Agenda

IEEE NATIONAL AEROSPACE ELECTRONICS CONFERENCE (NAECON 2019)

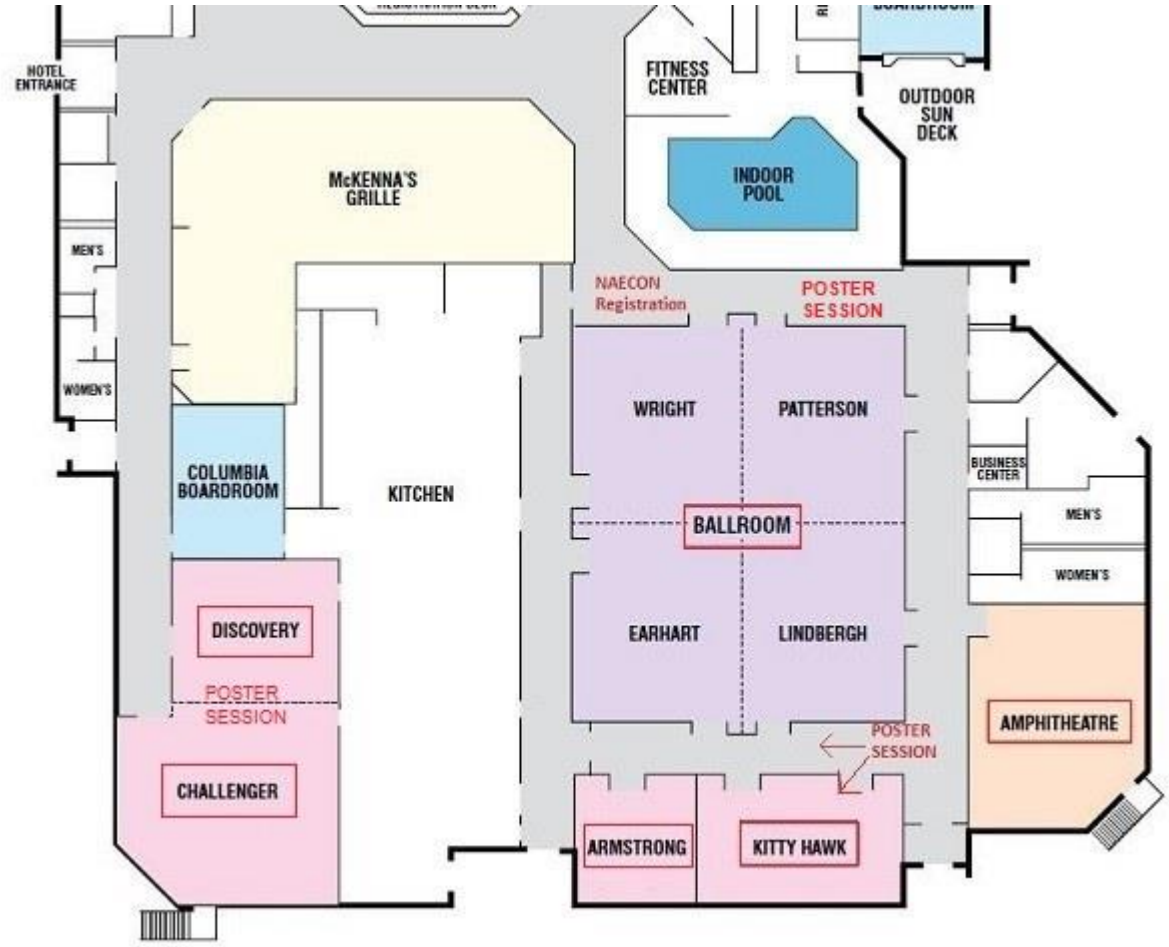
July 15 – July 19, 2019

Luncheons, Banquet & Tutorials *(Included with Conference Registration)*

Holiday Inn, 2800 Presidential Dr., Fairborn, OH 45324 (15-18 July)
Russ Research Center, 2642 Indian Ripple Rd Dayton, OH 45440 (19 July)

PROGRAM CONTENTS

Holiday Inn Dayton/Fairborn I-675 Venue Floorplan



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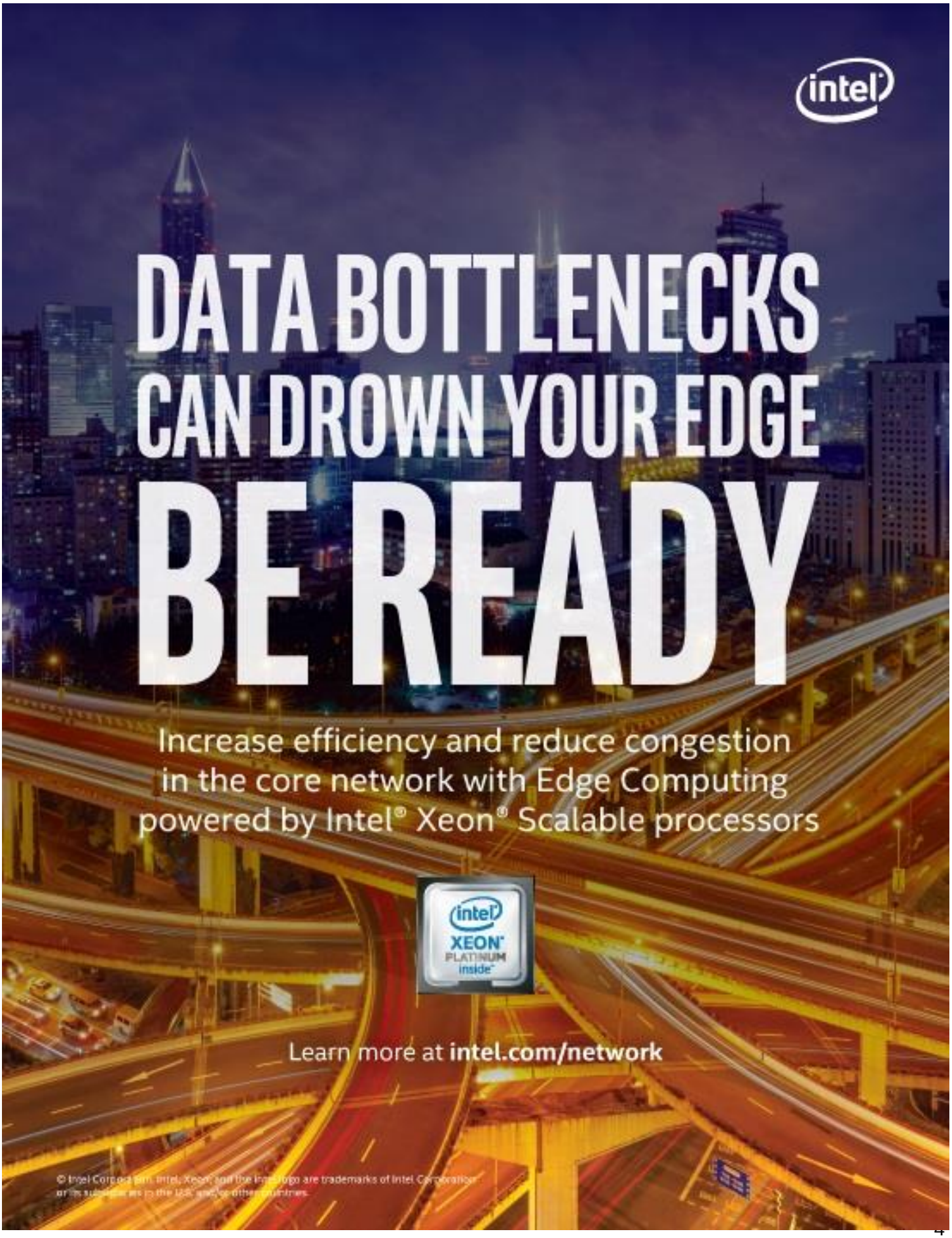
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Detailed Agenda
Day 1 – Tutorials-Monday, July 15, 2019
Coffee Break 3:00pm – 3:15pm

Time	Event	Location
12:00-4:00pm	Registration	Ballroom Foyer

1:00pm-3:00pm	**Tutorial A AI and Machine Learning with Embedded Systems presented by Xilinx (Ballroom)**
3:15pm-5:15pm	**Tutorial B AI-Focused tools and hardware supporting the future of Autonomy presented by Intel) (Ballroom)**
1:00pm-4:00pm	**Tutorial C Hidden outlier noise and its Mitigation (Kitty Hawk)**
1:00pm-5:15pm	**Tutorial D AI, Visual Perception and Deep Learning with Examples (Auditorium)**

Day 2 – Tuesday, July 16, 2019

Time	Event	Location
7:00am-8:00am	**Registration (until 4:00pm) & Breakfast**	**Ballroom Foyer**
8:00am-8:15am	**Opening Remarks (NAECON Committee)**	**Ballroom**

8:15am-9:00am

Opening Keynote: Alberto Valdes-Garcia, IBM
"Vertical Integration for mmWave Systems: Building a Bridge between Antennas and AI"

Morning Sessions 9:00am-12:00pm (Coffee Break 10:30am-10:45am)

Title		Location
THz and mmwave I & II	**(9:00am-12:15pm)**	**Ballroom**
Low SWAP	**(9:00am-10:30am)**	**Auditorium**
Deep Learning & AI I	**(10:45am-11:45am)**	**Auditorium**
Aerospace Power Systems and Power Electronics I & II (9:00am-12:05pm)		**Kitty Hawk**

9:00am-12:15pm THz and mmwave I & II **Ballroom**
Chairs: Elliott Brown (Wright State University) & Kubilay Sertel (Ohio State University)

9:00am-9:30am **Magnetoceramic Integration with Wide Band Gap Semiconductor Heterostructures for mm-wave MMICs,** Vincent Harris, *Northeastern University* **(Invited)**
9:30am-9:50am **W-Band GaN IMPATT Diodes for High Power Millimeter-Wave Generation**, Patrick Fay, *University of Notre Dame*
*9:50am-10:10*am **True-time Delay Engine Harnessing the Frozen-mode in Coupled Silicon Ridge Waveguides,** Banaful Paul, *Ohio State University.*
10:10am-10:30am **Demonstration of W-Band Polarimetric Radar with High-Extinction, Substrate-Based, Wire-Grid Polarizers,** W.-D. Zhang, *Wright State University*

Coffee Break

10:45am-11:15am **3D mmWave Imaging with Si-based Phased Array Modules,** Alberto Valdes-Garcia, *IBM* (**Invited**)
11:15am-11:35am **Development of Optically Controlled Tunable/Reconfigurable Terahertz Waveguide Circuits/Components For Advanced Sensing and Adaptive Wireless Communications**, Jun Ren, *University of Notre Dame*
11:35am-11:55am **Polarimetric Terahertz Imaging of Biomedical Tissues**, Maruf Hossain, *Ohio State University*
11:55am-12:15pm **Spectroscopic Sensing of Opioids in the THz Region,** L. Himed, *Wright State University*

9:00am-10:30am Low SWaP Auditorium
Chairs: Kerry Hill & Marc Koffman (AFRL Sensors Directorate)

9:00am-9:20am **Low SWaP Array Processing Architecture,** Michael Parker, *Raytheon SAS* (**Invited**)
9:20am-9:40am **Xilinx Adaptive Compute Acceleration Platform (ACAP) Featuring AI Engines for Diverse, Heterogenous Workloads for Aerospace & Defense Applications,** Jason Vidmar, *Xilinx* **(Invited)**
9:40am-9:55am **The Development of an Embedded Low SWaP, FPGA Accelerated SAR Image Formation Chain,** David Mundy, *University of Dayton Research Institute*
9:55am-10:15am **An Indoor Navigation and Localization System,** Francis Wolff, *Case Western Reserve University*
10:15am-10:30am **GPU Accelerated Atmospheric Aberration Correction,** Paul Sundlie, *University of Dayton*

Coffee Break

10:45am-11:45am Deep Learning & AI I Auditorium
Chairs: Tarek Taha (University of Dayton), Temesgen Kebede (AFRL Sensors Directorate) & Anca Ralescu (University of Cincinnati)

10:45am-11:05am **Computationally Efficient U-Net Architecture for Lung Segmentation in Chest Radiographs,** Barath Narayanan, *University of Dayton Research Institute*
11:05am-11:25am **CNN Optimization with a Genetic Algorithm,** Anthony Reiling, *University of Dayton*
11:25am-11:45am **High Performance SqueezeNext for CIFAR-10,** Jayan Duggal**,** *Purdue University*

9:00am-12:05pm Aerospace Power Systems and Power Electronics I & II Kitty Hawk
Chairs: Zhenhua Jiang & Bang Tsao (University of Dayton Research Institute)

9:00am-9:20am **A generalized equivalent circuit model for large-scale battery packs with cell-to-cell variation,** Yaping Cai, *Ohio State University*
9:20am-9:40am **Recursive Least Squares Parameter Estimation for DC Fault Detection and Localization,** Luis Herrera, *University of Buffalo*
9:40am-10:00am **Enhanced Model Predictive Control for Dynamic Power Management in Drone Applications,** Seyed Raziei, *University of Dayton*
10:00am-10:20am **Testbed for Real-Time Control & Parameter Estimation,** Yingda Tao, *University of Alabama*

