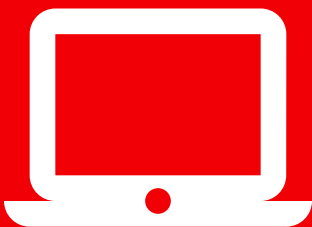
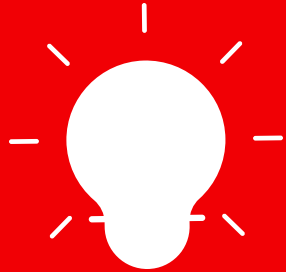
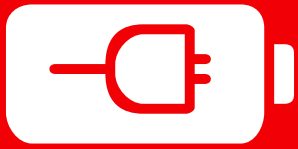


15th Annual Graduate Research and Capstone Design Conference



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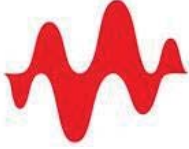
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15th Graduate Research Conference

April 26, 2019

The Hilton UH Hotel & Conference Center
Houston, Texas

8:30 - 8:55 am	Registration, Conrad N. Hilton, Lobby
8:50 - 8:55 am	Opening Remarks by Dr. Wanda Wosik, Plaza Room
8:55 - 10:05 am	Technical Program - Oral Session A , Plaza Room
10:05 -10:30 am	Welcoming Remarks, Plaza Room <ul style="list-style-type: none">• Dr. Badri Roysam, Chairman, Electrical and Computer Engineering• Dr. Claudia Neuhauser Associate Vice President/Associate Vice Chancellor for Research and Technology Transfer• Dr. Suresh Khator, Associate Dean, College of Engineering
10:30 - 10:45 am	Coffee Break, Conrad N. Hilton, Lobby
10:45- 11:50 am	Technical Program - Oral Session B , Plaza Room
11:55- 12:45 pm	Lunch, Waldorf-Astoria Ballroom
12:30 - 1:15 pm	Keynote Presentation: “Engineers are from Mars, Students are from Neptune” <i>Dr. Douglas Verret</i> , IEEE Life Fellow, Chair of ECE Industry Advisory Board
1:15 - 2:20 pm	Technical Program - Oral Session C , Plaza Room
2:20 - 2:30 pm	<i>Coffee Break</i> , Conrad N. Hilton, Lobby
2:30 - 3:35 pm	Technical Program - Oral Session D , Plaza Room
3:35 - 5:30 pm	Technical Program - Poster Session, Conrad CD Ballroom
5:30 - 6:00 pm	Elevator Talks by CDC students, Conrad AB Ballroom
6:00 - 6:30 pm	Awards Ceremony, Conrad AB Ballroom



Graduate Research Presentations

GRC 2019

The Hilton UH Hotel & Conference Center

April 26, 2019

8:30 – 8:55 am Registration, Conrad N. Hilton, Lobby

8:50 – 8:55 am **Opening Remarks in Plaza Room** by Dr. Wanda Wosik

TECHNICAL PROGRAM

Session A:

- **New Solutions for Power Supply, Transmission and Storage.**
- **Testing, Communication, and Control in Robotics and Prosthetics Including Biomedical Diagnostics and Treatment Methods.**

Session Type: Oral

Time: 8:55 – 10:05 am

Faculty Chair: Dr. Jose L. Contreras-Vidal

Poster #

8:55 – 9:00 am	A DROOP BASED SOC CONTROL OF MODULAR MULTI-LEVEL CONVERTER FOR SOC BALANCING IN GRID ENERGY STORAGE <i>Amir Hussain, Krishna Raj, and Kaushik Rajashekara</i>	A1
9:00 – 9:05 am	A NOVEL DROGI BASED CONTROL ALGORITHM WITHOUT PLL FOR SHUNT COMPENSATION USING FOUR-LEG CONVERTER <i>Shilei Jiao, Kaushik Rajashekara, and Krishna Raj R.</i>	A2
9:06 – 9:11 am	MULTI-PHASE 3-LEVEL BUCK CONVERTER WITH CURRENT SELF -BALANCING FOR HIGH BANDWIDTH ENVELOPE TRACKING POWER SUPPLY <i>Srikanth Yerra and Harish Krishnamoorthy</i>	A3
9:12 – 9:17 am	POWER CYCLING TEST BENCH FOR ACCELERATED LIFE TESTING FOR RELIABILITY ASSESMENT OF SiC-MOSFET IN EXTREME OFFSHORE ENVIRONMENT <i>Amin Sadat and Harish Krishnamoorthy</i>	A4
9:18 – 9:23 am	UNDERWATER ROBOTICS COMMUNICATIONS <i>Javier Garcia, Steban Soto, and Aaron Becker</i>	A5

9:24 – 9:29 am	SURVIVABILITY OF DRONE SWARMS WITH FLOCKING AND SWARMING FLIGHT PATTERNS USING VIRTUAL REALITY <i>Arun Mahadev, Daniel Biediger, and Aaron T. Becker</i>	A6
9:30 – 9:35 am	DEVELOPMENT OF A LOW-COST 3D PRINTED MYOELECTRIC PROSTHETIC ARM: CASE STUDY OF A 7-YEAR OLD WITH CONGENITAL DEFICIENCY <i>Alexander G. Steele, Akshay Ravindra, and Jose L. Contreras-Vidal</i>	A7
9:36 – 9:41 am	USE OF SENSORIMOTOR LATERALIZATION-BASED MEASURES FOR MONITORING CHRONIC STROKE MOTOR RECOVERY <i>Zachery R. Hernandez and Jose L. Contreras-Vidal</i>	A8
9:42 – 9:47 am	CLASSIFICATION AND IDENTIFICATION OF ABNORMAL CILIARY MOVEMENT <i>Alexander R. Craik, Ryan Thackston, Michelle Gale, and Jose L. Contreras-Vidal</i>	A9
9:48 – 9:53 am	BAYESIAN FILTERING METHODS FOR TRACKING AROUSAL AND ENERGY <i>Dilranjan S. Wickramasuriya and Rose T. Faghieh</i>	A10
9:54 – 9:59 am	STATE-SPACE MODELING AND FUZZY FEEDBACK CONTROL OF COGNITIVE STRESS <i>Hamid Fekri Azgomi, Dilranjan S. Wickramasuriya, and Rose T. Faghieh</i>	A11
10:00 – 10:05 am	PARALLEL SEMANTIC SEGMENTATION OF HIGH-THROUGHPUT IMAGING MOUSE BRAIN DATA <i>Leila Saadatfard, Pavel Govyadinov, Aryan Mobiny, Guoning Chen, and David Mayerich</i>	A12
10:05 – 10:30 am	Welcoming Remarks and Addresses in Plaza Ballroom <ul style="list-style-type: none"> • Dr. Badri Roysam, Chairman, Electrical and Computer Engineering • Dr. Claudia Neuhauser Associate Vice President/Associate Vice Chancellor for Research and Technology Transfer • Dr. Suresh Khator, Associate Dean, College of Engineering 	
10:30 – 10:45 am	<i>Coffee Break</i> , Conrad N. Hilton, Lobby	

Session B: Fabrication Methods, Design, and Characterization Methods for Materials, Devices, and Sensors.

