify the effectiveness of the proposed technique.

8401-16: **Compressive signal processing**, Richard Baraniuk, Rice Univ.

Sensing and imaging systems are under increasing pressure to accommodate ever larger and higher-dimensional data sets; ever faster capture, sampling, and processing rates; ever lower power consumption; communication over ever more difficult channels; and radically new sensing modalities. The foundation of today's digital data acquisition and processing systems is the Shannon/Nyquist sampling theorem, which asserts that to avoid losing information when digitizing a signal or image, one must sample at least two times faster than the signal's bandwidth, at the so-called Nyquist rate. Unfortunately, the physical limitations of current sensing systems combined with inherently high Nyquist rates impose a performance brick wall to a large class of important and emerging applications. This talk will overview the foundations and recent progress on compressive signal processing, a new approach to data acquisition and processing in which analog signals are digitized not via uniform sampling but via measurements using more general, even random, test functions. In stark contrast with conventional wisdom, the new theory asserts that one can combine "sub-Nyquist-rate sampling" with digital computational power for efficient and accurate signal acquisition when the signal has a sparse structure. The implications of compressive sensing are promising for many applications and enable the design of new kinds of communication systems, cameras, microscopes, and pattern recognition systems. Special emphasis will be placed on the pros and cons of the compressive sensing technique.

8401-18: **Video image cliff notes**, H. H. Szu, The Catholic Univ. of America; Charles C. Hsu, Trident Systems Inc. Smartphone images and keeps all, contributing to societal info(-po)llution. Our eyes sense all, reject many, and keep only the salient differences.
Optical microscopy is an essential tool in biological research. However, the spatial resolution of optical microscopy, classically limited by diffraction to several hundred nanometers, is substantially larger than typical molecular length scales in cells, leaving many biological structures unresolvable. We recently developed a new form of super-resolution light microscopy, stochastic optical reconstruction microscopy (STORM) that surpasses the diffraction limit. STORM uses single-molecule imaging and photo-switchable fluorescent probes to temporally separate the spatially overlapping images of individual molecules. This approach allows the localization of fluorescent probes with nanometer precision and the construction of sub-diffraction-limit images. Using this method, we have achieved multicolor and three-dimensional (3D) imaging of living cells with nanometer-scale resolution. In this talk, I will discuss the general concept, recent technical advances and biological applications of STORM.

Information Systems and Networks: Processing, Fusion, and Knowledge Generation

8403-3: High-fidelity modeling and simulation for radar electronic warfare system, Chen Wu, Anne Young, Defence Research and Development Canada, Ottawa.

This paper introduces an approach to conduct Research and Development (R&D) of Radar Electronic Warfare (REW) system concepts using a High-Fidelity Modeling and Simulation (HFM&S) environment with advanced computer hardware and software technologies. More specifically, it defines HFM&S as it pertains to REW systems, discusses the reasons why an REW system-level HFM&S is needed, explains the differences between HFM&S and modeling and simulation tools that are currently used in the REW area, and demonstrates the development and use of HFM&S for REW system concepts. Although the approach discussed in this paper focuses on REW systems in general, and many examples are drawn from electronic support measures for unmanned aerial vehicle payloads in particular, this approach can be applied to other fields, including the R&D of communications electronic warfare, navigation electronic warfare, radar system development, as well as distributed electronic warfare system concepts.

8404-2: Prototype rf sensing platform for wireless sensor networks, Christopher Barber, Rastko Selmic, Louisiana Tech Univ.

This paper discusses the design, development, and integration of a prototype RF sensing system for the IRIS wireless sensor network platform. Integration of this RF sensing system with a wireless sensor network provides a method by which the real-time continuous sensing of the RF environment at specific frequencies can occur. Using a set of secondary receivers for received signal strength (RSS) detection we are able to expand the spectrum sensing capabilities beyond the operational frequency of the IRIS nodes primary receiver. The results of testing this prototype RF sensing platform will be presented in this paper.

8405-17: Advanced thermal management technologies for defense electronics, Avram Bar-Cohen, Univ. of Maryland, College Park; Kristen Bloschock, System Planning Corp.
Thermal management technology plays a key role in the continuing miniaturization, performance improvements, and higher reliability of electronic systems. For the past decade, and particularly, the past 4 years, DARPA has aggressively pursued the application of micro- and nano-technology to reduce or remove thermal constraints on the performance of defense electronic systems. The DARPA Thermal Management Technologies (TMT) portfolio is comprised of five technical thrust areas: Thermal Ground Plane (TGP), Microtechnologies for Air-Cooled Exchangers (MACE), NanoThermal Interfaces (NTI), Active Cooling Modules (ACM), and Near Junction Thermal Transport (NJTT). An overview of the TMT program will be presented with emphasis on the goals and status of these efforts relative to the current State-of-the-Art. The presentation will close with future challenges and opportunities in the thermal management of defense electronics.


Saccadic eyes are important human behaviors and have important applications in commercial and security fields. In this paper, we focus on saccadic eyes recognition from 3-D shape data acquired from a 3-D near infrared sensor. Two salient features, normal vectors of meshes and curvatures of surfaces, are extracted. The distributions of normal vectors and curvatures are computed to represent eye states. The support vector machine (SVM) is applied to classify saccadic and non-saccadic eyes states. To verify the proposed method, we performed three groups of experiments using different strategies for samples selected from 300 3-D data, and present experimental results that demonstrate the effectiveness and robustness of the proposed algorithm.


Complex object interactions and behaviors pose many challenges to existing tracking algorithms. Successful tracking of these objects and their behaviors can provide great insight into the intentions of a group of objects for security reasons, as well as, for situational awareness. This work presents an automated tracking system that tracks multiple 2D or 3D objects in a real-life scene while they interact, split, collide, deform, occlude, and move in various different motions. The system will detect, segment, track, and predict the objects motion by combining various classic image-processing techniques with a modified version of an energy contour minimization algorithm that incorporates an adaptive interacting multiple model estimator previously used for tracking biological cells. The system will also analyze the overall pattern of all the objects for classifying and identifying group intentions. The results of this work are applicable to a variety of applications pertaining to the detection of security threats.


When deploying multiple network defense appliances, today's serial architectures have numerous side effects. If a packet is dropped by one appliance, subsequent appliances will not process that packet. This introduces three significant limitations, (1) Stateful appliances placed later in the processing chain will maintain an internal "state" which will increasingly veer away from network reality; (2) The network manager cannot determine, or unit test, how each appliance would have treated each packet; (3) The
appliance "votes" cannot be combined to achieve higher-level functionality. We have developed a novel, backwards-compatible parallel architecture which addresses these limitations while opening new possibilities.