Coffee Break

10:45am-11:05am **Energy Storage Controller Design to Mitigate Impact of Pulsed Power Loads**, Jonathan Trainer, *University of Dayton Research Institute*
11:05am-11:25am **Time Response of a De-energizing Aerospace Synchronous Generator,** Kevin Yost, *AFRL RQ*
11:25am-11:45am **High Power Capacitive Power Transfer for Electric Aircraft Charging Application,** Fei Lu, *Drexel University*
11:45am-12:05pm **A Compact Onboard Battery Self-Heater for All-Electric Aircraft Applications at Cold Climates,** Fei Lu, *Drexel University*

12:15pm–1:30pm Luncheon **Ballroom**

Luncheon Keynote: Rajesh Naik, Chief Scientist, 711/HPW, AFRL
"Human-Machine Teaming in the Era of Autonomy"

Afternoon Sessions 1:45pm-5:45pm (Coffee Break 3:30pm-3:45pm)

Title		Location
Cyber Security & Trusted Systems I & II (1:45pm-5:45pm)		**Ballroom**
Deep Learning & AI II & III	**(1:45pm-5:45pm)**	**Auditorium**
Photonics and Electro-Optics I & II	**(1:45pm-5:15pm)**	**Kitty Hawk**

1:45pm-5:45pm Cyber Security & Trusted Systems I & II Ballroom
Chairs: Rob Williams (DLG), Nicholas Kovach (AFRL Sensors Directorate) & Randall Geiger (Iowa State University)

1:45pm-2:15pm **Cyber Resilience Through Strategic Analysis,** Jeff Hughes, *Tenet 3, LLC* **(Invited)**
2:15pm-2:35pm **Block Chain Methods for Trusted Avionic Systems***,* Erick Blasch*, AFOSR*
2:35pm-2:55pm **Trust and deception in Hypergame theory,** Nicholas Kovach, *AFRL Sensors Directorate*
2:55pm-3:15pm **A Foray into Extracting Malicious Features from Executable Code with Neural Network Salience,** Daniel Koranek, *AFRL Sensors Directorate*
3:15pm-3:35pm **Cognitive Malice Representation and Identification,** Daniel Koranek, *AFRL Sensors Directorate*

Coffee Break

3:45pm-4:05pm **Detecting Patterns in Assembly Code,** Anca Ralescu, *University of Cincinnati*
4:05pm-4:25pm **Static Analysis through Topic Modeling and its Application to Malware Programs Classification,** Temesgen Kebede, *AFRL Sensors Directorate*
4:25pm-4:45pm **Automated Synthesis of Differential Power Attack Resistant Integrated Circuits,** Chris Chuvalas**,** *University of Cincinnati*
4:45pm-5:05pm **Physical Cyber-Security of SCADA Systems**, Steven Bibyk, Wade Hoffman, *Ohio State University*
5:05pm-5:25pm **Authentication Circuit with Low Incorporation Barrier for COTs Manufacturers,** Randall Geiger, *Iowa State University*
5:25pm-5:45pm **A Novel Encryption Methodology with Prime Factorization through Reversible Logic Gates,** Patrick Bollinger, *Youngstown State University*

1:45pm-5:45pm Deep Learning & AI II & III Auditorium
Chairs: Tarek Taha (University of Dayton), Temesgen Kebede (AFRL Sensors Directorate) & Anca Ralescu (University of Cincinnati)

1:45pm-2:05pm **An Analysis of Univariate and Multivariate ECG Signal Classification** Magdy Bayoumi*, University of Louisiana at Lafayette*
2:05pm-2:25pm **A Continuous High-level Adaptive Runtime Integration Testbed,** Christopher Stewart**,** *Ohio State University*
2:25pm-2:45pm **Deep Learning Ensemble Methods for Skin Lesion Segmentation to Aid in Melanoma Detection,** Redha Ali, *University of Dayton*
2:45pm-3:05pm **Predicting Invasive Ductal Carcinoma in breast histology images using Convolutional Neural Network,** Hesham Alghodhaifi, *University of Michigan at Dearborn*
3:05pm-3:25pm **Hand Gestures from Low-Cost Surface-Electromyographs,** Sudarshan Chawathe, *University of Maine*

Coffee Break

3:45pm-4:05pm **Future Emergency Management through Artificial Intelligence**, Syama Chaudhuri, *Sensor Data Integration*
4:05pm-4:25pm **Human Presence Detection via Deep Learning of Passive Radio Frequency Data**, Jennifer Liu, *Oakland University*
4:25pm -4:45pm **A Comparative Study of Different CNN Encoders for Monocular Depth Prediction,** Zaid El-Shair, *University of Michigan at Dearborn*
4:45pm-5:05pm **Expiry Date Digits Recognition using Deep Learning,** Tareq Khan, *Eastern Michigan University*
5:05pm-5:25pm **Real-Time 3-D Segmentation on An Autonomous Embedded System: using Point Cloud and Camera,** Dewant Katare, *Purdue University*
5:25pm-5:45pm **In Situ Process Monitoring for Laser-Powder Bed Fusion using Convolutional Neural Networks and Infrared Tomography,** Dimitri Papazoglou & Hamad Elwarfalli, *University of Dayton*

1:45pm-5:15pm Photonics & Electro-Optics I & II Kitty Hawk
Chairs: Nicholaos Limberopoulos (AFRL Sensors Directorate)

1:45pm-2:15pm **Wideband 3D Frequency Selective Engineered Structures in the Terahertz Regime,** Kenneth Allen, *GTRI* **(Invited)**
2:15pm-2:35pm **Satellite Laser Communication to the Arctic,** Paul Christopher, *PFC Associates*
2:35pm-2:55pm **Image Transmission via Profiled Electromagnetic Beams through Modified Von Karman Phase Turbulence,** Ali Mohamed, *University of Dayton*
2:55pm-3:15pm **Gaussian Beam Propagation through Different Atmospheric Turbulance Conditions**, Elforjani Jera, *University of Dayton*

Coffee Break

3:45pm-4:15pm **Deep Learning based Automatic Building Roof Detection from Airborne Infrared & Visible Multispectral Imaging Data: Strengths and Weaknesses,** Dalila Megherbi**,** *University of Massachussetts at Lowell* **(Invited)**
4:15pm-4:35pm **Graphene Modified Plasmonic Sensors,** Tingyi Gu, *University of Delaware*
4:35pm-4:55pm **Imaging with Thick Lenses using ABCD Matrices and First-Order Material Dispersion,** Salaheddeen Bugoffa, *University of Dayton*
4:55pm-5:15pm **Planar Electromagnetic Propagation of an RCP Wave Across an Achiral/Chiral and Chiral/Achiral Interface using Fresnel Coefficients,** Rajab Ataai, *University of Dayton*

NAECON RECEPTION (HOLIDAY INN)
5:45pm – 7:30pm
Ballroom Foyers

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IEEE DAYTON SECTION
PEAL CHAPTER

Day 3 – Wednesday, July 17, 2019

Time	Event	Location
7:30am-8:30am	**Registration (until 4:00pm) & Breakfast**	**Ballroom Foyer**

Morning Sessions 8:30am-12:00pm (Coffee Break 10:15am-10:30am)

Title		Location
Cybersecurity and Trusted Systems III	**(8:30am-10:10am)**	**Ballroom**
Autonomy I	**(10:30am-12:10pm)**	**Ballroom**
Digital Signal Processing I	**(8:30am-11:50pm)**	**Auditorium**
Radar, Tomography	**(8:30am-11:30am)**	**Kitty Hawk**

8:30am-10:10am Cybersecurity & Trusted Systems III **Ballroom**
Chairs: Rob Williams (DLG), Nicholas Kovach (AFRL Sensors Directorate) & Randall Geiger (Iowa State University)

8:30am-8:50am **Detecting Wireless Intrusions With RF Watermarks,** Yousuke Matsui, *AFIT*
8:50am-9:10am **Privacy Preserving Medium Access Control Protocol for wireless Body Area Sensor Networks**, Ahmed Oun*, University of Toledo*
9:10am-9:30am **Evolvable Hardware for Security through Diverse Variants**, Bayley King, *University of Cincinnati*
9:30am-9:50am **Towards Code Recovery using Avida,** Grace Gamstetter, *University of Cincinnati*
9:50am-10:10am **ReRAM-Based Intrinsically Secure Memory: A Feasibility Analysis,** Nicholas Olexa, *University of Cincinnati*

Coffee Break

10:30am-12:10pm Autonomy I **Ballroom**
Chairs: Todd Jenkins (AFRL Sensors Directorate) & Christopher Stewart (Ohio State University)

10:30am-10:50am **High Speed Approximate Cognitive Domain Ontologies for Constrained Asset Allocation based on Spiking Neurons,** Nayim Rahman*, University of Dayton*
10:50am-11:10am **Simulation Toolset for Adaptive Remote Sensing,** Christopher Ball, *Ohio State University*
11:10am-11:30am **Toward the Development of a Cognitive Agent for Wide Area Search,** Benjamin Purman, *Soar Technology Inc.*
11:30am-11:50am **A Distributed System for Connectivity Tracking with UAVs,** James Trimble, *University of Tennessee at Chattanooga*
11:50am-12:10pm **Formation control of UAVs for Connectivity Maintenance and Collison Avoidance**, Srijitha Mukherjee, *University of North Texas*

8:30am-11:50am Digital Signal Processing I & II **Auditorium**
Chairs: Russell Hardie & Barath Narayanan (University of Dayton)

8:30am-8:50am **Comparison of MUSIC variants for Sparse Arrays,** Kaushalya Adhikari, *Louisiana Tech University*
8:50am-9:10am **A Multi-Cluster Tracking Algorithm with an Event Camera,** Mohamed Aladem*, University of Michigan at Dearborn*
9:10am-9:30am **Smart Phone as Toolbox for Height Measurement,** Ahmed Oun, *University of Toledo*
9:30am-9:50am **Mitigating Atmospheric Phase-Errors in SAL Imagery using Model-Based Reconstruction,** Randy Depoy, *AFRL Sensors Directorate*
9:50am-10:10am **Collision Avoidance and Drone Surveillance using Thread Protocol in V2V and V2I Communications,** Niranjan Ravi, *Purdue University*

Coffee Break

10:30am-10:50am **Fast and Robust System Identification on Compressive Sensing Signal Recovery Based on Multiple Time-Vary Step-size Adaptation Technique,** Haider Mohamed Kazim*, Western Michigan University*

10:50am-11:10am **Digital Integrated Monobit Dithering in FPGA,** Dan Pritsker, *Intel Corp.*
11:10am-11:30am **A Humanoid Robot Object Perception Approach Using Depth Images,** Aaron Cofield, *U. of Michigan at Dearborn*
11:30am-11:50am **AI Powered Unmanned Aerial Vehicle for Autonomous Payload Transport Application,** Muhammad Mustafa Hussaini, *UC Berkeley*

8:30am-11:30am Radar, Tomography I & II Kitty Hawk
Chairs: Brian Rigling (Wright State University) & Bob Penno (University of Dayton

8:30am-8:50am **Jammer Localization Through Smart Estimation of Jammer's Transmission Power**, Waleed Aldosari, *Oakland University*
8:50am-9:10am **Experimental Results of a Multstatic Doppler Radar System for Aeroecology,** David Boutte, *AKELA Inc.*
9:10am-9:30am **Conclusive Analysis and Cause of the Flyby Anomaly**, V. Guruprasad, *Inspired Research LLC*
9:30am-9:50am **A DNN-LSTM based Target Tracking Approach using mmWave Radar and Camera Sensor Fusion,** *Arindam Sengupta, University of Arizona*
9:50am-10:10am **Advanced Radar Modeling & Simulation Tools**, *Sandeep Gogineni, Information Systems Laboratories*

Coffee Break

10:30am-10:50am **The Use of a Reflectometer as a Monostatic Radar for Measuring Aircraft Structural Flutter,** William Wilson, *NASA Langley Research Center*
10:50am-11:10am **A Receiver for Doppler Estimation Capable Waveforms Utilizing Chirp Signature Diversity,** Alex Byrley, *University at Buffalo*
11:10am-11:30am **Non-Synchronized Integration using Multiple Radars via Least Squares Fitting,** Siyang Cao, *University of Arizona*

12:00pm–1:15pm Luncheon Ballroom

Luncheon Keynote Speaker: Maj Gen William T Cooley, Commander, AFRL
"Adapting S&T for Future Force Development"

1:15pm-2:00 pm Keynote Speaker Ballroom

Keynote Speaker: Shannon Jackson, Director, DOD SBIR Office
"Cybersecurity as a Small Business Opportunity"

Afternoon Sessions 2:15pm-5:00pm (Coffee Break-3:15pm-3:30pm)

Title		Location
Autonomy II & III	**(2:15pm-5:00pm)**	**Ballroom**
Emerging Electronics and Microsystems I & II	**(2:15pm-5:10pm)**	**Auditorium**
Machine Learning & AI I & II	**(2:15pm-5:10pm)**	**Kitty Hawk**

2:15pm-5: 00pm Autonomy II & III Ballroom
Chairs: Todd Jenkins (AFRL Sensors Directorate) & Christopher Stewart (Ohio State University)

2:15pm-2:35pm **Competing Objective Optimization in Networked Swarm Systems**, Shankarachary Ragi, *South Dakota School of Mines*
2:35pm-2:55pm **Influence of Emotions in Shaping Decisions,** Aritra Ghosh, *Florida Atlantic University*
2:55pm-3:15pm **Cluster based Hungarian Approach to Task Allocation for Unmanned Aerial Vehicles,** Arezoo Samiei, *New Mexico State University*