Session Type: Oral

Time: 10:45 – 11:56 am

Faculty Chair: Dr. Stanko Brankovic

- | | | |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 10:45 – 10:50 am | FLEXIBLE MACROPOROUS ELECTRODES FOR METAL-OXIDE BASED ELECTRO-CHEMICAL SUPERCAPACITORS
<i>Sasidharan Prakasan, Rabi Ebrahim, Steven Pei, and Alex Ignatiev</i> | B1 |
| 10:51 – 10:56 am | NOVEL POLYMER CATHODE FOR HIGH-CAPACITY AND LONG-CYCLE-LIFE AQUEOUS ZINC BATTERIES
<i>Ye Zhang and Yan Yao</i> | B2 |
| 10:57 – 11:02 am | A NOVEL AQUEOUS-BASED SENSOR BY ENGINEERING CHEMI-RESISTIVITY OF AU THIN FILMS USING METAL DEPOSITION VIA SLRR
<i>Kamyar Ahmadi, Dongjun Wu, and Stanko R. Brankovic</i> | B3 |
| 11:03 – 11:08 am | IN-SITU SURFACE REFLECTIVITY MEASUREMENT FOR ELECTROLESS ATOMIC LAYER DEPOSITION
<i>Dhaivat J. Solanki and Stanko R. Brankovic</i> | B4 |
| 11:09 – 11:14 am | UNDERCUT GOLD NANODISKS IN AN ARRAY FOR PLASMONIC BIOSENSING
<i>Ibrahim Misbah and Wei-Chuan Shih</i> | B5 |
| 11:15 – 11:20 am | SERS NANOPARTICLE-BASED LATERAL FLOW ASSAY FOR ULTRASENSITIVE, QUANTITATIVE DETECTION OF PROTEIN BIOMARKERS
<i>Dilani Gunawardhana, Katerina Kourentzi, Richard C. Willson, and Wei-Chuan Shih</i> | B6 |
| 11:21 – 11:26 am | DEEP LEARNING FOR GLUCOSE SENSING BY STAMPING SURFACE-ENHANCED RAMAN SPECTROSCOPY (S-SERS)
<i>Chun-Jen Lin, Ibrahim Misbah, and Wei-Chuan Shih</i> | B7 |
| 11:27 – 11:32 am | TIB₂ MICRO-PATTERNED SUBSTRATE FOR THE DIFFERENTIATION OF MESENCHYMAL STEM CELLS INTO INSULIN PRODUCING CELLS.
<i>Jefferson Friguglietti, Fatima A. Merchant, Wanda Wosik, and Daniel W. Fraga</i> | B8 |
| 11:33 – 11:38 am | MULTIPLEX SENSING OF LEAD AND MERCURY IN DRINKING WATER USING SMARTPHONE NANO-COLORIMETRY
<i>Hoang Nguyen and Wei-Chuan Shih</i> | B9 |

11:39 – 11:44 am	SELECTIVE PLASMONIC SUBSTRATE MODIFICATION VIA PHOTOTHERMALLY GENERATED MICROBUBBLES <i>Nareg Ohannesian, Jingting Li, Ibrahim Misbah, Fusheng Zhao, and Wei-Chuan Shih</i>	B10
11:45 – 11:50 am	HOLOGRAPHIC OPTICAL TWEEZERS ASSISTED IMAGING SPECTROSCOPY <i>Mohsen Rakhshandehroo and Wei-Chuan Shih</i>	B11
11:51 – 11:56 am	BROADBAND EMISSION ENHANCEMENT OF LEAD HALIDE PEROVSKITE CSPB2BR5 MICROPLATES UNDER HIGH PRESSURE <i>Shenyu Dai, Zhaojun Qin, and Jiming Bao</i>	B12
11:56 – 12:45 pm	Lunch , Waldorf Astoria, Ballroom	
12:30 – 1:15 pm	Keynote Presentation: “Engineers are from Mars, Students are from Neptune” <i>Dr. Douglas Verret</i> , IEEE Life Fellow, Chair of ECE Industry Advisory Board	

Session C: The *magic* of Imaging: from Hyperspectral Image Analyzes to Sub-Cellular and Physiological Recognition Techniques

Session Type: Oral

Time: 1:15 – 2:20 pm

Faculty Chair: Dr. David Mayerich

1:15 – 1:20 pm	IMPROVING SPATIAL SPECIFICITY IN BROADBAND HYPERSPECTRAL IMAGES USING CURVELET-BASED IMAGE SHARPENING <i>Rupali Mankar, Mahsa Lotfilohi, Saurabh Prasad, and David Mayerich</i>	C1
1:21 – 1:26 pm	A THEORETICAL FRAME WORK FOR CHEMICAL HOLOGRAPHY <i>Shihao Ran, David Mayerich, and Rohith Reddy</i>	C2
1:27 – 1:32 pm	TIMING: HIGH-THROUGHPUT SINGLE-CELL PROFILING OF DYNAMIC CELL–CELL INTERACTIONS BY TIME-LAPSE IMAGING MICROSCOPY IN NANOWELL GRIDS <i>Rachel Mills, Badrinath Roysam, Navin Varadarajan, and Hengyang Lu</i>	C3
1:33 – 1:38 pm	CELL SEGMENTATION IN SUPER-RESOLUTION MICROSCOPY USING LOCALIZATION-REINFORCED PERCEPTURAL GROUPING (LRPG) <i>Jiabing Li, Camille Artur, Badrinath Roysam, and David Mayerich</i>	C4

1:39 – 1:44 pm	DIGITAL STAINING OF HIGH-RESOLUTION FTIR SPECTROSCOPIC IMAGES <i>Mahsa Lotfollahi, Sebastian Berisha, Davar Daeinejad, and David Mayerich</i>	C5
1:45 – 1:50 pm	HIGH-THROUGHPUT THREE-DIMENSIONAL MICROSCOPY BY MILLING WITH ULTRAVIOLET EXCITATION (MUVE) <i>Jiaming Guo, Camille Artur, Jason Eriksen, and David Mayerich</i>	C6
1:51 – 1:56 pm	HIGH RESOLUTION MID-INFRARED PHOTOTHERMAL IMAGING OF OVARIAN CANCER CELLS <i>Chalapathi C Gajjela and Rohith Reddy</i>	C7
1:57 – 2:02 pm	ANALYSIS OF BONE DISORDER USING OPTICAL PHOTOTHERMAL INFRARED MICROSCOPY <i>Licheng Zhang, Chalapathi Charan Gajjela, and Rohith Reddy</i>	C8
2:03 – 2:08 pm	MENTAL WORKLOAD CLASSIFICATION VIA HIERARCHICAL LATENT DICTIONARY LEARNING: A FUNCTIONAL NEAR INFRARED SPECTROSCOPY STUDY <i>Srinidhi Parshi, Md. Rafiul Amin, Hamid Fekri Azgomi, and Rose T Faghieh</i>	C9
2:09 – 2:14 pm	A SYSTEM THEORETIC INVESTIGATION OF CORTISOL DYSREGULATION IN FIBROMYALGIA PATIENTS WITH CHRONIC FATIGUE <i>Divesh Deepak Pednekar, Md. Rafiul Amin, Hamid Fekri Azgomi, Kirstin Aschbacher, Leslie J. Crofford, and Rose T. Faghieh</i>	C10
2:15 – 2:20 pm	INFERRING SYMPATHETIC NERVOUS SYSTEM ACTIVITY FROM ELECTRODERMAL ACTIVITY: A SPARSE SYSTEM IDENTIFICATION APPROACH <i>Md. Rafiul Amin and Rose T. Faghieh</i>	C11
2:20 – 2:35 pm	<i>Coffee Break, Conrad N. Hilton, Lobby</i>	

Session D: Numerical Optimization, Deep Learning, Electromagnetics and Electronics for Systems, Circuits and Sensors.

Session Type: Oral

Time: 2:35 – 3:40 pm

Faculty Chairs: Dr. David Jackson

2:35 – 2:40 pm	GRAPH CONVOLUTIONAL NEURAL NETWORKS FOR HYPERSPPECTRAL DATA CLASSIFICATION <i>Farideh Foroozandeh Shahraki and Saurabh Prasad</i>	D1
2:41 – 2:46 pm	MEMORY-CENTERED NEURAL COMPUTER ARCHITECTURE FOR DEEP LEARNING <i>Yawen Luo, Aswini Kumar Tata, and Yuhua Chen</i>	D2
2:47 – 2:52 pm	FIRST ARRIVAL PICKING USING U-NET WITH LOVASZ LOSS AND NEAREST POINT PICKING METHOD <i>Pengyu Yuan, Wenyi Hu, Xuqing Wu, Jiefu Chen, and Hien Van Nguyen</i>	D3
2:53 – 2:58 pm	SPARSE PCE SURROGATE ASSISTED INVERSION ALGORITHM FOR ULTRA-DEEP ELECTROMAGNETIC RESISTIVITY LOGGING-WHILE-DRILLING DATA <i>Han Lu, Jiefu Chen, Xuqing Wu, Xin Fu, Mohammad Khalil, Cosmin Safta, and Yueqin Huang</i>	D4
2:59 – 3:04 pm	A FAST MOM SOLVER FOR WIRE-TO-SURFACE JUNCTIONS IN LAYERED UNIAXIAL MEDIA <i>Shubin Zeng, Donald R. Wilton, and Jiefu Chen</i>	D5
3:05 – 3:10 pm	SIW MICROSTRIP CAVITY RESONATORS WITH A SENSING APERTURE <i>Chaoxian Qi, David R. Jackson, Yan Yao, and Jiefu Chen</i>	D6
3:11 – 3:16 pm	NO ONE LEFT BEHIND: AVOID DEATH IN HOT CARS VIA WIFI DETECTION <i>Dian Shi, Jixiang Lu, and Miao Pan</i>	D7
3:17 – 3:22 pm	SIW PATCH ANTENNA WITH LOSSY SUBSTRATE FOR NEAR-FIELD COMMUNICATION <i>Muhammad I. Khan, David R. Jackson, and Chatwin Lansdowne</i>	D8
3:23 – 3:28 pm	6-BIT 5 GS/S FLASH ASSISTANT TIME-INTERLEAVED SAR ADC IN 28 nm SOI CMOS <i>Hao Deng, Qingjun Fan, and Jinghong Chen</i>	D9
3:29 – 3:34 pm	A LOW-POWER SIPM READOUT FRONT-END WITH FAST PULSE GENERATION AND SUCCESSIVE-APPROXIMATION REGISTER ADC IN 0.18 μm CMOS <i>Yuxuan Tang, Qingjun Fan, and Jinghong Chen</i>	D10

3:305 – 3:40 pm **A K-BAND QUADRATURE FREQUENCY SYNTHESIZER WITH** D11
< -64 dBc SPURS AND > 27.94% LOCKING RANGE FOR
MULTIBAND 5G mm-WAVE APPLICATIONS
Yulang Feng, Qingjun Fan, and Jinghong Chen

Session E: POSTER PRESENTATIONS

Time: 3:40 – 5:30 pm, Conrad CD Ballroom

All posters will match talks presented by the graduate students in oral sessions.

5:30– 6:00 pm **Elevator Talks by CDC Students**, hosted by Dr. Len Trombetta,
Conrad AB Ballroom

6:00 – 6.30 pm **Awards Ceremony and Reception**, Conrad AB Ballroom

Plenary Speaker: Douglas Verret, Ph.D.
“Engineers are from Mars, Students are from Neptune”

This talk is about the state of engineering education in the modern age and the challenges that educators and students will face in a dynamic and fast-changing environment. The global population of engineers has been growing for decades and is forecasted to continue through the next decade and beyond. Except for BSEEs this trend is evident in the US as well. The largest percentage growth of technical professionals has been outside North America and Western Europe. There will be a growing commoditization of technical professionals globally. The average length of a 'technical career' is diminishing, which increases the need for continuing education to prepare people for mid-career job shifts or simply to update people in their current jobs. *The need for and interest in technical information is increasing dramatically.*

There is increasing emphasis on conserving natural resources and on developing renewable energy sources as alternatives to oil and coal. There will be a continuing shift of world influence from present developed nations to developing nations. There will be a continuing “flattening” of the world as the internet allows people to be easily connected around the globe to conduct business. This will be especially true in areas of information and knowledge access *which will influence business and education competitiveness.* Centers of technology excellence (*e.g.* universities) have spread rapidly across the flat world.

There is a greater disconnect between individuals and employers. Engineering will continue to become more interdisciplinary. Employers are expecting immediate value contribution. Changing age demographics will pose a threat of knowledge loss as the “baby boom” generation’s more experienced professionals retire. There will be a need to identify gaps in *practical knowledge* in transfer from one generation to the next.

Because of the ubiquity of mobile devices technical information is available pretty much anywhere at any time. Current boundaries between various disciplines, including science and technology are less distinguishable. There is greater activity in biological and medical systems and interaction with engineering. Many enterprises are awash in data of many different types at high velocity (2.5×10^{18} bytes/day¹) and uncertain veracity, some needing rapid analysis. Public perception of the security of data is low. Everything that can be is being made “smart” via artificial intelligence.

Given this climate and the state of the profession, we will provide some perspectives about what this implies for engineering schools and their students, which challenges are present in the current university structure (cost, value, insularity, competition) that will have to be overcome or mitigated and what students will need to do to prepare for this environment beyond what is in the current curriculum. The perception of the student experience is often perceived by industry as “other worldly” as if students inhabit another planet. An attempt will be made to describe the “real world” environment of engineering practice in contrast with the orderly academic environment.

1. Bernard Marr, www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-the-mind-blowing-stats-everyone-should-read/#6d2f7aa160ba



Dr. Douglas Verret

IEEE Life Fellow

Texas Instruments Fellow Emeritus

Chairman of the *Industry Advisory Board* for the Department of Electrical and Computer Engineering.

Dr. Douglas Verret is a world recognized expert in microelectronics with lifetime achievements in the semiconductor industry—a physicist and an engineer in action to create better electronics. He was an architect and leader in developing many new generations of silicon devices and processes for electronic circuits and systems, since he first joined Texas Instruments Inc in 1979. Terms such as double-level metal (DLM) process for Low Power Schottky TTL devices, polysilicon emitter, deep trench isolation and planarized metal technologies in TI digital Bipolar and BiCMOS circuits and many others have now an important meaning as pioneering steps in the development and progress of microelectronics. The teams he led created numerous Integrated Circuits (ICs) still in use today and sold by companies such as Apple Computer, IBM, Intel, Bosch, Sirius XM and Delphi among others.

Dr. Verret's career in microelectronics includes multiple managerial positions at TI and also in SEMATECH, a consortium of fourteen US semiconductor companies and the US government residing in Austin TX where he was the Director of Manufacturing Techniques and Standards and developed their 0.5um CMOS technology. His most recent positions included Program Manager of 65nm eflash technology followed (in 2012) by Manager of TI's next generation embedded flash technology. The 65nm technology was the first and still is the only 65nm embedded flash technology in the automotive and safety markets.

Dr. Douglas Verret's contributions to science and technology are well recognized by his numerous editorial positions in IEEE journals and conferences, program and leadership committees and by his membership in truly many council and advisory, educational and science boards at several foundations, schools and universities. He holds sixteen patents.

He is married to Ellen Verret Ph.D., who is a psychologist in Fort Bend Independent School District and they are the proud parents of Sybil Lincecum Au.D and Laurence Verret, MBA, CPA. They are also the fawning grandparents of four granddaughters. In his spare time he is a student of comparative mythology and alternates between playing the guitar badly and the trumpet miserably.

ABSTRACTS

A1. A DROOP BASED SOC CONTROL OF MODULAR MULTI-LEVEL CONVERTER FOR SOC BALANCING IN GRID ENERGY STORAGE

Amir Hussain, Krishna Raj, and Kaushik Rajashekara, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

The split battery type modular multilevel converter (SBMMC) has become a promising technology for interfacing the storage system with a medium voltage grid which can also perform battery management. This paper proposes a droop based control of a SBMMC for the state of charge (SoC) balancing among the battery modules (BMs) in a grid-connected battery energy storage system (BESS). First, steady-state analysis of the SBMMC is performed which forms the basis for SoC balancing scheme. Consequently, the droop based control is applied to balance SoC among the arms and sub-modules(SM) by controlling appropriate reference voltages. The proposed method is validated through relevant simulation results.

A2. A NOVEL DROGI BASED CONTROL ALGORITHM WITHOUT PLL FOR SHUNT COMPENSATION USING FOUR-LEG CONVERTER

Shilei Jiao, Kaushik Rajashekara, and Krishna Raj R.
Department of Electrical and Computer Engineering, University of Houston
Houston, TX 77204-4005

Four-leg converter has been an attractive solution for addressing power quality problems caused by unbalanced loading condition in three-phase four-wire distributed systems. However, its phase-locked-loop (PLL) based control methods can be affected by the waveform quality of grid voltage and degrade the stability of control system. Therefore, in this paper, a novel double reduced order generalized integrators (DROGI) based control algorithm without PLL is proposed to improve the performance of four-leg converter. Double ROGIs are employed to decouple compensation mode and rectification mode of the converter. For rectification mode, DC link voltage is regulated by using a grid voltage modulated direct power control (GVM-DPC) to form the non-PLL control system. The effectiveness of the proposed algorithm is validated using both simulation and experimental results for 1.1 KW rated operation.