Coffee Break

3:30pm-4:00pm **What is the future of AI and what does this mean for Autonomy?,** Ronald Hartung **(*Invited*)**
4:00pm-4:20pm **Towards a Taxonomy of Planning for Autonomous Systems,** Trevor Bihl, *AFRL Sensors Directorate*
4:20pm-4:40pm **Spiking Neural Network for Adaptive Robotic Control,** Bright Ablordeppey*, University of Dayton*
4:40pm-5:00pm **A Probabilistic Decision Engine for Navigation of Autonomous Vehicles under Uncertainty,** Zhenhua Jiang*, University of Dayton Research Institute*

2:15pm-5:10pm Emerging Electronics and Microsystems I & II **Auditorium**
Chair: Soumyajit Mandal (Case Western Reserve University)

2:15pm-2:45pm **The role of low-power high-performance electronics in 4th industrial revolution,** Hossein Lavasani**,** *Case Western Reserve University* **(Invited)**
2:45pm-3:05pm **Adaptive-Hybrid Redundancy for Rad-Hardening,** Nicolas Hamilton*, AFIT*

Coffee Break

3:30pm-3:50pm **Quantum Computing: Architectures, Circuits, Algorithms,** Chris Papchristou*, Case Western Reserve University*
3:50-4:10pm **High Speed-Low Power GNRFET based Digital to Analog Converters for ULSI applications,** Mounica Patnala*, Indiana University Purdue University*
4:10-4:30pm **Gated-ReRAM Based Strategies for On-Chip Supervised Learning,** Andrew Rush, *University of Cincinnati*
4:30pm-4:50pm **A Study of the Heat Spreading Capabilities of Mass Via Arrays (MVA),** Devin Smarra*, University of Dayton*
4:50pm-5:10pm **High Performance GNRFET based Serializer***,* Avinash Yadav*, Indiana University Purdue University*

2:15pm-5:10pm Machine Learning, Guidance and Control I & II **Kitty Hawk**
Chairs: Trevor Bihl, Timothy Machin (AFRL Sensors Directorate) & Matthew Sambora (AFLCMC)

2:15pm-2:45pm **Global Measures of Robustness,** Mike Bakich, AFRL **(Invited)**
2:45pm-3:05pm **A Tutorial on Topological Data Analysis for Big Data Analytics***,* Trevor Bihl*, AFRL Sensors Directorate,* Elizabeth Campolongo*, The Ohio State University*

Coffee Break

3:30pm-3:50pm **Topological Learning for Semi-Supervised Anomaly Detection in Hyperspectral Imagery,** Juan Ramirez Jr, *AFRL Sensors Directorate*
3:50pm-4:10pm **Arduino-based implementation of an adaptive autopilot system,** Salam Hajjar, *Marshall University*
4:10pm-4:30pm **Real-Time Dynamic Gesture Recognition based on Boundary-Constraint Dynamic Time Warping**, Chunling Cheng, *Nanjing University of Posts and Technology, PRC*
4:30pm-4:50pm **Control-Theoretic Methods of Dynamic Resource Allocation and Digital Beamforming for MIMO over Satellite,** Khanh Pham**,** *AFRL Space Vehicles.*
4:50pm-5:10pm **Optimized Guidance Methods for Smooth Transitions in UAS Path Following,** Thomas Le Pichon, *University of Kansas*

5:00pm-6:00pm Poster Session I Judging of Best Posters (by Tracks) **Ballroom Foyers, Kitty Hawk, Armstrong, Challenger, Discovery**
Chairs: Kenneth Simone (The Design Knowledge Company) and Bob Penno, (University of Dayton)

6:00pm-9:00pm NAECON Banquet **Ballroom**

7:15pm NAECON Banquet Speaker: Lt Col Randy "Laz" Gordon AFWERX

"Connecting Innovators and Accelerating Results"

Day 4 – Thursday, July 18, 2019

Time	Event	Location
7:30am-8:30am	**Registration (until 12:00pm) and Breakfast**	**Ballroom Foyer**

Morning Sessions 8:30am-12:00pm (Coffee Break: 10:15am-10:30am)

Title		Location
Autonomy IV & V	**(8:30am-12:10am)**	**Ballroom**
Deep Learning & AI IV	**(8:30am-10:10am)**	**Auditorium**
Analog Devices and Signal Processing	**(10:30am-11:50am)**	**Auditorium**
Machine Learning, Guidance and Control I & II	**(8:30am-12:20pm)**	**Kitty Hawk**

8:30am-12:10pm Autonomy IV & V **Ballroom**
Chairs: Todd Jenkins (AFRL Sensors Directorate), and Christopher Stewart (Ohio State University)

8:30am-8:50am **Detecting Anomalies in Dismount Tracking Data,** Holly Zelnio, *AFRL*
8:50am-9:10am **Autonomous Algorithm Development and Flight Test Using Unmanned Systems Autonomy Service (UxAS),** Steven Rasmussen, *Miami Valley Aerospace LLC*
9:10am-9:30am **Towards high-level, verifiable autonomous behaviors with temporal specifications and persistent goals**, Sagar Pundit, *Virginia State University*
9:30am-9:50am **Engage or Retreat Differential Game with Two Targets,** Zhachariah Fuchs, *University of Cincinnati*
9:50am-10:10am **Design and Implementation of an Unmanned Aerial and Ground Vehicle Recharging System,** Nansong Wu, *Arkansas Tech University*

Coffee Break

10:30am-10:50am **Computational Thinking Curriculum for Unmanned Aerial Systems,** Christopher Stewart**,** *Ohio State University*
10:50am-11:10am **Towards a Heterogeneous Swarm for Object Classification**, Ross Arnold, *US Army CCDC AC*
11:10am-11:30am **Evaluating the Power Efficiency of Visual SLAM on Embedded GPU Systems,** Tao Peng**,** *University of Dayton*
11:30am-11:50am **Rotorcraft Obstacle Avoidance Simulation Environment (ROSE),** Will Trautman & Zach Smithson, *GTRI*
11:50am-12:10pm **Fast Lane Filtering for Autonomous Driving,** Ying Li, *Volvo Cars Test Center*

8:30am-10:10am Deep Learning & AI IV **Auditorium**
Chairs: Tarek Taha (University of Dayton), Temesgen Kebede (AFRL Sensors Directorate) & Anca Ralescu (University of Cincinnati)

8:30am-8:50am **FPGA based Multi-core Architectures for Neural Network and Router Configuration Exploration,** Yangjie Qi, *University of Dayton*
8:50am-9:10am **Pattern Matching on Neuromorphic Hardware,** William Mitchell & Ben Ausdenmoore, *Riverside Research*
9:10am-9:30am **Ambiguity Resolution in Direction of Arrival Estimation using Mixed Integer Optimization and Deep Learning,** Joel Goodman, *US Naval Research Lab*
9:30am-9:50am **Convolutional Neural Networks as Classification Tools and Feature Extractors for Distinguishing Malware Programs,** Venkata Salini Davuluru, *University of Dayton*
9:50am-10:10am **Radar-based Object Classification Using An Artificial Neural Network,** Dan Pritsker*, Intel Corp.*

Coffee Break

10:30am-11:50am Analog Devices and Signal Processing Auditorium
Chairs: Charles Cerny and Robert Ewing (AFRL Sensors Directorate)

10:30am-10:50am **Experimental Verification of Microwave Phase Shifters Using Barium Strontium Titanate (BST) Varactors,** Guru Subramanyam*, University of Dayton*
10:50am-11:10am **A 10-bit 100MS/s SAR ADC for the Hadronic Calorimeter Upgrade,** Yuan Mei, *Brookhaven National Laboratory*
11:10am-11:30am **Low Noise High Stability Amplifiers over Very High Frequency Range Using Mismatching Approach within Linvill Plane Simulation,** Joshua Woodward, *IUPUI*
11:30am-11:50am **Unique Compressive Sampling Techniques for Wideband Spectrum Sensing,** Andrew Schaefer, *Binghamton University*

8:30am-12:20pm Machine Learning, Guidance and Control III & IV Kitty Hawk
Chairs: Trevor Bihl, Timothy Machin (AFRL Sensors Directorate) & Matthew Sambora (AFLCMC)

8:30am-8:50am **Analytical Science for Autonomy Evaluation,** Erik Blasch, *AFOSR*
8:50am-9:10am **Multi-Eye Guidance Method for UAVs Path Following,** Jeffrey Xu, *University of Kansas*
9:10am-9:30am **An Intelligence Artificial Fish Swarm Optimization Technique**, Okechukwu Ugweje, *University of Mount Union*
9:30am-9:50am **Systems-Theoretic Innovation Framework for Machine Learning,** Adedeji Badiru, *AFIT*
9:50am-10:10am **Improved Magnetic Attitude Control,** Mohammed Desouky, *Michigan Tech University*

Coffee Break

10:30am-10:50am **Experimental Implementation of an ANN Controller for Quadrotor Trajectory Control in Confined Environment,** Ahmed Mekky**,** *Old Dominion University*
10:50am-11:10am **Dynamic Motion Planning and Control of Autonomous Vehicles,** Seyed Raziei, *University of Dayton*
11:10am-11:30am **Supervise Learning With Copulas,** Xiaoping Shen**,** *Ohio University*
11:30am-11:50am **REEF Estimator: A Simplified Open Source Estimator and Controller for Multirotors,** Prashant Ganesh, *University of Florida*
11:50am-12:20pm **Intelligent Collaboration among Humans and Machines (from Natural Language Understanding Perspective)***,* Huan Sun, *Ohio State University* **(Invited)**

12:00pm-1:15pm Luncheon Ballroom

Luncheon Keynote: Rob Williams, Director of Discovery Lab Global
"Artificial Intelligence Research – Through the Eyes of an Avatar"

1:15pm-3:15pm Poster Session II Judging of Posters for Awards Ballroom Foyers, Kitty Hawk, Armstrong, Challenger, Discovery
Chairs: Kenneth Simone (The Design Knowledge Company) & Bob Penno, (University of Dayton)

3:15pm-5:15pm Discovery Lab Global Special Session Ballroom

5:15pm-6:00pm Closing Session with Best Poster Awards Ballroom

Day 5 – Friday, July 19, 2019

Time	Event	Location
8:00am-4:00pm	**NAECON 2019 Industry Demo Day**	**Russ Research Ctr, 2642 Indian Ripple Rd, Beavercreek, OH**

IMPORTANT: As noted below, some events on Industry Day are capacity limited to 50 persons and require preregistration on the NAECON registration website. Also, please note that pay on your own Food Trucks will be present for Friday lunch and are *not* included in NAECON registration costs.

8:00am-8:30am Refreshments — Bld 2642, Alcove

8:30am-9:00am Opening remarks: — **Classroom** Bld 2642
Michael Deis, Scott Miller, *Russ Research Center, Ohio University* — Capacity: 50 **(PREREGISTER)**

9:00am-10:30am and 2:00pm-2:50pm Industry Demos

Sandeep Gogineni, Gregory Carter, *ISL* & Mark Kaschner, *NI* — **Small Conference Rm** Bld 2642 (Walkins)
Abstract: Real-Time Electromagnetic Environment Simulation (RTEMES) provides real-time stimulation of a test radar system using a high-fidelity, site-specific clutter and target channel computed using ISL's RFView(TM) simulation software. The system allows users to perform virtual test flights anywhere in the world without leaving the laboratory! The RTEMES demo shows the hardware and software in action with a real commercial maritime surveillance radar. During the demo the maritime radar under test is taken for test flights over several CONUS locations including the Chesapeake Bay and off the coast of Los Angeles. The RTEMES hardware platform uses the National Instruments FlexRio IF transceiver technology.

Niranjan Ravi, *Purdue School of Engineering and Technology* — **Conference Room** Bld 2642 (Walkins)
Tittle: Applications of Drones using Wireless Sensor Networks
Abstract: Wireless sensor networks (WSN) are one of the recent advancements in the field of research that helps in the process of data exchange between devices using battery-operated computing and sensing devices. But reliability, security of data, power consumption and range are onerous challenges which still exist. On the other hand, Unmanned Aerial Vehicle (UAVs) has emerged as a widely used application with increasing its scalability from commercial to personal applications. This paper aims at providing a architecture addressing the above challenges faced by WSN using a Low-Powered IPv6 based wireless protocol, Thread by incorporating with UAV to extend the range of WSN and ECC cryptography to secure the data transmission in WSN. A practical application for this new architecture is described in the paper which aids in maintaining an eco-friendly environment for human society.