A3. MULTI-PHASE 3-LEVEL BUCK CONVERTER WITH CURRENT SELF-BALANCING FOR HIGH BANDWIDTH ENVELOPE TRACKING POWER SUPPLY

Srikanth Yerra and Harish Krishnamoorthy, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Efficiency of a radio frequency (RF) transmitter system can be improved by modulating the drain power supply of radio frequency power amplifier (RFPA) at higher bandwidth. This paper presents the design of a multi-phase 3-level buck converter as an Envelope Tracking (ET) power supply to improve the RF transmitter efficiency. Fourth order low pass filter is designed to track 20 MHz bandwidth envelope signal and also to maintain the current self-balancing in the multi-phase converter. Gallium Nitride (GaN) MOSFETs are used to switch up to 25 MHz and Zero Voltage Switching (ZVS) technique is used to improve the efficiency. SPICE simulation results along with preliminary experimental results are presented as proof of concept. The proposed design has the potential to enhance both the peak-to-average-power ratio (PAPR) and the bandwidth of envelope tracking in applications such as 4G LTE base stations.

A4. POWER CYCLING TEST BENCH FOR ACCELERATED LIFE TESTING FOR RELIABILITY ASSESMENT OF SiC-MOSFET IN EXTREME OFFSHORE ENVIRONMENT

Amin Sadat and Harish Krishnamoorthy, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

A better understanding of the failure mechanisms and barriers to the utilization of electronic devices in extreme environments lead to reliable power converters in offshore drilling applications. In this paper, a testing platform for health monitoring of power converters is introduced. These circuits help to analyze the performance of power converters using various test modes, such as power cycling (PC) and variation of ambient operating temperatures, which provide critical information about the failure mechanisms and lifetime characteristics of devices including SiC-MOSFETs, gate drivers and capacitors. This test platform is used to get accurate data from the Device-Under-Test (DUT), the information from which are envisioned to be used in a real application to statistically estimate the remaining useful life (RUL) of a converter system (such as a downhole motor drives).

A5. UNDERWATER ROBOTICS COMMUNICATIONS

Javier Garcia, Steban Soto, and Aaron Becker, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Underwater communication is a challenging problem in modern society. Boats, submarines and underwater robots would have a much easier time navigating and collecting data if the signals we regularly use to communicate didn't die out in a matter of meters. To combat this problem we are implementing two approaches. The first involves data ferrying, where sensor nodes are deployed underwater and after a while, they are retrieved so the robots can process the gathered data. The second is developing a combination of magnetic induction, acoustics and other types of feedback mechanisms to create algorithms that would allow multiple agents in a swarm to perform complex underwater tasks.

A6. SURVIVABILITY OF DRONE SWARMS WITH FLOCKING AND SWARMING FLIGHT PATTERNS USING VIRTUAL REALITY

Arun Mahadev, Daniel Biediger, and Aaron T. Becker, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Controlling drone swarms with 1000s of drones is a fast-growing field of study. They are deployed in surveillance, formation entertainment and in defense. It has been natural to program them with bio-mimetic motion models such as flocking or swarming and our focus in this work is to study these motion models evolved to survive against predators, in a survivability test across various observable parameters in a Virtual Reality simulation where participants shoot down drone swarms following different flight patterns. Study includes findings about predictable behavior and statistically significant results on effectiveness of implementing pattern break in flight patterns.

A7. DEVELOPMENT OF A LOW-COST 3D PRINTED MYOELECTRIC PROSTHETIC ARM: CASE STUDY OF A 7-YEAR OLD WITH CONGENITAL DEFICIENCY

Alexander G. Steele, Akshay Ravindra, and Jose L. Contreras-Vidal, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Managing high-level pediatric limb deficiency is a challenging problem. No two children are alike so, including the physical needs and prosthetic fit are critical while designing the best solution. While there are prosthetic designs that correct common types of limb differences available, this approach is unsuitable for a subset of users. Here, we develop a low cost, 3D printed, myoelectric prosthetic arm that enables a 7-year old to grasp everyday objects and navigate daily tasks. This project contributes to the increased access to affordable assistive devices for individuals with upper limb differences.

A8. USE OF SENSORIMOTOR LATERALIZATION-BASED MEASURES FOR MONITORING CHRONIC STROKE MOTOR RECOVERY

Zachery R. Hernandez and Jose L. Contreras-Vidal, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Stroke physical therapy effectiveness is typically measured by changes in the functionality, strength, or daily accessibility of the trained upper limb. In addition, brain activation measures can be beneficial, especially since certain therapies induce neuroplastic changes to the brain. Here we investigate a neurophysiological feature of stroke recovery called sensorimotor lateralization by calculating a ratio between each subject's sensorimotor hemispheric activation throughout multiple sessions of a brain-machine interface-controlled robot-assisted therapy. We find differences between the first and last three sessions for each subject, and conclude that the

therapy does induce cortical changes specific to bilateral sensorimotor activity in the brain.

A9. CLASSIFICATION AND IDENTIFICATION OF ABNORMAL CILIARY MOVEMENT

Alexander R. Craik, Ryan Thackston, Michelle Gale, and Jose L. Contreras-Vidal, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Primary Ciliary Dyskinesia (PCD) affects approximately 17,000 people and can lead to chronic cough, reversed organs, fertility issues, respiratory failure, and death. The diagnosis of this condition typically involves manual analysis of nasal biopsies by expert practitioners, which is time and cost intensive. Current state-of-the-art commercial software provides the frequency and magnitude of cilia movement, but does not include information on the cilia pattern. In this study, machine learning algorithms were used to determine the frequency of the cilia beat and the specific pattern of cilia beat movement, including classification of immotile cilia, stiff cilia, circular movements, and incomplete stroke.

A10. BAYESIAN FILTERING METHODS FOR TRACKING AROUSAL AND ENERGY

Dilranjan S. Wickramasuriya and Rose T. Faghih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Multiple internal states are regulated within the body and give rise to measurable electrical and chemical phenomena. Stress states processed by the central nervous system manifest themselves through physiological signals such as skin conductance and cortisol. We use a state-space approach for tracking latent internal states by considering different pulsatile and impulse-like signals as the observations. We apply Bayesian filtering within an Expectation-Maximization framework for state estimation and model parameter recovery. Promising results are obtained in two application scenarios where: (i) arousal is tracked using skin conductance and heart rate; (ii) energy is estimated using serum cortisol.

A11. STATE-SPACE MODELING AND FUZZY FEEDBACK CONTROL OF COGNITIVE STRESS

Hamid Fekri Azgomi, Dilranjan S. Wickramasuriya, and Rose T. Faghih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Physiological signals such as skin conductance could be used to look into one's cognitive-stress-related arousal state. In this research, we present excitatory and inhibitory wearable machine-interface (WMI) architectures to regulate one's cognitive-stress-related arousal state. In this regard, we first present a model for skin

conductance response events as a function of environmental stimuli associated with cognitive stress and relaxation. Then, we perform Bayesian filtering to estimate the hidden cognitive-stress-related arousal state. We finally close the loop using fuzzy control. WMI architectures have a great potential to be used conveniently in daily life to regulate one's cognitive stress seamlessly.

A12. PARALLEL SEMANTIC SEGMENTATION OF HIGH-THROUGHPUT IMAGING MOUSE BRAIN DATA

Leila Saadatifard, Pavel Govyadinov, Aryan Mobiny, Guoning Chen, and David Mayerich, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Modern microscopy data collection methods attain large stack of high-fidelity images. While the most common tactic of dealing with such data is to process it using super-computing resources, these are not always available. We present two methods of achieving fast segmentation of high-throughput microscopy data using affordable systems by: intelligently controlling thread divergence to maximize computation time and exploiting GPU texture memory to avoid the host-to-device bottlenecks.

B1. FLEXIBLE MACROPOROUS ELECTRODES FOR METAL-OXIDE BASED ELECTRO-CHEMICAL SUPERCAPACITORS

Sasidharan Prakasan, Rabi Ebrahim, Steven Pei, and Alex Ignatiev, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Over the past decade, thin flexible electrochemical supercapacitors have been widely investigated because of their high market potential. Manganese-dioxide based electrode is one among the most studied electrode materials for this purpose. However, the poor electrical conductivity and low specific area of MnO_2 are severely limiting the performance of the supercapacitor. In this work, we report an ultra-thin (20 microns) macroporous flexible graphene/porous Ni based MnO_2 electrodes with very high surface area for supercapacitor applications. We build a symmetric supercapacitor using this electrode and were able to achieve a very high specific capacitance of around 290 F/g. The electrode preparation process is very simple, cheap and environmentally friendly and it does not involve any binding materials as in other conventional electrodes.

B2. NOVEL POLYMER CATHODE FOR HIGH-CAPACITY AND LONG-CYCLE-LIFE AQUEOUS ZINC BATTERIES

Ye Zhang and Yan Yao, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Rechargeable aqueous zinc batteries are feasible choices for grid-scale applications when cost, safety and cycle life are taken into consideration. However, their practical

applications are limited by the choice of cathode materials which show low capacity and short cycle life. Herein, we report a novel polymer, namely poly(benzoquinonyl sulfide) (PBQS) as the cathode material for aqueous zinc batteries. It is demonstrated that the PBQS cathode shows a high specific capacity (230 mAh g^{-1}) for Zn^{2+} storage with fast kinetics and high reversibility.

B3. A NOVEL AQUEOUS-BASED SENSOR BY ENGINEERING CHEMI-RESISTIVITY OF AU THIN FILMS USING METAL DEPOSITION VIA SLRR

Kamyar Ahmadi, Dongjun Wu, and Stanko R. Brankovic, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

This research studies chemi-resistive behavior of ultrathin films of gold in exposure to 0-50 ppm HS^- ions. Surface resistivity of the gold film has been tuned using metal deposition via surface limited redox replacement method. Resistivity change of Au films as a function of the HS^- concentration in the solution was measured by AC method. Comparison of as deposited Au films with the modified ones, has shown that deposition of monolayers of Pd and AuPd on Au films improves the sensitivity and response behavior of the film. Results of this study can be used to develop novel aqueous-based chemi-resistive sensors.

B4. IN-SITU SURFACE REFLECTIVITY MEASUREMENT FOR ELECTROLESS ATOMIC LAYER DEPOSITION

Dhaivat J. Solanki and Stanko R. Brankovic, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Electroless deposition is technique in which metal ions are chemically reduced to produce coating from aqueous solution. Electroless monolayer of Pb is deposited on substrate (Cu or Ru) by V^{2+} as reducing agent. Atomic layer of Pb is replaced by Cu with SLRR. Based upon difference in reflectivity of pristine substrate, Pb monolayer, and noble metal (Cu), in-situ characterization of film thickness and roughness development is studied. Automated deposition setup with LabVIEW is used to measure intensity change over deposition cycles as a measure of quality of ELALD process. Statistical image processing algorithm is used to determine surface roughness from AFM images.

B5. UNDERCUT GOLD NANODISKS IN AN ARRAY FOR PLASMONIC BIOSENSING

Ibrahim Misbah and Wei-Chuan Shih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Radiative coupling among nanodisks within an array is combined with reduced substrate effects to fabricate ultra-sensitive plasmonic sensors in the visible and NIR region. Using HF-based etching technique, the LSPR peak of these nanodisks in an

array have been engineered to have a peak at ~672 nm with a sensitivity of 570 nm/RIU. For a given wavelength, the plasmonic sensors fabricated by this method are superior to all the previously reported sensors. We also demonstrate that this low-cost NSL-made, environmentally stable plasmonic sensors has promising prospects in local biosensing experiments.

B6. SERS NANOPARTICLE-BASED LATERAL FLOW ASSAY FOR ULTRASENSITIVE, QUANTITATIVE DETECTION OF PROTEIN BIOMARKERS

Dilani Gunawardhana , Katerina Kourentzi , Richard C. Willson, and Wei-Chuan Shih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Lateral flow assay (LFA) is an in vitro diagnostic technique used for point-of-care-testing (POCT) which can detect the presence of a wide range of biomarkers and environmental contaminants. In this work, we demonstrate the use of surface enhanced Raman scattering (SERS) nanoparticles as optical labels in quantitative detection of the pregnancy hormone, human chorionic gonadotropin (hCG) in place of the gold standard in commercially available LFA. We show that SERS-LFA can detect hCG levels as low as 2 pg/mL, nearly 1000 times more sensitive than the commercially available LFA based on light scattering from colloidal gold. The excellent Raman signal make these labels an ideal choice for ultrasensitive detection.

B7. DEEP LEARNING FOR GLUCOSE SENSING BY STAMPING SURFACE-ENHANCED RAMAN SPECTROSCOPY (S-SERS)

Chun-Jen Lin, Ibrahim Misba, and Wei-Chuan Shih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

In this work, we apply 1-D convolutional neural networks (CNNs) on glucose sensing. We first employ stamping surface-enhanced Raman spectroscopy (S-SERS) technique to measure glucose concentrations in samples of different levels of complexity, ranging from 10 mM to 0.1 mM in water. Next, we incorporate the Raman spectra of glucose under different concentrations into the 1-D CNNs for glucose prediction. We also compare the results with normal glucose detection on cover slip. By combining the S-SERS technique and 1-D CNNs, we can precisely predict glucose concentration even under very low concentration.

B8. TIB₂ MICRO-PATTERNED SUBSTRATE FOR THE DIFFERENTIATION OF MESENCHYMAL STEM CELLS INTO INSULIN PRODUCING CELLS.

Jefferson Friguglietti¹, Fatima A. Merchant², Wanda Wosik³, and Daniel W. Fraga⁴,
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The increasing prevalence of diabetes and consequent long-term effects of traditional insulin shots has made the search for an alternative treatment option a priority. One alternative entails the transplantation of donor insulin-producing cells (IPCs) into patients, but success is limited due to scarcity of viable donor cells. Cell replacement therapy via differentiation of mesenchymal stem cells (MSCs) into glucose-responsive IPCs has shown promise, but the IPCs have inadequate performance with poor long-term insulin response. In this study, we will use novel microfabricated scaffolds that promote beneficial 3D microenvironments and mechanotransduction effects to increase the differentiation efficiency of MSCs into IPCs.

B9. MULTIPLEX SENSING OF LEAD AND MERCURY IN DRINKING WATER USING SMARTPHONE NANO-COLORIMETRY

Hoang Nguyen and Wei-Chuan Shih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Identifying dangerous heavy metals contaminants such as lead (Pb^{2+}) and mercury (Hg^{2+}) in municipal water typically requires bulky and costly laboratory analytical instrument and time-consuming process. This leads to inefficiency in water quality monitoring in residential areas, thus a mobile analytical device for rapid Pb^{2+} and Hg^{2+} is on high demand. Here, we report smartphone nano-colorimetry (SNC) for mobile and multiplex detection and quantitation of dissolved Pb^{2+} and Hg^{2+} in drinking water. The limit of detection for both metal using SNC is well below EPA action level, 15 ppb for Pb^{2+} and 2 ppb for Hg^{2+} .

B10. SELECTIVE PLASMONIC SUBSTRATE MODIFICATION VIA PHOTOTHERMALLY GENERATED MICROBUBBLES

Nareg Ohannesian, Jingting Li, Ibrahim Misbeh, Fusheng Zhao, and Wei-Chuan Shih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Optically assisted assembly of nanoparticles via photothermally generated microbubbles is a low-cost method for fabrication and modification of plasmonic sensing platforms. A point laser was focused on a Nano Porous Gold Disk (NPGD) patterned substrate immersed in a solution. Heat generated from plasmonic excitation caused boiling and the formation of gas/water vapor bubbles capable of collecting surrounding hydrophobic and hydrophilic particles. Upon deactivation of the laser, the microbubble shrank and the adhered particles formed a new structure on the NPGD surface. Removing air molecules from the medium via degassing inhibited any formation of hydrophobic particle assembly while leaving hydrophilic particles unaffected. A Spatial Light Modulator (SLM) to project the laser in arbitrary patterns produced arrays of nanoparticle clusters for use as plasmonic sensing units.