John Emmert, *University of Cincinnati* — **Conference Room** Bld 2642 (Walkins)
Title: NSF CHEST IUCRC: Case Study for Leveraging NSF IUCRCs for R&D
Abstract There are many advantages for industry and DoD sponsors of National Science Foundation (NSF) Industry/University Cooperative Research Centers (IUCRCs). This paper not only enumerates existing advantages, it also proposes an improved paradigm for standing up IUCRCs that provides additional benefits to both university and industry. The NSFCenter for Hardware and Embedded System Security and Trust (CHEST) IUCRC is presented and used as a case study to demonstrate the effectiveness

10:30am-12:00pm Tutorial — **Classroom** Bld 2642
Jim Zhu, *Ohio University* — Capacity: 50 **(PREREGISTER)**
Title: Autonomous Vehicle Control
Abstract: A biopsychically inspired integrated cognitive control system architecture for autonomous vehicles and robots, collectively knowns autonomous agents, is presented in this workshop. The architecture is modeled after the human biological Central Nervous System (CNS), and algorithms are based off the dynamical human psychological cognitive processes. The pain-driven motivated learning algorithms allow the agent to set goals autonomously so as not only to survive but also thrive in uncertain or unknown environments. They endow the agent with the ability of improvisation, innovation and imagination. Dynamics of the environment and the agent's motion platform of different modes, e.g. terrestrial, aerial, naval and multimodal, are modeled in a unified approach, which enables the high-level cognitive control and low-level motion control systems to be designed using a unified multi-nested-loop approach by virtue of the singular perturbation (time-scale separation) principle. Live demos of the presented control architecture and algorithms will be presented on a number of ground vehicle development platforms of different sizes and weights, under a multitude of operational scenarios with low cost computing, sensing and actuator components. These demos should serve to validate the applicability and effectiveness of the presented autonomous control approach.

12:00pm-2:30pm Student Demos — **Outdoor**
Autonomous Vehicles Group, Ohio University
Title: Autonomous Vehicles at Ohio University

12:00pm-1:00pm Lunch Food Trucks (attendees pay on own)

1:00pm-1:50pm Presentation 1 **Classroom** Bld 2642
Corey Schumacher, CTO of ARCNet project at AFRL, Capacity: 50 **(PREREGISTER)**
Ken Wall, SP Galoball Inc,
Title: The Autonomy Research Collaboration Network (ARCNet)
Abstract: The Air Force Research Laboratory unveiled a consortium working to accommodate collaborative research and development initiatives for autonomous platforms and related technologies. This talk will describe the Autonomy Research Collaboration Network (ARCNet, which) is designed to rapidly carry out technology transition processes to further autonomous studies through the use of communication and speed of processes. AFRL developed ARCNet through a $196 million agreement with the SPG Institute and is eligible for usage by Department of Defense organizations. The laboratory also plans to use the platform to support the U.S. Air Force's 2030 Science and Technology Strategy.
The consortium platform allows for a deeper dialogue between the government and potential performers on research projects, allowing the potential performers to participate in defining the requirements and execution strategy for a project.

2:00pm-2:50pm Presentation 2 **Classroom** Bld 2642
Sandeep Gogineni, *ISL Inc* Capacity: 50 **(PREREGISTER)**
Title: High-Fidelity RF M&S Tools
Abstract: Introduction to two unique high-fidelity radio frequency M&S tools, RFView™ and RTEMES™, that support high-fidelity virtual flight testing which allows systems to be "flight-tested anywhere in the world" without leaving the laboratory leading to significant system development cost savings as well as significantly improved warfighter readiness!.

2:50pm - 4:00pm Free Discussion/Tours

Thank you for attending NAECON 2019!

Tutorials-Monday, July 15, 2019
(See abstracts on NAECON 2019 website)

Tutorial A 1:00pm-3:00pm
AI-Focused Tools and Hardware Supporting the Future of Autonomy presented by Intel (Ballroom)
Presented By: *Greg Nash, Intel PSG*

Tutorial B 3:15pm-5:15pm
Xilinx AI Edge Tutorial and Versal Portfolio presented by Xilinx (Ballroom)
Presented By:
Terry O'Neal, Xilinx Machine Learning Specialist FAE
Jason Vidmar, Xilinx System Architect, Military & Satellite Communications

Tutorial C 1:00pm-4:00pm
Hidden outlier noise and its Mitigation (Kitty Hawk)
Presented By: *Alexei V. Nikitin, Nonlinear LLC, Wamego, Kansas 66547, USA*

Tutorial D 1:00pm-5:15pm
Fundamentals of Artificial Intelligence & Deep Learning (Auditorium)
Presented By:
Rob Williams, Discovery Lab – Global (DLG)
Vijayan Asari, University of Dayton
Zahangir Alom, University of Dayton

Keynote Presentations Tuesday-Thursday

Alberto Valdes-Garcia, IBM

Vertical Integration for mmWave Systems: Building a Bridge between Antennas and AI

Si-based millimeter-wave transceivers and associated antenna-in-package integration techniques have recently reached a high level of complexity and maturity. These advances have enabled the commercial deployment of millimeter-wave systems in mobile communication networks and automotive radar systems.

The complexity and reconfigurability enabled by the co-integration of digital and millimeter-wave circuits has also resulted in a practically infinite configurability space, especially in the context of beamforming systems. Current millimeter-wave beamforming systems employing hand-crafted configuration algorithms can access <1% of this space. At IBM Research, we envision a future where the application space of millimeter-wave systems enters new domains as the capabilities of such systems are fully realized by AI-driven adaptation and data interpretation. Effective mmWave hardware-to-software vertical integration is a key step towards the realization of this vision by closing the gap between antennas and AI.

This talk presents two examples of such vertically integrated systems. First, a Software Defined Phased Array Radio (SDPAR) is discussed. The SDPAR consists of a highly configurable 64-element dual polarized phased array operating at 28 GHz, a Software Defined Radio (SDR), and a software stack enabling access to both radio and spatial beamforming functions from a single API. The second example is a multi-spectral imaging platform consisting of a 60-GHz imaging radar, an IR camera, a visible domain camera, and software for the joint visualization of information from these three distinct spectral domains. Experimental results obtained with these platforms will be presented along with an outlook of their evolution towards the development of AI technology tailored to adaptive communication systems and portable imaging devices.

Rajesh Naik, Chief Scientist, 711/HPW, AFRL

Human-Machine Teaming in the Era of Autonomy

To enable the right balance of human and machine capability to meet Air Force challenges in the future, one needs to consider the role of our airmen and how they integrate with machines. The Air Force is invested in growing autonomous systems capabilities to execute high-tempo, complex decision making. We can no longer evaluate the effectiveness of these autonomous technologies on its own without also evaluating the inextricable link to the human elements of the overall system. For the successful use of autonomous systems, it will have to be integrated the human system such that these technologies adapt to the airmen who operate the system and execute the commander's intent. These human-machine teams will increasingly rely on the human sciences to deliver those solutions as we begin to understand these interdependencies. In my talk, I will highlight some of the advances in human sciences to enable and enhance human-machine teaming.

Maj Gen William T Cooley, Commander, AFRL

Adapting S&T for Future Force Development

This presentation will provide an historical perspective of changes in technology and the critical need to recognize these changes and adapt strategies and tactics to deliver warfighting capabilities at the speed of relevance and necessity. The current technology climate will be described followed by an elaboration of Air Force Science & Technology Strategy objectives. These objectives include: 1) Develop and Deliver transformational strategic capabilities for the Air Force; 2) Reform the way science and technology is led and managed through the appointment of an Air Force Chief Technology Officer; and 3) Deepen and expand the science and technology enterprise through an increased focus in partnerships and adopting agile and innovative business processes. The transformational objective will focus on strategic capabilities that support the vision to dominate time, space, and complexity across all operating domains. These areas include: 1) Global persistent awareness (cyber intelligence); 2) Resilient information sharing (quantum); 3) Rapid, effective decision making (AI); and 4) Speed & Reach of disruption and lethality (hypersonic flight). Included is a discussion of what and how to adjust in the S&T portfolio to adapt to changes and methods to transition technologies rapidly to the warfighter.

Shannon Jackson, Director, DOD SBIR Office

Cybersecurity as a Small Business Opportunity

The Small Business Innovation Research (SBIR) program is a United States Government program, coordinated by the Small Business Administration. Annually, the DoD SBIR budget represents more than $1 billion in research funds. Over half the awards are to firms with fewer than 25 people and a third to firms of fewer than 10. A fifth are minority or women-owned businesses. Historically, a quarter of the companies are first-time winners. Cybersecurity is an increasingly high priority for DoD – for protecting not only information systems and critical infrastructure but increasingly the need to protect defense capabilities that depend on cyber-physical and embedded computing capabilities in our air, ground, sea, and space platforms. This talk will be about the opportunities for small businesses to contribute to the nation's growing need for innovations in cybersecurity through DoD's SBIR program and the supporting programs that DoD provides such as Department of Defense Mentor-Protégé Program.

Lt Col Randy "Laz" Gordon, AFWERX

Connecting Innovators and Accelerating Results

AFWERX is a product of the Air Force, directly envisioned by Secretary of the Air Force Heather Wilson. Her vision of AFWERX is to solve some of the toughest challenges that the Air Force faces through innovation and collaboration amongst our nation's top subject matter experts. The world is changing quickly — new technologies, new threats and new opportunities.

AFWERX taps into the power of creativity and empowers intentional innovation that unleashes emergent approaches for the warfighter through a community of entrepreneurs, industry, academia, and non-traditional contributors. AFWERX has the ability to bring together our nation's best and brightest to collaborate, innovate, fabricate, and present accelerated results to the United States Air Force to better serve our #1 customer: the warfighter and operators in the Air Force.

Rob Williams, Director, Discovery Lab Global

Artificial Intelligence Research – Through the Eyes of an Avatar

There is growing global interest and competition among nations and global industries to gain dominance in all things artificial intelligence (AI). This race to become the dominating global leader in AI is well underway with a growing number of countries developing and releasing national strategies to promote the use and development of AI for commercial and defense priorities. But these initiatives highlight the growing need for AI innovations and AI innovators.

In response, we present a novel crowd-sourcing strategy for accelerating today's AI innovations while also growing tomorrow's AI innovators that we call Massive Open Online Research as a natural extension of the Massive Open Online Courses (MOOC) concept. MOOR utilizes open-source virtual reality (VR) technologies and publicly available information (PAI) to create a 3D virtual AI research campus we call Deep HoriXons (DHX). This "battle-tested" approach has the potential to attract and engage scores of top-tier students from across the nation in AI pathfinding and prototyping projects within a 3D virtual AI campus with the potential to scale to hundreds of students nationally. A 3D virtual campus was successfully piloted under an Air Force STEM workforce development program that ran for 10 years before it ended upon the founding director retirement to continue it philosophically and further refine as the separate and independently operated non-profit Discovery Lab Global (DLG).

DLG's unique crowd-sourcing strategy utilizing a 3D virtual AI campus approach can be easily adapted and implemented by global AI competitors interested in cost-effectively accelerating their own Artificial Intelligence initiatives while also attracting and growing future AI talent. Successes and challenges will be highlighted.

Tuesday Track Abstracts

THz and mmwave I & II

Magnetoceramic Integration with Wide Band Gap Semiconductor Heterostructures for mm-wave MMICs, Vincent Harris, *Northeastern University* **(Invited)**

Magnetoceramics are insulating magnetic materials that offer high performance and a means to break time reversal symmetry at RF frequencies. As such, these materials provide non-reciprocal performance in RF isolators and circulators among other devices. Here, we present a review of the basic principles of modern magnetoceramics in the context of next generation RF device electronics including self-biased circulators/isolators, and filters and phase shifters.

Starting from a material science perspective, the chemistry, structure, and super-exchange magnetism of magnetoceramics will be discussed. Following this, the role of intrinsic material properties upon functional RF device performance will be presented, including coercivity, magnetic anisotropy, FMR linewidth, magnetism, and device isolation and insertion loss. Additionally, the methods used to process magnetoceramics into usable RF device materials, such as manipulating magnetic anisotropy using crystallographic texture and the integration of ferrite materials onto lattice matched semiconductor substrates, will be reviewed.Hartung

W-Band GaN IMPATT Diodes for High Power Millimeter-Wave Generation, Patrick Fay, *University of Notre Dame*

The DC and large signal characteristics of a GaN IMPATT diode designed for operation at W-band are investigated using Sentaurus TCAD simulations. The impact ionization model for GaN is calibrated using measured impact ionization coefficients of both electrons and holes, and both field- and carrier-concentration dependent velocity-field relationships are considered for accurate simulation. Large signal simulation results show that the IMPATT diode design evaluated is capable of generating an output RF power larger than 1 MW/cm^2 from 80 GHz to 120 GHz with an efficiency larger than 18%.

True-time Delay Engine Harnessing the Frozen-mode in Coupled Silicon Ridge Waveguides, Banaful Paul, *Ohio State University.*

We propose an integrated photonic structure consisting of three coupled straight Si ridges with periodic gaps for achieving frozen-mode behavior associated with a stationary inflection point (SIP) in its dispersion. The SIP is tuned to 190 THz and the extraordinary group delay performance is demonstrated via simulations of a finite-length 3-way coupled structure. This tunable, photonic-based true-time-delay engine paves way for ultra-wideband beamforming in phased arrays.

Demonstration of W-Band Polarimetric Radar with High-Extinction, Substrate-Based, Wire-Grid Polarizers, W.-D. Zhang, *Wright State University*

In this research we utilize new high-extinction-ratio (60 dB), substrate-based wire-grid polarizers to carry out measurements with a 94-GHz (W-band) polarimetric radar test-bed. Measurements of the complex 2x2 scattering matrix will be presented for various targets, such as metal rods and small projectiles (bullets).

3D mmWave Imaging with Si-based Phased Array Modules, Alberto Valdes-Garcia, *IBM* **(Invited)**

Millimeter-wave frequencies are attractive for all-weather 3D radar imaging systems and recent Si-based phased arrays are suitable for the implementation of such systems in a compact form factor. This presentation will describe examples of prototype portable 3D imaging systems at 60 GHz and 94 GHz. Potential applications will also be discussed.