B11. HOLOGRAPHIC OPTICAL TWEEZERS ASSISTED IMAGING SPECTROSCOPY

Mohsen Rakhshandehroo¹ and Wei-Chuan Shih^{1, 2, 3, 4}, ¹Department of Electrical and Computer Engineering, ²Department of Biomedical Engineering, ³Program of Materials Science and Engineering, ⁴Department of Chemistry, University of Houston, Texas 77204-4005.

Optical tweezers can exert force on small particles for contactless manipulation. Massively-parallel of many tweezers have been realized using holography. Dubbed holographic optical tweezers (HOT), they allow many particles to be manipulated simultaneously. Although the tweezed particles can be readily imaged by wide-field imaging techniques, spectroscopic imaging is not as straightforward. We have implemented an instrument prototype that utilized a spatial light modulator as the pattern generator for a HOT-Raman system that enables the simultaneous tweezing of multiple micro-objects while acquiring full-range Raman spectra from them. Herein potential application of gathering and detection of nanoscale objects have been suggested.

B12. BROADBAND EMISSION ENHANCEMENT OF LEAD HALIDE PEROVSKITE CSPB2BR5 MICROPLATES UNDER HIGH PRESSURE

Shenyu Dai, Zhaojun Qin, and Jiming Bao, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

We use diamond anvil cell to investigate the optical properties of CsPb₂Br₅ microplates under hydrostatic pressure. At ambient pressure, CsPb₂Br₅ microplates feature broadband emission with a large Stokes shift centered at 700 nm. The emission intensity experiences a significant increase upon compression to ~2 GPa and then gradually decrease to zero as pressure further increase to ~5 GPa. At the same time, the emission center is blue shifted to 520 nm. The absorbance results show that the band gap is slightly shifted from 3.44 eV to 3.34 eV. This phenomenon can be attributed to the distortion of [PbBr₆]⁴⁻ octahedral.

C1. IMPROVING SPATIAL SPECIFICITY IN BROADBAND HYPERSPECTRAL IMAGES USING CURVELET-BASED IMAGE SHARPENING

Rupali Mankar, Mahsa Lotfilohi, Saurabh Prasad, and David Mayerich, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Broadband hyperspectral microscopy, including many forms of vibrational imaging, provides high molecular specificity by sampling large regions of the optical spectrum. Microscopy pushes the acquired spatial resolution towards the diffraction limit, which introduces a trade-off between spectral and spatial bandwidth. This is because the inclusion of shorter wavenumbers, often the source of chemical specificity in the spectrum, limits spatial resolution. In this paper, we present an unsupervised image

fusion method that merges high spatial frequencies across the broadband image to enhance spatial resolution in bands rich with chemical information. The proposed method provides an unsupervised extension of pansharpening methods used in remote sensing that relies only on a single hyperspectral image.

C2. A THEORETICAL FRAME WORK FOR CHEMICAL HOLOGRAPHY

Shihao Ran, David Mayerich, and Rohith Reddy, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

In this manuscript, we propose a theoretical framework of a phase-sensitive mid-infrared spectroscopic imaging system capable of high-resolution characterization of heterogeneous chemical and biological samples. A new approach that utilizes coherent mid-infrared illumination to perform *chemical holography* is proposed. The additional phase information provides the key to addressing the limitations encountered in existing imaging systems. By comparing the results of applying Convolutional Neural Networks (CNNs) to both chemical holography and traditional intensity-imaging techniques in solving the inverse Mie-scattering problem, we demonstrated the contribution of the additional phase information with higher regression accuracy in retrieving material composition of a sphere.

C3. TIMING: HIGH-THROUGHPUT SINGLE-CELL PROFILING OF DYNAMIC CELL-CELL INTERACTIONS BY TIME-LAPSE IMAGING MICROSCOPY IN NANOWELL GRIDS

Rachel Mills, Badrinath Roysam, Navin Varadarajan, and Hengyang Lu, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Understanding cell-cell interactions is crucial to immunology. In order to automatically profile individual cell-cell interactions high-throughput time-lapse microscopy in nanowell grids (TIMING) is used. This pipeline performs cell tracking and segmentation to a large array of time-dependent images of nanowells by the use of deep learning and computer vision techniques. A graphical user interface provides the ability to visualize the results. New additions include implementing instance segmentation for the detection and segmentation of cells without the use of fluorescent labels. This profiling of cell-cell interactions provide necessary information for the progression of immunotherapy research and applications.

C4. CELL SEGMENTATION IN SUPER-RESOLUTION MICROSCOPY USING LOCALIZATION-REINFORCED PERCEPTURAL GROUPING (LRPG)

Jiabing Li, Camille Artur, Badrinath Roysam, and David Mayerich, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

We present a method for segmenting cells when dealing with dim, heterogeneous, and hollow cells commonly seen in super-resolution microscopy. The proposed technique leverages both iterative voting and perceptual grouping to refine a tensor field that can be used for level set segmentation. We first use iterative voting to localize cell positions. We then generate a structure tensor field from the input image and identify the angular discrepancy between the calculated tensor field and seeds distance field. This discrepancy is used to iteratively refine the tensor field using tensor voting. The resulting field is more suitable for level-set to extract cell binary mask and then watershed segmentation separate every single cell.

C5. DIGITAL STAINING OF HIGH-RESOLUTION FTIR SPECTROSCOPIC IMAGES

Mahsa Lotfollahi, Sebastian Berisha, Davar Daeinejad, and David Mayerich, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Histological stains, such as hemotaxylin and eosin (H&E), are commonly used to label tissue in clinical biopsies. However, these labels modify the tissue chemistry, making it difficult to use for further downstream analysis. Fourier transform infrared spectroscopy (FTIR) has shown promising results for characterizing disease-relevant tissues without chemical labels or dyes. One proposed approach is digital staining, which uses machine learning to map an infrared spectroscopic image to the image that would be ideally produced with a chemical stain. We demonstrate that high-resolution mappings can be obtained using FTIR imaging and histological staining of the same sample with convolutional neural networks (CNNs) that take advantage of both spatial and spectral features.

C6. HIGH-THROUGHPUT THREE-DIMENSIONAL MICROSCOPY BY MILLING WITH ULTRAVIOLET EXCITATION (MUVE)

Jiaming Guo, Camille Artur, Jason Eriksen, and David Mayerich, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Researchers and pathologists are currently in need of a comprehensive method that allows routine three-dimensional imaging of large tissue volumes at the cellular level. In this presentation, we propose an imaging methodology that realizes high-throughput three-dimensional imaging of large-scale samples across multiple fluorescent channels. This technique is based on recent research demonstrating block-face microscopy with ultraviolet surface excitation (MUSE). The proposed instrumentation overcomes several constraints inherent in current state-of-the-art 3D microscopy, such as confocal and light-sheet microscopy. The proposed instrumentation is faster and less expensive than existing methods, and overcomes depth limitations inherent in optical sectioning methods by using serial ablation. These advantages provide the opportunity for true whole-organ imaging at microscopic resolution.

C7. HIGH RESOLUTION MID-INFRARED PHOTOTHERMAL IMAGING OF OVARIAN CANCER CELLS

Chalapathi C. Gajjela and Rohith Reddy, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Mid-infrared spectroscopic imaging (MIRSI) has broad applications, ranging from material characterization to forensics to cancer grading. While MIRSI has shown great promise in cancer diagnosis, one important limitation is its spatial resolution due to the relatively long wavelengths used. We overcome this limitation by vibrational excitation with a mid-infrared light and probing the absorption with a visible light through the thermal lensing effect. In our current work, we study ovarian cancer tissue using the aforementioned imaging technique and compare it to conventional MIRSI using FT-IR microspectroscopy. We show that the resolution is improved by an order of magnitude using the new technique.