Development of Optically Controlled Tunable/Reconfigurable Terahertz Waveguide Circuits/Components For Advanced Sensing and Adaptive Wireless Communications, Jun Ren, *University of Notre Dame*

We report our recent progress towards the development of optically controlled tunable/reconfigurable THz waveguide circuits for advanced sensing and communications. Optically tunable WR-4.3 attenuator with 60-dB range and 0.7-dB IL will be reviewed followed by the investigation of a reconfigurable waveguide BSF based on photo-induced EBG. Finally, high-performance optically controlled integrated RF switches enabling more advanced reconfigurable THz circuits will be discussed.

Polarimetric Terahertz Imaging of Biomedical Tissues, Maruf Hossain, *Ohio State University*

We present a polarimetric THz imaging system using full-duplex frequency extenders driven by a conventional vector network analyzer (VNA) for high-resolution imaging of morphological features in biological tissue samples. To demonstrate the efficacy of the proposed instrument, we image the axon bundles in brain tissue for millimeter-Wave and Terahertz frequencies (100GHz-2THz). Our approach also harnesses the high-index of the silicon lens, resulting in 3.4× improved image resolution as compared to free-space based THz imaging instrument.

Spectroscopic Sensing of Opioids in the THz Region, L. Himed, *Wright State University*

We present a study of the THz electromagnetic signatures of a few opioid drugs by computer modeling and experiments. Oxycodone and Vicodin display vibrational absorption resonances between ~1.4 and 1.6 THz. Molecular dynamics simulations predict that fentanyl should also display THz resonances with several of them occurring below 1.0 THz.

Low SWAP

Low SWaP Array Processing Architecture, Michael Parker, *Raytheon SAS* **(Invited)**

Radar and EW systems generally use AESA antennas. However, by combining the array elements at the array, these systems fail to take full advantage of the array capabilities. Recent AESA antennas architectures have the ability to provide I/Q digital inputs and outputs for each element. This creates new processing challenges, and the need for a new architecture to enable capabilities such as very high adaptation rates with unprecedented independent beam counts.

Jason Vidmar*,* Xilinx Adaptive Compute Acceleration Platform (ACAP) Featuring AI Engines for Diverse, Heterogenous Workloads for Aerospace & Defense Applications, *Xilinx* **(Invited)**
Recent technical challenges have forced the semiconductor industry to explore options beyond the conventional "one size fits all" CPU scalar processing solution. Very large vector processing (DSP, GPU) solves some problems, but it runs into traditional scaling challenges due to inflexible, inefficient memory bandwidth usage. Traditional FPGA solutions provide programmable memory hierarchy, but the traditional hardware development flow can be a barrier to rapid development, particularly as device complexity increases. Xilinx's latest solution combines all three elements with a new tool flow that offers a variety of different abstractions—from framework to C to RTL-level coding— into an adaptive compute acceleration platform (ACAP). This new category of devices, Xilinx's Versal™ ACAPs, allows users to customize their own domain specific architecture (DSA) from these three programmable elements. In this session, we will highlight key aspects of the architecture, and discuss how it can enable multiple levels of heterogenous integration (including direct RF) that is crucial for breakthroughs in low-SWaP processing. Emphasis will be given to the new AI Engines, which are an array of VLIW SIMD, mixed precision vector processors, optimized for streaming DSP workloads, that deliver up to 8X silicon compute density at 50% the power consumption of traditional programmable logic solutions.

The Development of an Embedded Low SWaP, FPGA Accelerated SAR Image Formation Chain, David Mundy, *University of Dayton Research Institute*
Previous development efforts resulted in the creation of a scalable FPGA based image formation chain to provide the acceleration for wide-area video-SAR utilizing a 2-stage backprojection. These efforts provide the basis of a low SWaP embedded implementation based on the same design, scaled down to a single FPGA that includes an embedded processor and an abstracted hardware/software interface.

An Indoor Navigation and Localization System, Francis Wolff, *Case Western Reserve University*
This paper introduces a mobile navigation and localization system suitable to guide visitors indoors without GPS. Useful in multilevel structures such as hospitals, shopping malls. The system is implemented on smartphone platforms equipped with embedded sensors. The technique uses a) Wi-Fi signal capturing from routers, b) pedestrian step identification using sensory data.

GPU Accelerated Atmospheric Aberration Correction, Paul Sundlie, *University of Dayton*
Digital holography provides a new opportunity for one look 3D imaging. However, computationally intensive wavefront propagation and correction provides an obstacle to rapid technological development. In this paper, we present our efforts to accelerate a CPU based atmospheric distortion correction
algorithm by leveraging modern GPU processing capabilities. We show a dramatic improvement in computation time, achieving near real time performance

Deep Learning & AI I

Computationally Efficient U-Net Architecture for Lung Segmentation in Chest Radiographs, Barath Narayanan, *University of Dayton Research Institute*
Lung segmentation plays a crucial role in computer-aided diagnosis using Chest Radiographs (CRs). We effectively implement a U-Net architecture for lung segmentation in CRs across multiple publicly available datasets. We utilize a private dataset with 160 CRs provided by the Riverrain medical group for training purposes. A publicly available dataset provided by the Japanese Radiological Scientific Technology (JRST) is used for testing. The active shape model based results would serve as the ground truth for both these datasets. In addition, we also study the performance of our algorithm on a publicly available Shenzhen dataset which contains 566 CRs with manually segmented lungs (ground truth). Our overall performance in terms of pixel-based classification is about 98.3% and 95.6% for a set of 100 CRs in Shezhen dataset and 140 CRs in JRST dataset. We also achieve an intersection over union value of 0.95 at a computation time of 8 seconds for the entire suite of Shenzhen testing cases.

CNN Optimization with a Genetic Algorithm, Anthony Reiling, *University of Dayton*
Hand tuning convolutional neural networks (CNN) for performance optimization can be tedious. A novel approach using a genetic algorithm to automate CNN hyper-parameter adjustment is proposed. This automated approach shows a 5\% accuracy improvement over hand tuned methods and highly energy efficient networks on the Intel Movidius Compute Stick.

High Performance SqueezeNext for CIFAR-10, Jayan Duggal**,** *Purdue University*
The convolution neural networks (CNN) is the foundation for deep learning and computer vision domain. CNN is a memory and computationally intensive algorithm. This paper proposes an efficient and a compact CNN to ameliorate the performance of existing CNN architectures using a high performance squeezenext architecture. The focus is to make an adaptable and a flexible model for efficient CNN performance which can perform better with the minimum trade off between model accuracy, size, and speed. The proposed architecture supplants convolution layers with a more sophisticated block module and develops a compact architecture with a competitive accuracy. The proposed architecture is trained on the CIFAR-10 dataset from scratch. All the training and testing results are visualized with live loss and accuracy graphs. As a result, the performance of CNN is improved by developing such architecture.

Aerospace Power Systems and Power Electronics I & II

A generalized equivalent circuit model for large-scale battery packs with cell-to-cell variation, Yaping Cai, *Ohio State University*

A critical issue in large-scale battery pack is the capability of assessing the impact of cell-to-cell variation on the pack/module performance. The inhomogeneity of cell parameters is due to manufacturer tolerances, cell degradation, and temperature gradients and leads to unbalanced current and voltage distribution in a pack. In this paper, a generalized equivalent circuit model for battery packs is proposed that effectively allows estimating the current and voltage difference between cells/strings in a pack as function of the system parameters. The model is based on a simplified equivalent circuit model that separates the healthy cells from the ones affected by parameters variation. The proposed model can be used during the design of the battery pack for estimating the impact of degradation and thermal unbalance in a pack.

Recursive Least Squares Parameter Estimation for DC Fault Detection and Localization, Luis Herrera, *University of Buffalo*

The advancement of modern aircraft seeks to place a higher priority on the electrical power systems to execute flight operations. Transitioning to aircraft with a larger dependence on these systems is advantageous because they increase reliability, maintainability, and cost efficiency. This requires an intelligent power system that is capable of not only powering the aircraft at ideal conditions, but also detecting faults and autonomously redistributing power to flight-critical electrical loads. This paper investigates how to detect parallel faults using recursive least squares estimation. Results indicate how estimation is affected by system variables.

Enhanced Model Predictive Control for Dynamic Power Management in Drone Applications, Seyed Raziei, *University of Dayton*

MPC is a promising control algorithm that by predicting the future behavior of the system, can optimally control a multi-objective system. However, MPC cannot predict the disturbances and changes in the system's parameters. As a result, the underlying system that is used for the prediction may not match the actual system, which would cause the MPC to become inefficient. To overcome this problem, to enhance the MPC performance a control structure consists of a neural network to predict the future value of the disturbances for the application of power management in drones is proposed

Testbed for Real-Time Control & Parameter Estimation, Yingda Tao, *University of Alabama*

The electromagnetic constants of permanent magnet synchronous motors (PMSM) used in vector control equations are typically determined during manufacturing for each individual motor. AC electric motor control is widely needed and used in industrial applications, including process industry and robotic automation. In practical applications, motor parameters can be changed broadly depending on environment and conditions. However, these motor parameters are not actually constant, but have some small variance depending on the context of use. Therefore, it is beneficial for motor control & power efficiency to have a way to accurately estimate and update these parameters in real-time, thus further optimizing motor performance. The goal of this project is to design a real-time control and parameter estimation technology for a Permanent Magnet Synchronous Motors (PMSM) and drive.

Energy Storage Controller Design to Mitigate Impact of Pulsed Power Loads, Jonathan Trainer, *University of Dayton Research Institute*

The transition to more-electric military and commercial aircraft designs continues to increase the complexity of designing the electric power system. In particular, the energy storage controller faces challenges in meeting the highly dynamic power demands of advanced power electronic based loads. This paper will focus on the energy storage controller design to mitigate the impact of pulsed power loads on the electrical system and the engine. Simulation results are then implemented using both electrical and mechanical components to illustrate the effectiveness of the proposed controller.

Time Response of a De-energizing Aerospace Synchronous Generator, Kevin Yost, *AFRL RQ*

The electrical power generation capacity of aerospace electric machines has grown considerably in both modern and future aircraft. While electrical power provides many performance and efficiency advantages, the added capacity also increases the available electrical fault current. Consequently, it is critical to understand the response of the electric machine to a fault and design protection schemes to de-energize the machine in order to mitigate any potential damage to the aircraft. This paper experimentally compares the total time response of a wound-field synchronous generator when simultaneously shorting the terminal windings and opening the exciter field windings under both no-load and loaded conditions.

High Power Capacitive Power Transfer for Electric Aircraft Charging Application, Fei Lu, *Drexel University*

This digest proposes to use the capacitive power transfer (CPT) method to achieve the high power charging of the electric aircraft. The capacitive coupler structure is presented, and the finite element analysis simulates the coupling capacitance. The power capability is calculated to show that MW level charging is achievable.

A Compact Onboard Battery Self-Heater for All-Electric Aircraft Applications at Cold Climates, Fei Lu, *Drexel University*

As the primary power source of all-electric aircraft, the lithium-ion batteries suffer severe capacity and power degradation at subzero temperatures, leading to serious "range anxiety" in winter. Therefore, a compact onboard battery preheating equipment is developed for internally preheating the batteries without external power supplies, extending the available flying range.

Cyber Security & Trusted Systems I & II

Cyber Resilience Through Strategic Analysis, Jeff Hughes, *Tenet 3, LLC* **(Invited)**
Cyber-physical system insecurity is expressible as information arbitrage practiced by the attacker (i.e. the attacker knows something the defender doesn't and profits by it). The adversary gains this knowledge by both observing the defender's system over time and practicing their attacks on similar systems or components that are often commercially available. The attacker typically has a limited set of objectives which aids in focused application of his resources. The defender has multiple competing requirements to satisfy. First, the system cannot be hamstrung by security and must support the mission by providing a useful capability (where usefulness is often characterized by availability, adaptability, and extensibility). Second, the defender must protect the system (and hence the mission) against multiple adversaries. The defender's resources are spread amongst these competing objectives with the hope that defenses have been optimally applied. The defender only becomes aware that an attacker/defender information differential existed when a system vulnerability is internally discovered, published by others, or worse yet, demonstrated by the adversary. Hope is not a defensive strategy ...identifying, tracking, and mitigating opportunities for information arbitrage is. This talk examines application of strategic analysis to mitigate opportunities for information arbitrage and provide for cyber physical system resiliency to threats.

Block Chain Methods for Trusted Avionic Systems*,* Erick Blasch*, AFOSR*
In this paper, we explore blockchain methods for a notional example for Automatic dependent surveillance—broadcast (ADS–B) from Flight24 data (https://www.flightradar24.com/) to determine whether blockchain is feasible for avionics systems. The methods are incorporated into the Lightweight Internet of Things(IoT) based Smart Public Safety (LISPS) framework.

Trust and deception in Hypergame theory, Nicholas Kovach, *AFRL Sensors Directorate*
Hypergame theory has been used to model advantages in decision-making. This research provides a formal representation of deception to further extend the hypergame model. We propose a hypergame framework based on temporal logic to model decision making under the potential for trust and deception. Using the temporal hypergame model, the concept of trust is defined within the constraints of the model. With a formal definition of trust in hypergame theory, the concepts of distrust, mistrust, misperception, and deception are then constructed. These formal definitions are then applied to an Attacker-Defender hypergame to show how the deception within the game can be formally modeled.