C8. ANALYSIS OF BONE DISORDER USING OPTICAL PHOTOTHERMAL INFRARED MICROSCOPY

Licheng Zhang, Chalapathi Charan Gajjela, and Rohith Reddy, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

The resolution of Infrared(IR) Microscopy is limited by the diffraction limit using traditional technique (e.g. FTIR). But with Optical Photothermal Infrared(O-PTIR) Microscopy, a fast and non-contact optical technique, the diffraction limit can be overcome by using the photothermal effect induced by a mid-IR laser on a sample surface. A new imaging system called mIRage IR Microscope was designed and implemented to acquire image of the sample surface using photothermal effect. The spectrum of the sample can be acquired using this system as well. This introduction will include the application of O-PTIR Microscopy on bone cancer tissue.

C9. MENTAL WORKLOAD CLASSIFICATION VIA HIERARCHICAL LATENT DICTIONARY LEARNING: A FUNCTIONAL NEAR INFRARED SPECTROSCOPY STUDY

Srinidhi Parshi, Md. Rafiul Amin, Hamid Fekri Azgomi and Rose T Faghih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Variations in the brain's blood oxygenation and deoxygenation reflect neuronal activation patterns and can be measured using functional near-infrared spectroscopy (fNIRS). We use fNIRS to infer the dynamic functional connectivity of different brain regions as a function of the mental workload. A hierarchical latent dictionary learning approach which provides covariance matrices is used to interpret the dynamic functional connectivity. Using features from the obtained covariance matrices, we investigate three types of mental workload tasks. Furthermore, we use

support vector machines to classify different tasks based on the functional connectivity. Our classification results outperform previously published results using the same dataset.

C10. A SYSTEM THEORETIC INVESTIGATION OF CORTISOL DYSREGULATION IN FIBROMYALGIA PATIENTS WITH CHRONIC FATIGUE

Divesh Deepak Pednekar, Md. Rafiul Amin, Hamid Fekri Azgomi, Kirstin Aschbacher, Leslie J. Crofford, and Rose T. Faghih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Fibromyalgia Syndrome (FMS) and Chronic Fatigue Syndrome (CFS) are complex medical conditions with superficial similarities and unknown causes. The objective of this study is to characterize FMS in presence of CFS. We use a state-space approach to analyze the variations in the model parameters as well as amplitudes, timings and number of underlying hormone pulses. Analyzing experimental data, our results indicate the clearance rate of cortisol by the liver is higher in healthy individuals compared to the patients. This suggests that there is a higher accumulation of serum cortisol levels in the patients as opposed to the matched healthy subjects.

C11. INFERRING SYMPATHETIC NERVOUS SYSTEM ACTIVITY FROM ELECTRODERMAL ACTIVITY: A SPARSE SYSTEM IDENTIFICATION APPROACH

Md. Rafiul Amin and Rose T. Faghih, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Sweat secretions in the epidermis due to the sympathetic nervous system (SNS) activity result in electrodermal activity (EDA). To better understand the neural information encoded in the EDA, it is necessary to decompose it into its constituent components. We propose three novel methods to infer SNS activity from EDA addressing non-convexity in the optimization problem, noise robustness with multi-channel measurements, and tonic component separation. In all these methods, we consider sparsity constraints on SNS activity and physiologically plausible constraints on system parameters. By analyzing simulated and experimental data, we show that our framework can successfully infer SNS activity.

D1. GRAPH CONVOLUTIONAL NEURAL NETWORKS FOR HYPERSPECTRAL DATA CLASSIFICATION

Farideh Foroozandeh Shahraki and Saurabh Prasad, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Graph based manifold learning and embedding techniques have been very successful at representing high dimensional hyperspectral data in lower dimensions for visualization and classification. Graph based convolutional neural networks (GCNs)

have been recently developed for applications on high-dimensional irregular domains represented by graphs, such as citation networks. We demonstrate a framework that can leverage GCNs to effectively represent data residing on smooth manifolds, such as reflectance spectra of hyperspectral image pixels. We also propose a robust spatial-spectral semi-supervised adjacency matrix that learns the underlying manifold structure of the data using a limited amount of labeled spectra and a large amount of unlabeled spectra. Classification performance with a benchmark hyperspectral image analysis dataset is also provided that demonstrates the efficacy of this approach.

D2. MEMORY-CENTERED NEURAL COMPUTER ARCHITECTURE FOR DEEP LEARNING

Yawen Luo, Aswini Kumar Tata, and Yuhua Chen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Deep Learning is widely used in many artificial intelligence (AI) applications, such as speech recognition, photo clustering, and translation. More recently proposed Differentiable Neural Computer (DNC) applies external memory to traditional Neural Networks and stores data over long timescales, which allows it to potentially solve more complex tasks, like graph-structured data. However, due to the limitation of memory bandwidth, DNC scales poorly in both space and time as the amount of memory grows. We present a Memory-Centered Neural Computer Architecture (MCNCA) to eliminate the performance bottleneck and allows DNC to scale to real-world applications. We believe MCNCA will enable researchers to explore new types of Neural Networks.

D3. FIRST ARRIVAL PICKING USING U-NET WITH LOVASZ LOSS AND NEAREST POINT PICKING METHOD

Pengyu Yuan, Wenyi Hu, Xuqing Wu, Jiefu Chen¹ and Hien Van Nguyen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

We proposed a robust segmentation and picking workflow to solve the first arrival picking problem for seismic signal processing. Unlike traditional classification algorithm, image segmentation method can utilize the location information by outputting a prediction map which has the same size of the input image. A Lovasz loss instead of the traditional cross-entropy loss is used to train the network for a better segmentation performance. A parameter-free nearest point picking algorithm is proposed to further improve the accuracy of the first arrival picking. The algorithm is test on both synthetic data and field data and performs well on all of them.

D4. SPARSE PCE SURROGATE ASSISTED INVERSION ALGORITHM FOR ULTRA-DEEP ELECTROMAGNETIC RESISTIVITY LOGGING-WHILE-DRILLING DATA

Han Lu, Jiefu Chen, Xuqing Wu, Xin Fu, Mohammad Khalil, Cosmin Safta, and Yueqin Huang, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

The recent development of azimuthal electromagnetic (EM) resistivity logging-while-drilling (LWD) tool has brought new challenges to inversion and interpretation of the logging measurements. The results by deterministic methods are oftentimes strongly affected by chosen initial models. The development of surrogates/meta-models in optimization problems offers the opportunity to enhance the performance of the earth model interpretation. In this work, we construct a surrogate based on polynomial chaos expansion (PCE) by Bayesian compressive sensing (BCS) technique for the azimuthal electromagnetic resistivity LWD measurements. The results show that the sparse PCE surrogates are helpful in avoiding local minimums during the inversion.

D5. A FAST MOM SOLVER FOR WIRE-TO-SURFACE JUNCTIONS IN LAYERED UNIAXIAL MEDIA

Shubin Zeng, Donald R. Wilton, and Jiefu Chen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Wire-to-surface structures in layered uniaxial media are of great importance to practical applications. This paper presents the essential procedures to build a fast method of moments (MoM) solver for modeling wire-to-surface structures with junctions in layered uniaxial media. These procedures include the modeling of junctions, accelerated evaluation of layered media Green's function (LMGF), efficient interpolation of LMGF, and thin-wire modeling in layered uniaxial media. Three numerical examples are presented to demonstrate the accuracy and applications of our method.

D6. SIW MICROSTRIP CAVITY RESONATORS WITH A SENSING APERTURE

Chaoxian Qi, David R. Jackson, Yan Yao, and Jiefu Chen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

Microstrip antennas are widely used in various fields such as mobile and satellite communications, global positioning, and navigation systems, as they are low-profile, easy to fabricate, and easy to feed. In an effort to extend the usefulness of microstrip antennas to near-field sensing applications, a substrate integrated waveguide (SIW) microstrip cavity sensor is introduced. It consists of a resonant SIW microstrip cavity with a sensing aperture, which uses the fields leaking out of the resonator from the aperture for sensing. An object near the sensing aperture will perturb the resonant cavity and alter the scattering matrix (S) parameters that describe the cavity. The changes in the S parameters are used to sense the presence of the object.