A Foray into Extracting Malicious Features from Executable Code with Neural Network Salience, Daniel Koranek, *AFRL Sensors Directorate*
We have previously created successful neural networks for malware detection. Here, we examine a network with salience to extract parts of an input deemed important. We show that the blocks we extract are what is important to the network, are unique to their class, and show clear similarities when clustered.

Cognitive Malice Representation and Identification, Daniel Koranek, *AFRL Sensors Directorate*
A cognitive system to identify malice must begin with definition and representation. Two components must be present in a cognitive security system, the current state of the system and a model that captures the current actor's behavior. This study outlines behavioral models of malice classification based upon execution traces.

Detecting Patterns in Assembly Code, Anca Ralescu, *University of Cincinnati*
Current malware detection solutions are limited in their ability to identify obfuscated malware. We discuss ways to examine a disassembled program with the goal to identify similar patterns. The first approach is to represent a collection of tokens drawn from assembly language opcodes as a 2D walk. Similarity of walks corresponds to functional similarities. Furthermore, we discuss possible distance metrics between collections of tokens.

Static Analysis through Topic Modeling and its Application to Malware Programs Classification, Temesgen Kebede, *AFRL Sensors Directorate*
The present study performs static analysis of malware programs in the BIG 2015 dataset. Our main goal is to provide a framework for classification of the programs in the dataset. Our analysis of the programs is static in the sense that the representations of the said programs are constructed their execution. More precisely, opcodes are extracted from the programs and concatenated in order to construct documents representing these programs. Opcodes being words, we then employ Natural Language Processing techniques for analysis of the documents. Mainly, using the Latent Dirichlet Allocation (LDA) technique, we model documents as weighted mixtures of a fixed number of topics, which, in turn, are collection of words capturing meaningful attributes about the documents. Using the weights of topics within each document as features, we train a k-NN classifier that achieves a 97.2% classification accuracy in testing, thereby attesting to the efficacy of the overall approach.

Automated Synthesis of Differential Power Attack Resistant Integrated Circuits, Chris Chuvalas**,** *University of Cincinnati*
We present a fully automated synthesis methodology for Differential Power Analysis (DPA) resistant integrated circuits based on the Secure Differential Multiplexer Logic (SDMLp). We show its effectiveness by synthesizing the layouts, from RT level Verilog specifications, of both the DES and AES encryption ICs in 90nm CMOS.

Physical Cyber-Security of SCADA Systems, Steven Bibyk, Wade Hoffman, *Ohio State University*
This paper seeks to combine the concepts of power signal monitoring with previous research into embedded system physical cyber-security. This combination presents a potential approach to securing the operation of Supervisory Control and Data Acquisition

(SCADA) systems. With this approach, the concepts of trust metrics, derived from power signal data, will be applied to ensure the security and consistent performance of the dynamic SCADA system control processes.

Authentication Circuit with Low Incorporation Barrier for COTs Manufacturers, Randall Geiger, *Iowa State University*
A simple PUF-based authentication circuit has been proposed to lower the entry barrier of counterfeit countermeasure by the COTs manufacturers. The on-chip fingerprint circuit does not require additional die area, I/O pins and read-out circuits. This inflicts negative financial incentives for the counterfeiters. An 80 bit authentication circuit which includes a 16 bit frame header has been designed in UMC 65nm process with an area estimate of 0.01 mm2.

A Novel Encryption Methodology with Prime Factorization through Reversible Logic Gates, Patrick Bollinger, *Youngstown State University*
An investigation of one encryption methodology, RSA, focused on factoring semi-prime numbers. This novel approach used programming to represent digital logic gates and deduce information for each logic gate in an array multiplier. A sweep of factoring semi-primes from 4 to 1024 bits determined this method is currently not sufficient.

Deep Learning & AI II & III
An Analysis of Univariate and Multivariate ECG Signal Classification Magdy Bayoumi*, University of Louisiana at Lafayette*
Heart diseases are mainly diagnosed by the electrocardiogram (ECG) or (EKG). Correct classification of ECG signals helps in diagnosing heart diseases. In this paper, we study and analyze the univariate and multivariate ECG signal classification problem to find the optimal classifier for ECG signals from existing state-of-the-art time series classification models.

A Continuous High-level Adaptive Runtime Integration Testbed, Christopher Stewart**,** *Ohio State University*
The integration of complex, distributed systems typically takes thousands of man-hours and years of detailed design and testing. Despite all this effort, the effectiveness of classical system integration becomes a major issue when one adds the runtime adaptive behavior that is increasingly vital for dynamic, autonomous systems influenced by their surroundings. Self-integrating systems proposed in recent research strive to autonomously integrate new components, reducing design and testing costs. However, these systems are challenging to validate, especially at scale.
We propose CHARIOT, Continuous High-level Adaptive Runtime IntegratiOn Testbed, to allow for different approaches and systems to be dynamically deployed, assessed and compared on a shared common platform. CHARIOT uses self-flying drones and self-driving cars to validate autonomous signal integration. This paper will discuss our early work in designing the CHARIOT architecture and integration protocol.

Deep Learning Ensemble Methods for Skin Lesion Segmentation to Aid in Melanoma Detection, Redha Ali, *University of Dayton*
Skin cancer has a significant impact across the world. Melanoma is a malignant form of skin cancer. Skin lesion segmentation is one important step in computer-aided diagnosis (CAD) for automated diagnosis of melanoma. In this paper, we describe our research work and the submission to the International Skin Imaging Collaboration's (ISIC) 2018 Challenge in Skin Lesion Analysis Towards Melanoma Detection. We propose Convolutional Neural Network (CNN) based ensemble methods for improving the existing performance of lesion segmentation. The proposed ensemble technique includes VGG19-UNet, DeeplabV3+ and other preprocessing methodologies. Extensive experiments are conducted on the ISIC 2018 challenge dataset without using any external dataset to demonstrate the efficacy of the proposed model. Our model is currently ranked #12 for lesion segmentation on the live leaderboards (https://challenge2018.isic-archive.com/live-leaderboards/).

Predicting Invasive Ductal Carcinoma in breast histology images using Convolutional Neural Network, Hesham Alghodhaifi, *University of Michigan at Dearborn*
Over the past ten years, there has been a rise in using deep learning for medical image analysis such as CNN. Deep learning is used extensively in the field of healthcare to identify patterns, classify and segment tumors and so on. The classification of breast cancer is a well-known problem that attracts the attention of many researchers in the field of healthcare because breast cancer is the second major cause of cancer-related deaths in women. The most common subtype of all breast cancers is the Invasive Ductal Carcinoma (IDC). There are many ways to identify this type of breast cancer such as a biopsy where tissue is removed from the patient and studied under a microscope. In this paper, we have experimentally tested dataset augmentation techniques to enhance the accuracy of the convolutional neural network as well as ''sotmax + convolutional neural network'' and ''convolutional neural network features + SVM classifier'' configurations. The results show convolutional neural networks outperformed the sotmax classifier, where we achieved ~86% classification accuracy, ~85% sensitivity, and ~85% specificity.
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Hand Gestures from Low-Cost Surface-Electromyographs, Sudarshan Chawathe, *University of Maine*
Low-cost and commodity off-the-shelf surface electromyographs (sEMGs) may be used for unobtrusive detection of human hand gestures. Although these EMG signals are not as detailed as conventional ones, an experimental investigation of feature engineering and classification reveals that they can yield accurate hand gesture information.

Future Emergency Management through Artificial Intelligence, Syama Chaudhuri, *Sensor Data Integration*

One significant gap in the Army's current Physical Security Integration Framework (PSIF) is the absence of any emergency management (EM) functions such as prevention, response and recovery from human-initiated emergency incidents. The goal of this paper is to address an AI application that will fill this gap. The first objective of this paper to address knowledge in AI computing algorithms and methods to identify, prevent, and plan response and recovery actions from human-initiated destructive incidents. The second objective of this paper is to address an integrated application to the existing PSIF framework.

Human Presence Detection via Deep Learning of Passive Radio Frequency Data*,* Jennifer Liu*, Oakland University*
Human presence detection is a critical problem in certain circumstances such as nature disasters and surveillance systems. This paper presents a new way of solving this problem by using software defined radio to passively collect radio frequency data and applying deep learning neural network to detect human presence. It's a low cost and environment friendly solution. The long term goal of this study is to develop a deep learning based spectrum monitoring system.

A Comparative Study of Different CNN Encoders for Monocular Depth Prediction, Zaid El-Shair, *University of Michigan at Dearborn*
Depth estimation of an observed scene is an important task for many domains such as mobile robotics, autonomous driving, and augmented reality. Traditionally, specialized sensors such as stereo cameras and structured light (RGB-D) ones are used to obtain depth along with color information of the environment. However, extending typical monocular cameras with the ability to infer depth information is an attractive solution. In this paper, we will demonstrate a Convolutional Neural Network (CNN) in an encoder-decoder architecture to perform monocular depth prediction. Additionally, we will evaluate and compare different CNN encoders performance.

Expiry Date Digits Recognition using Deep Learning, Tareq Khan, *Eastern Michigan University*
In this paper, a deep learning model is proposed to recognize expiry date digits from images. This model can be used with smart expiry architecture to get automatic notification in the smartphone for the foods that are expiring soon. The proposed model is tested and has an accuracy of 80%.

Real-Time 3-D Segmentation on An Autonomous Embedded System: using Point Cloud and Camera, Dewant Katare, *Purdue University*
This paper presents an approach to combine the input of camera and lidar for semantic segmentation purpose. The proposed model for outdoor scene segmentation is based on the frustum pointnet, and ResNet which utilizes the 3-D point cloud and camera input for the 3-D bounding box prediction across the moving and non-moving object and thus finally recognizing and understanding the scenario at the point-cloud or pixel level. For real time application the model is deployed on the RTMaps framework with Bluebox (an embedded platform for autonomous vehicle). The proposed architecture is trained with the CITYScpaes and the KITTI dataset.

In Situ Process Monitoring for Laser-Powder Bed Fusion using Convolutional Neural Networks and Infrared Tomography, Dimitri Papazoglou & Hamad Elwarfalli, *University of Dayton*
In situ process monitoring of additive manufacturing laser-powder bed fusion processes, can reveal defect formation and occurrence internally in produced parts. Ensuring high quality of parts is possible using convolutional neural networks and infrared tomography to detect geometries. This work is one of the first steps in developing in situ processing monitoring algorithms for defect detection.

Photonics & Electro-Optics I & II

Wideband 3D Frequency Selective Engineered Structures in the Terahertz Regime, Kenneth Allen, *GTRI* **(Invited)**
In this work, the three-dimensional cellular architecture for frequency-selective engineered structure (FSES) arrays are designed for a variety of electromagnetic responses in the terahertz (THz) regime. The design is optimized through a process mimicking evolutionary, i.e. a genetic algorithm. The cost functions are rooted in physics based estimations. In a similar fashion, the basis functions are constrained based on state-of-the-art fabrication processes for nanoscale fabrication. As an example, an absorptive response was engineered (Fig. 1). The 3D nature of the cell leads to angularly stable responses, out to 45 degrees for TM-polarization, as shown in Figs. 1(c-d). To highlight the bandwidth of the response, the result is directly compared with a split ring resonator (SRR), Fig. 1(a). The SRR has a resonance straddling 15 THz whereas the 3D FSES with a fragmented pattern is highly absorptive from 15-25 THz, Figs. 1(c-d) respectively.

Satellite Laser Communication to the Arctic, Paul Christopher, *PFC Associates*
Gerard O'Neill's outstanding satellite solar array concepts are updated from geostationary systems to include sun synchronous low earth orbits and Brandon Molniya orbits. Brandon orbits would offer the convenience of stationary ground antennas.

Image Transmission via Profiled Electromagnetic Beams through Modified Von Karman Phase Turbulence, Ali Mohamed, *University of Dayton*
Propagation of uniform and Gaussian profiled image-bearing beams through random phase turbulence is investigated in the Fraunhofer far- and deep-field regimes. Beam propagation through planar apertures is examined using a split-step approach; the numerical approach is thereafter extended to the case of isoplanatic propagation through modified von Karman (MVKS) turbulence on lens-based 2D imaging and PCM-digitized time signals of the image propagated through arbitrary turbulence regimes.

Gaussian Beam Propagation through Different Atmospheric Turbulance Conditions, Elforjani Jera*, University of Dayton*
In this work, we will be studying the propagation of Gaussian beam through turbulent atmosphere. The main goal of this work is to study the impact of the atmosphere turbulence on Gaussian beam waist's location and size, and the impact of the atmosphere turbulence on the 3D beam shape.