D7. NO ONE LEFT BEHIND: AVOID DEATH IN HOT CARS VIA WiFi DETECTION

Dian Shi¹, Jixiang Lu² and Miao Pan¹

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Nowadays there is a growing concern that people sometimes forget their children behind them, after they leave the car. This leads to a number of children dying by heat stroke. In this work, we propose to utilize the fine-grained channel state information (CSI) from off-the-shelf WiFi to detect if a child has been forgotten in the rear seat of the car. We then recognize the baby through the baby's movements captured by CSI radio images according to CNN. The experiment results show that the performance of our deep learning based system increases dramatically, and the recognition accuracy can reach more than 95%.

D8. SIW PATCH ANTENNA WITH LOSSY SUBSTRATE FOR NEAR-FIELD COMMUNICATION

Muhammad I. Khan, David R. Jackson, and Chatwin Lansdowne, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

In a recent application, NASA-JSC was interested in communication between nanosatellites inside of metallic launch tubes. NASA-JSC was able to successfully develop an SIW (Substrate Integrated Waveguide) patch antenna with a lossy substrate for this scenario. The purpose of this research project is to show why this antenna is more immune to a metallic environment than a regular patch antenna, and to characterize its properties. Both regular and SIW patch antennas with lossy and non-lossy substrates are simulated in HFSS. It is found that the SIW antenna is more immune to nearby conductors, but has a lower radiation efficiency.

D9. 6-BIT 5 GS/s FLASH ASSISTANT TIME-INTERLEAVED SAR ADC IN 28 nm SOI CMOS

Hao Deng, Qingjun Fan, and Jinghong Chen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

We present a 6-bit 5 GS/s flash assistant time-interleaved SAR analog-to-digital converter (ADC) in 28 nm SOI CMOS technology. The circuit is designed with the objective of achieving speed performance as well as lower power consumption compared with conventional high-speed flash ADC. This ADC has a flash stage to resolve first 2.5b MSBs, then four 4-bit time-interleaved SAR channel resolve 4-bit LSB. The passive residue transfer technique is used to reduce the effect of timing skew between SAR channels. The 0.5-bit redundancy between two stages makes the ADC tolerates errors such as comparator offset and settling error. The ADC achieves an effective number of bits (ENOB) of 5.8 at 5 GS/s with a power consumption of 15 mW (Nyquist frequency). The figure of merit (FOM) of the ADC is 53.8 fJ per conversion step.

D10. A LOW-POWER SiPM READOUT FRONT-END WITH FAST PULSE GENERATION AND SUCCESSIVE-APPROXIMATION REGISTER ADC IN 0.18 μm CMOS

Yuxuan Tang, Qingjun Fan, and Jinghong Chen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX 77204-4005

A low-power front-end with on-chip fast pulse generation and customized SAR ADC structure is presented for SiPM readout design. The on-chip fast pulse generation helps to improve the timing resolution without the need of extra I/O pins. The proposed customized SAR ADC, reusing the SiPM charge integrator and eliminating the power-hungry charging sensing amplifier, is implemented with a much lower power consumption and higher sampling rates comparing with conventional designs. The front-end is designed in a 0.18 μm 1P6M standard CMOS technology, and has a low-power consumption of 4 mW. The on-chip HPF reshapes the long-tailed SPE pulse width from 50 ns to 3 ns. At 1 MS/s, the SAR ADC consumes 132 μW from a 1.8 V supply, and achieves a SNDR of 58.11 dB and a SFDR of 72.47 dB, respectively.

D11. A K-BAND QUADRATURE FREQUENCY SYNTHESIZER WITH < -64 dBc SPURS AND > 27.94% LOCKING RANGE FOR MULTIBAND 5G mm-WAVE APPLICATIONS

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This work presents a K-band quadrature frequency synthesizer (QFS) using a novel switched-coupled slotted inductor (SCSI) to suppress the reference spurs and the out-of-band phase noise while achieving a wide frequency range for 5G millimeter-wave (mm-Wave) applications. The proposed QFS has been implemented in a 55 nm CMOS process, achieving a measured reference spurs of -64.04 to -71.99 dBc, an in-band phase noise of -81.69 to -87.02 dBc/Hz at 100 kHz offset and an out-of-band phase noise of -119.11 to -125.42 dBc/Hz at 10 MHz offset, respectively, over the entire 19.89 to 26.35 GHz frequency locking range. The synthesizer occupies a die area of 1.31 \times 2.13 mm² including the testing pads and dissipates 101 mW of power.

GRC AUTHOR INDEX

	Poster Number		Poster Number
Ahmadi, Kamyar	B3	Jackson, David R.	D6, D8
Amin, Rafiul Md.	C9, C10, C11	Jiao, Shilei	A2
Artur, Camille	C4, C6	Khalil, Mohammad	D4
Aschbacher, Kirstin	C10	Khan, Muhammad I.	D8
Azgomi F., Hamid	A11, C9, C10	Kourentzi, Katerina	B6
Bao, Jiming	B12	Krishnamoorthy, Harish	A3, A4
Becker, Aaron	A5, A6	Lansdowne, Chatwin	D8
Berisha, Sebastian	C5	Li, Jiabing	C4
Biediger, Daniel	A6	Li, Jingting	B10
Brankovic, Stanko R.	B3, B4	Lin, Chun-Jen	B7
Chen, Guoning	A12	Lotfilohi, Mahsa	C1, C5
Chen, Jiefu	D3, D4, D5, D6	Lu, Han	D4
Chen, Jinghong	D9, D10, D11	Lu, Hengyang	C3
Chen, Yuhua	D2	Lu, Jixiang	D7
Contreras-Vidal, Jose L.	A7, A8, A9	Luo, Yawen	D2
Craik, Alexander R.	A9	Mahadev, Arun	A6
Crofford, Leslie J.	C10	Mankar, Rupali	C1
Daeinejad, Davar	C5	Mayerich, David	A12, C1, C2, C4, C5, C6
Dai, Shenyu	B12	Merchant, Fatima A.	B8
Deng, Hao	D9	Mills, Rachel	C3
Ebrahim, Rabi	B1	Misbah, Ibrahim	B5, B7, B10
Eriksen, Jason	C6	Mobiny, Aryan	A12
Faghih, Rose T.	A10, A11, C9, C10, C11	Nguyen, Hien Van	D3
Fan, Qingjun	D9, D10, D11	Nguyen, Hoang	B9
Feng, Yulang	D11	Ohannesian, Nareg	B10
Fraga, Daniel	B8	Pan, Miao	D7
Friguglietti, Jefferson	B8	Parshi, Srinidhi	C9
Fu, Xin	D4	Pednekar, Divesh D.	C10
Gajjela, Chalapathi	C7, C8	Pei, Shin Shem Steven	B1
Gale,Michelle	A9	Prakasan, Sasidharan	B1
Garcia, Javier	A5	Prasad, Saurabh	C1, D1
Govyadinov, Pavel	A12	Qi, Chaoxian	D6
Gunawardhana, Dilani	B6	Qin, Zhaojun	B12
Guo, Jiaming	C6	Raj, Krishna	A1, A2
Hernandez, Zachery	A8	Rajashekara, Kaushik	A1, A2
Hu, Wenyi	D3	Rakhshandehroo, Mohsen	B11
Huang, Yueqin	D4	Ran, Shihao	C2
Hussain, Amir	A1	Ravindra, Akshay	A7
Ignatiev, Alex	B1	Reddy, Rohith	C2, C7, C8
		Roysam, Badrinath	C3, C4

Poster Number

Saadatifard, Leila	A12
Sadat, Amin	A4
Safta, Cosmin	D4
Shahraki, Farideh Foroozandeh	D1
Shi, Dian	D7
Shih, Wei-Chuan	B5, B6, B7, B9, B10, B11
Solanki, Dhaivat	B4
Soto, Steban	A5
Steele, Alexander	A7
Tang, Yuxuan	D10
Tata, Aswini Kumar	D2
Thackston, Ryan	A9
Varadarajan, Navin	C3
Wickramasuriya, Dilranjan	A10, A11
Willson, Richard C.	B6
Wilton, Donald R.	D5
Wosik, Wanda	B8
Wu, Dongjun	B3
Wu, Xuqing	D3, D4
Yao, Yan	B2, D6
Yerra, Srikanth	A3
Yuan, Pengyu	D3
Zeng, Shubin	D5
Zhang, Licheng	C8
Zhang, Ye	B2
Zhao, Fusheng	B10

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