Deep Learning based Automatic Building Roof Detection from Airborne Infrared & Visible Multispectral Imaging Data: Strengths and Weaknesses, Dalila Megherbi**,** *University of Massachussetts at Lowell* **(Invited)**
Hyperspectral/multispectral sensing for situational awareness is of major importance for supporting government activities in many homeland security and defense applications, as well as in many civilian applications, such as target detection & identification, bio-imaging and medical field. This is due to its intrinsic ability to integrate spectral and spatial target information, such as buildings blocks-boundaries or roads. Many machine learning and object recognition algorithms display complex performances, yet not enough is known about these performance complexities. Deep learning techniques are becoming an ever-present and relatively popular part of recent approaches in imaging and vision. However, in many cases they are used on a virtually empirical basis without the needed understanding of their behavior. In particular, current deep learning techniques for Infrared & visible multispectral/hyperspectral machine vision are limited. Adding different layers and increasing the size of training data, (big data) will not be enough to shed light on these learning complexities. While various multi-spectral/hyperspectral detection/recognition algorithms have been proposed in the literature, unfortunately many of them remain in their infancy. This is mainly due to their lack of high detection recognition rates in the presence of time-varying image artifacts and conditions, even slight ones. In order to develop more accurate recognition systems, there is a primary need to identify and derive some of the causes that affect some hyperspectral multispectral target recognition accuracy rates. In this talk, I will focus on some of these causes and I present our latest findings on investigation and analysis of how and what factors may affect the recognition accuracy rate of some of the most popular and currently widely used deep-learning algorithm for automatic airborne multispectral building roof automatic detection and other applications. In particular, in this presentation, as an example, we propose and show how a “Fully” Convolutional Neural Network (FCNN)-based deep learning system with a novel Pixel Rearrangement technique results in significantly reduced computational complexity and improved accuracy than its state-of-the-art counterparts. With three NVIDIA GeForce GTX 1060 GPUs, our findings show an improvement in the performance by 0.3% in comparison to the top winning submission to the national building roof detection challenge competition that took place in year 2017, but with an additional 43% reduction in the number of deep learning architecture layers. We also present a benchmark comparison result with various existing approaches to highlight our reduced computational complexity but improved accuracy.

Graphene Modified Plasmonic Sensors, Tingyi Gu*, University of Delaware*
We observed broadening of the plasmonic guided modes in gold nanorod arrays by a single layer graphene, which can manifest CO2 detection. The plasmonic modes enhance absorption by over 35% from 729 to 621 cm-1.

Imaging with Thick Lenses using ABCD Matrices and First-Order Material Dispersion, Salaheddeen Bugoffa, *University of Dayton*
ABCD matrices for a thick lens are used to ascertain imaging behavior for a colored 2D object under first-order material dispersion. Frequency-dependent dispersion of dielectric permittivity is incorporated in the analysis and results are compared with the non-dispersive problem. The possibility of introducing chirality and negative index in the lens material is also discussed.

Planar Electromagnetic Propagation of an RCP Wave Across an Achiral/Chiral and Chiral/Achiral Interface using Fresnel Coefficients, Rajab Ataai, *University of Dayton*
Propagation across chiral interfaces are studied for incident electromagnetic plane waves with right circular polarization (RCP). The first analysis consists of propagation across a purely achiral interface, followed by an achiral/chiral (ACC) interface, and the second across a chiral/achiral (CAC) interface. The analysis consists of deriving corresponding Fresnel coefficients for reflection and transmission, and comparison between the ACC and CAC interfaces.

Wednesday Track Abstracts

Cybersecurity & Trusted Systems III

Detecting Wireless Intrusions With RF Watermarks, Yousuke Matsui, *AFIT*
Validation of devices at the physical layer can be accomplish with radio frequency watermarks to enhance wireless network security. For this application, watermarks are implemented as small signal offsets below the noise floor. These watermarks can be used to validate network devices while maintaining the integrity of the original signal.

Privacy Preserving Medium Access Control Protocol for wireless Body Area Sensor Networks, Ahmed Oun, *University of Toledo*
In this paper, a Privacy-Preserving Medium Access Control (PP-MAC) protocol is proposed to detect selfish attacks that lead to security and power-consumption issues. Simulation results show that the proposed protocol performs better than the exiting protocols in terms of rate, energy, and throughput for detecting selfish attacks.

Evolvable Hardware for Security through Diverse Variants, Bayley King, *University of Cincinnati*
Evolvable hardware is attractive as a design strategy to hardware engineers, but suffers due to its lack of scalability to larger hardware systems. This work examines how hardware designers can make use of evolvable hardware to improve the security of their systems, and to create hardware systems that are better resistant to reverse engineering.

Towards Code Recovery using Avida, Grace Gamstetter, *University of Cincinnati*
Modern malware detection capabilities are limited to detecting programs which have already been identified as malicious. This paper discusses how malware progression can be modeled using evolutionary models for adaptive software behavior. We use Avida, an evolution generation tool for digital organisms, to simulate the evolution of computer programs. We show that programs can recover full functionality from a similar algorithm by evolving in a digital environment.

ReRAM-Based Intrinsically Secure Memory: A Feasibility Analysis, Nicholas Olexa, *University of Cincinnati*
This paper studies the use of resistive RAM (ReRAM) devices in crossbar arrays for intrinsically secure self-encrypted memory. A security analysis is used to demonstrate the feasibility of realizing intrinsically secure memory using experimentally available ReRAM devices. It is shown that ReRAM is a good candidate for this application due to its nature, which allows forward and reverse operations for securely storing and retrieving data.

Autonomy I

High Speed Approximate Cognitive Domain Ontologies for Constrained Asset Allocation based on Spiking Neurons, Nayim Rahman, *University of Dayton*
Cognitive agents are typically utilized in autonomous systems for automated decision making, and there is a strong need for a real time agent running on a low power platform. One problem that is often tasked to these systems is asset allocation. In the presented low power implementation, a grid of spiking neurons is capable of generating solutions to this problem very quickly. This approximate spiking approach is able to complete nearly all allocation simulations with greater than 98% accuracy. Our results also show that constraining the solution space by creating specific rules for a scenario can alter the quality of the allocation result. We present a study compares allocation score and computation time for three different constraint implementation cases. Given the vast increase in speed, as well as the reduction computational requirements, the presented algorithm is ideal for moving asset allocation to low power embedded hardware.

Simulation Toolset for Adaptive Remote Sensing, Christopher Ball, *Ohio State University*
The Simulation Toolset for Adaptive Remote Sensing (STARS) software library was developed to support future observing system simulation experiments for autonomous satellite-based Earth remote sensing missions. Specifically, STARS models and optimizes the performance of next generation adaptive sensors, resource constrained platforms (such as CubeSats), and constellations of collaborative satellites.

Toward the Development of a Cognitive Agent for Wide Area Search, Benjamin Purman, *Soar Technology Inc.*
This paper presents the development of a cognitive agent for wide area search applications. The agent encodes knowledge about objects of interest, and how they occur in the environment. This allows the object detector to stay focused on detecting a single object in the environment, keeping training data requirements manageable. The cognitive agent provides external reasoning to reduce false alarm rates and explore additional inferences. We develop an agent design, conduct feasibility studies for reasoning strategies, and we identify areas for future agent contributions.

A Distributed System for Connectivity Tracking with UAVs, James Trimble, *University of Tennessee at Chattanooga*
Algebraic connectivity is the second-smallest eigenvalue of the Laplacian matrix, a graph-theoretic representation for connections in a multi-agent system, and can be used as a metric for the robustness and efficiency of the network. This work develops a distributed method for tracking an algebraic connectivity profile with UAV teams.

Formation control of UAVs for Connectivity Maintenance and Collison Avoidance, Srijitha Mukherjee, *University of North Texas*

In this paper, a formation control law for Unmanned Air Vehicles (UAVs) is proposed. This model combines the control and communication constraints in a balanced fashion while the UAVs attain formation. Here, a leader-follower structure is implemented with consensus laws along-with social potential functions ensuring collision avoidance and connectivity maintenance.

Digital Signal Processing I & II

Comparison of MUSIC variants for Sparse Arrays, Kaushalya Adhikari, *Louisiana Tech University*
Nested and coprime arrays have high degrees of freedom that can be exploited in direction of arrival estimation using various algorithms. Most algorithms use a combination of product processing, min processing, and MUSIC. We show that direct MUSIC with unbiased autocorrelations estimates is superior to other algorithms.

A Multi-Cluster Tracking Algorithm with an Event Camera, Mohamed Aladem*, University of Michigan at Dearborn*
Robotic perception continues to be one of the main challenges in autonomous robotics. Accurate and real-time perception is very important as it constitutes the basis of important tasks such as decision making and control. The latency of the sensing pipeline is a major limiting factor for the agility of a robot. A novel sensor called an event camera has been recently developed to overcome the limitations of traditional frame-based ones. Event cameras mimic the human perception system as they measure the per-pixel intensity change rather than the actual intensity level. This paper presents our initial investigation of this novel sensing modality by building an event-based dynamic multi-cluster tracker. This can constitute a building-block for higher-level event-based multi-object trackers. The clustering algorithm will be experimentally evaluated including computational performance evaluation on constrained embedded device.

Smart Phone as Toolbox for Height Measurement, Ahmed Oun, *University of Toledo*
This paper uses elementary effects (EE) method to recognize variables that are non-influential. EE method is also used to sort affecting factors such as temperature and humidity, according to factors' significance. Furthermore, this paper minimizes the burst affecting variable random error by using a method called Filtering Burst Error and Random Error Process (FBEREP) to ensure the error rate. The validation is conducted using real smartphones. Based on the result, it can be observed that the error rate is controlled within 2%.

Mitigating Atmospheric Phase-Errors in SAL Imagery using Model-Based Reconstruction, Randy Depoy, *AFRL Sensors Directorate*
Synthetic Aperture Ladar is an emerging ladar sensing technology capable of providing fine-resolution imagery of an illuminated region-of-interest. Operating at optical wavelengths brings an increased susceptibility to atmospheric turbulence. We propose a novel extension of published model-based image reconstruction algorithms to mitigate atmospheric phase errors and restoring SAL image quality.

Collision Avoidance and Drone Surveillance using Thread Protocol in V2V and V2I Communications, Niranjan Ravi, *Purdue University*
Intra-vehicular communications (V2V) and vehicle to infrastructure communications (V2I) has been one of the important research topics nowadays due to the rapid growth of automotive industries and ideology of producing autonomous cars. This paper demonstrates the practice of integrating V2V communication with Thread, one of the low power WSN for data transmission, to initiate adaptive cruise control in a vehicle during a crisis. Also, UAV systems are employed as a part of V2I system to provide aerial view video surveillance if any accident occurs.

Fast and Robust System Identification on Compressive Sensing Signal Recovery Based on Multiple Time-Vary Step-size Adaptation Technique, Haider Mohamed Kazim*, Western Michigan University*
To improve the robustness of the algorithm against unknown sparsity levels, and to reduce the trading-off between complexity and quality of recovering sparse signals, a new technique for sparse signal reconstruction in compressive sensing (CS) is presented. The solution presented in this work based on a recently proposed algorithm that innovatively employs a tap-individualized time-varying stepsize for system identification. It converts the matrix operation of existing approaches to vector implementation and exploits the well-known property of time-varying stepsize algorithms of noise-tolerance in signal reconstruction. The essence is to allocate each tap a unique time-varying stepsize that updates according to the power of each row of the measurement matrix to control the step of decreasing of each stepsize individually. Advantages of the proposed technique such as robustness against sparsity level and noisy signals, and achieving faster convergence rate are demonstrated numerically.

Digital Integrated Monobit Dithering in FPGA, Dan Pritsker, *Intel Corp.*
Wideband receivers and transmitter are widely used in a variety of applications, including but not limited to Radio-Frequency (RF) surveillance systems and Electronic-Countermeasures systems. Such systems require enormously wide instantaneous bandwidth to allow concurrent monitoring of all potential signals of interest. This paper will present an innovative way to use FPGA digital high-speed transceivers, which are typically used for inter-device communication links, to reduce spurs in Monobit receivers. We propose an integrated dithering solution that has showed outstanding merit to suppress spurs, while allowing to keep HW SWaP more competative versus traditional analog approach.

A Humanoid Robot Object Perception Approach Using Depth Images, Aaron Cofield, *U. of Michigan at Dearborn*
Humanoid robots have had a significant research interest in the past two decades. Their classification as mobile manipulators allows them to work in unstructured environments creating new possibilities for human-robot interaction. In order to enable object grasping and manipulation, visual perception must be established. This paper presents an ongoing work that aims to integrate and test object

perception using depth images from an RGB-D camera for different scenarios, as well as an approach for humanoid object grasping according to the acquired visual feedback.

AI Powered Unmanned Aerial Vehicle for Autonomous Payload Transport Application, Muhammad Mustafa Hussaini, *UC Berkeley*
In this work, we demonstrate the use of drones in autonomous payload transport application. The 1.38 kg UAV was equipped with AI capability to detect the target object/target location with high accuracy for 1 kg payload release, autonomously. The payload release mechanism was achieved using a 3D printed system.

Radar, Tomography I & II

Jammer Localization Through Smart Estimation of Jammer's Transmission Power*,* Waleed Aldosari*, Oakland University*
Wireless Sensors Network (WSNs) susceptible to jamming attacks due to shared nature and open access medium. Jammer disrupts the wireless channel by injecting its signal into the legitimate traffic which caused to increase the amount of noise at the receiver. In order to improve the localization accuracy, this paper proposed Distance ratio (DR) based on signal to noise ratio (SNR). The primary process of Distance to signal noise Ratio (DSNR) algorithm consists of four steps: capturing jamming Signal Strength (JRSS) and compute the received power between boundary node and its neighbor, compute DR, estimating jammer's transmission power and its location, and minimizing localization error. Finally, extensive simulations are conducted to evaluate the performance, effectiveness and the robustness of the proposed method compared to similar localization algorithms

Experimental Results of a Multstatic Doppler Radar System for Aeroecology, David Boutte*, AKELA Inc.*
This paper focuses on experimental results from a multistatic Doppler radar system developed for detection and tracking of bats in wooded environments. Results from an experimental measurement campaign conducted in 2018 in Tennessee are shown and several three-dimensional tracks consistent with contemporaneously collected acoustic measurements are presented.

Conclusive Analysis and Cause of the Flyby Anomaly, V. Guruprasad, *Inspired Research LLC*
JPL's own data correlate to 1% NEAR and Rosetta trajectory discrepancies to unexpected doubling of path times in phase locked tracking. NEAR's radar residuals illustrate the doubling to 5σ. Analysis of these and other NASA-tracked flybys shows that a distance sensitive anomalous signal does generally exist.

A DNN-LSTM based Target Tracking Approach using mmWave Radar and Camera Sensor Fusion, *Arindam Sengupta, University of Arizona*
A new sensor fusion study for monocular camera and mmWave radar using deep neural network and LSTMs is presented. The proposed study includes a decision framework to produce reliable output when either sensor fails. Experiment results to demonstrate single sensor uncertainty and the proposed method's advantages are also presented.

Advanced Radar Modeling & Simulation Tools*, Sandeep Gogineni, Information Systems Laboratories*
This talk will address challenges and solutions related to HI-fidelity RF M&S and HWIL testing. Unique high-fidelity radio frequency M&S solutions RFView and RTEMES will be discussed. They support high-fidelity virtual flight testing which allows systems to be "flight-tested anywhere in the world" without leaving the laboratory leading to significant system development cost savings as well as significantly improved warfighter readiness

The Use of a Reflectometer as a Monostatic Radar for Measuring Aircraft Structural Flutter, William Wilson, *NASA Langley Research Center*
A commercial microwave reflectometer is used measure vibrations typical of aircraft flutter. The SFCW system (90 MHz and 7.5 GHz bandwidth) measured vibrations (1Hz ~125 Hz) of a carbon fiber–reinforced polymer (CFRP) composite panel. Also, a single frequency mode was used to measure vibration velocities (1Hz to 75 Hz).

A Receiver for Doppler Estimation Capable Waveforms Utilizing Chirp Signature Diversity, Alex Byrley*, University at Buffalo*
This paper discusses a receiver for a new class of Doppler estimation capable radar waveforms formed by appending a CDMA signature to a Doppler estimation capable radar code in a separate frequency band. The CDMA signature is created from a sequence of modulated chirp functions. Reception begins by separating the radar and signature bands via a bandpass filter, digitizing, and feeding the resulting signals into separate data buffers. The receiver is time sychronized and the Doppler shift is estimated by matched filtering the radar waveform. The CDMA signature is decoded by convolving the chips with a Doppler adjusted matched filter, thresholding, sampling at the peaks, and finding the closest signature in a codebook. This system has applications in multistatic radar environments. This paper gives an example of these waveforms, their receiver, derives the optimal matched filter threshold, and illustrates their performance against a Swerling III target and noise.

Non-Synchronized Integration using Multiple Radars via Least Squares Fitting, Siyang Cao*, University of Arizona*
In this paper, the non-synchronized integration of multiple frequency-modulated continuous-wave (FMCW) radars is presented. A phase error deduction method on different non-synchronized radars using trust-region-reflective least squares algorithm is introduced. Better angle of arrival (AoA) estimation, better angular resolution and better side lobes deduction are realized in experimental result. Therefore, integrating multiple independent radar systems to emulate a large aperture is achieved.

Autonomy II & III

Competing Objective Optimization in Networked Swarm Systems, Shankarachary Ragi, *South Dakota School of Mines*

We develop a collaborative sensing algorithm for target tracking, where the sensors are located onboard an autonomous aerial vehicle swarm. The goal is to optimize the motion of the swarm such that the target tracking error and the energy consumption are jointly minimized; leading to conflicting objective optimization problem.

Influence of Emotions in Shaping Decisions, Aritra Ghosh, *Florida Atlantic University*

Traditional software systems are rapidly learning skills that can beat human activities; humans still retain superior in the context of decision-making where emotions are involved. Human emotions are full of uncertainty and hence self-adaptive systems have yet to acquire a "gut's feeling". In this paper, we have discussed the influence of human emotions to quantify uncertainty and to contribute to the software's adaptation process.

Cluster based Hungarian Approach to Task Allocation for Unmanned Aerial Vehicles, Arezoo Samiei, *New Mexico State University*

In the context of autonomy for Unmanned Aerial Vehicles (UAVs), task allocation techniques play a significant role for collaborative UAVs to make optimal decisions in dynamic environments. This paper presents a novel Hungarian based approach to challenging multi-task allocation (MTA), where the number of UAVs is smaller than the number of tasks. We developed the Cluster-Based Hungarian Algorithm (CBHA), in which (1) tasks are grouped such that the number of UAVs is the same as the number of task groups; (2) the original Hungarian algorithm is applied; and (3) an algorithm for travel salesman- problem (TSP) is applied to perform path planning for each individual UAV. The proposed CBHA was compared with the Consensus-Based Bundle Algorithm (CBBA) in Monti Carlo simulations, where different numbers of UAVs and tasks were adopted in the scenario of a team of unmanned aerial vehicles traveling through a number of targeting locations. The result shows that the CBHA outperforms.

What is the future of AI and what does this mean for Autonomy?, Ronald Hartung **(Invited)**

This talk offers a purely personal perspective on the author's perception of the state of AI. It arose as a reaction to machine learning and current goals being expressed in the popular press and research literature. It sprang from discussions with the faulty at the University of Tromso, Norway and reflects the author's experience and observations of AI that date from the early 1980's.
SHORT BIO: As an EE and a computer scientist, Ron has worked on both hardware and software aspects of computing. His career path included The Naval Surface Weapons Center, Bell Labs, Franklin University and now TDKC working with RYWA in malware detection and response. His current work is delving into the use of genetic programming and evolutionary algorithms. His personal research interest is in General AI (hard AI) and especially how a system could achieve consciousness.

Towards a Taxonomy of Planning for Autonomous Systems, Trevor Bihl, *AFRL Sensors Directorate*

This document presents a vision of planners for UAVs from an architectural and algorithmic perspective. It reviews many approaches and develops a taxonomy of planning methods. This further explores various differences and similarities. A technical baseline is developed throughout this process to highlight current research interests, demand signals, and possible gaps in the research. Descriptions of the fundamental issues and limitations of present methods are also included.

Spiking Neural Network for Adaptive Robotic Control, Bright Ablordeppey, *University of Dayton*

This paper presents a spiking neural network approach for adaptive control of a mobile robot. In our case, we utilize a mobile inverted pendulum robot and subject it to various environmental disturbances and analyze its ability to learn, adapt and recover while maintaining stabilized upright position. Additionally we compare experimental results and performance of the spiking neural network model to that of a conventional controller as implemented on the same robot. Through our experiments, we find that using appropriate software and hardware platforms, neural network-based adaptive control can in fact be reliably implemented in a real time application, thus bringing the advantages of adaptive control closer to potential industrial applications.

A Probabilistic Decision Engine for Navigation of Autonomous Vehicles under Uncertainty, Zhenhua Jiang, *University of Dayton Research Institute*

This paper presents a probabilistic decision engine that can serve as the core for navigation of autonomous vehicles under uncertain conditions. The probabilistic decision engine takes a network connection matrix and a cost matrix (with entries of the cost's mean values and probability distributions) as its input and generates the probability distributions of optimal routes as its output.

Emerging Electronics and Microsystems I & II

The role of low-power high-performance electronics in 4th industrial revolution, Hossein Lavasani**,** *Case Western Reserve University* **(Invited)**

The Fourth Industrial Revolution (FIR) is characterized by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres, collectively referred to as cyber-physical systems. Internet of Things (IoT) is considered a revolutionary technological platform supporting data communication in such systems. However, the ever-increasing size of this global network has led to the exponential growth of the data traffic (> 1.4× per year) in recent years, requiring miniaturized low power transceivers with high data throughput not feasible with conventional radio frequency circuit design techniques. In addition to high-speed data communication,

reliable low power wireless connectivity is needed to link billions of intelligent objects at a low cost within the global distributed network. To overcome these challenges, a revolution/paradigm shift in circuit design is needed.
This presentation focuses on the development of a true IoT-compatible network consisting of high-speed data transceivers, smart sensors, microelectromechanical (MEM) devices, and low power cognitive radios. I will present ideas on efficient high-speed data communication as well as ultra-low power radios whose application help overcome obstacles in creating a low cost universal platform to integrate sensors with low power RF circuits. I will also discuss innovative low power interface circuits for MEM resonators needed for high-performance low-power clocks used in such radios. Finally, I will discuss the emerging trend to add AI functionality to various objects within this smart network which facilitates intelligent human-machine interaction and creates a truly cognitive network.

Adaptive-Hybrid Redundancy for Rad-Hardening, Nicolas Hamilton*, AFIT*
Radiation hardened by design processors are used in space environments to ensure reliability. These processors are difficult to develop, prohibitively expensive, and not state-of-the-art. Researchers now examine commercial processors and field programmable gate arrays for this purpose. Single event upsets are mitigated through redundancy. A novel adaptive-hybrid method is proposed.

Quantum Computing: Architectures, Circuits, Algorithms, Chris Papchristou*, Case Western Reserve University*
The aim of this paper is to provide a brief overview of Quantum Computing development with focus on quantum architectures, gates, circuits, tools, and quantum error correction. We also discuss research challenges and needs in quantum computing pertaining to architectures, circuits, tool developments and algorithms.

High Speed-Low Power GNRFET based Digital to Analog Converters for ULSI applications, Mounica Patnala*, Indiana University Purdue University*
DACs using GNRFET device technology were developed with 10nm channel length and 0.7V power supply. Biasing with current mirror topology provided high efficient small size implementation. The power consumption, DNR and INR were analyzed. The SNDR was 25.8 for the 4-bit DAC.

Gated-ReRAM Based Strategies for On-Chip Supervised Learning, Andrew Rush, *University of Cincinnati*
We report a gated-ReRAM synaptic devices-based strategy for on-chip supervised learning. A vacancy-driven compact model for gated-ReRAM is presented and corroborated with experimental results. A supervised learning architecture is proposed that allows the feedback to be provided via gate terminal of gated-ReRAM to update weights in a highly parallel manner.

A Study of the Heat Spreading Capabilities of Mass Via Arrays (MVA), Devin Smarra*, University of Dayton*
This paper analyzes the heat spreading capabilities of conventional Mass Via Arrays (MVA). Modeling and simulation are performed for MVAs and are compared to equivalent measurements for Thermal Via Arrays (TVA). Based on this analysis we determine that an MVA with many interspersed, planar heat spreaders provides superior heat spreading when compared to regular TVAs.

High Performance GNRFET based Serializer*,* Avinash Yadav*, Indiana University Purdue University*
Newly emerged GNRFET with channel length of nearly 10nm is used to implement 2:1 Input/output serializer using negative edge triggered D-flipflops and transmission gate multiplexers. The data was compared with standard CMOS serializer for features of nano scale technology. The power consumption of the serializer was found to be 0.4mW.

Machine Learning, Guidance and Control I & II
Global Measures of Robustness, Mike Bakich, AFRL **(Invited)**
We first present an error surface in R^3 in order to visualize the effect on robustness of algorithm design and uncertainty in input operating conditions and to understand how the slope of such a surface can impact the measure of trust placed in results as a form of operational “go/no go” gauge when in actual battlespace conditions. We then examine the general case in R^n where n>3 and visualization in the standard sense is not possible.

ATR performance varies as a function of Operating Condition variability. This is understood as uncertainty and is represented by a Gaussian distribution of probabilities rather than as a fixed certain value. As the actual value on input deviates from an assumed value, there is a propagation of error. When considering the global output of the algorithm, this results in an error surface characterizing robustness as Mean Square Error. Understood as uncertainty it is shown as a Gaussian distribution about a proposed or nominal value. Visualization of MSE as a surface in R^3 demonstrates that even under the most simple of shifts in operating conditions, there can be performance altering changes from the world of the algorithm design and the world of the real battlefield. An algorithm designed to determine a result from sensor data propagates this uncertainty. A Gaussian correlation matrix calculates MSE between an actual output (truth) and this result. The resulting error is inversely proportional to a level of “trust” in output results. Global measures of robustness in R^n are then developed using a histogram method and Gaussian curvature.

A Tutorial on Topological Data Analysis for Big Data Analytics*,* Trevor Bihl*, AFRL Sensors Directorate,* Elizabeth Campolongo*, The Ohio State University*
Topological Data Analysis (TDA) is a hypothesis free approach to data mining, incorporating clustering and distance-based methods to find similarities between observations and groups of observations. Its non-traditional dimensionality reduction methods are advantageous. This paper presents the theory and general process (through the Ayasdi Machine Intelligence Platform) of TDA.

Topological Learning for Semi-Supervised Anomaly Detection in Hyperspectral Imagery, Juan Ramirez Jr, *AFRL Sensors Directorate*
Herein, we develop a probabilistic methodology that enables the application of semi-supervised learning over a data architecture for knowledge representation. The data architecture, proposed here, is known as the Topological Hierarchical Decomposition (THD) and is derived from the use of topological compression to decompose data into subsets of increasing attribute similarity. We demonstrate the use of the THD and a probabilistic model for interrogating the THD for object detection in hyperspectral imagery. In particular, we develop a classifier to identify objects that share similar topological attributes with a training reference object.

Arduino-based implementation of an adaptive autopilot system, Salam Hajjar, *Marshall University*
an Arduino-based adaptive speed control for smart communicating vehicles is introduced in this paper. A simple prototype which incorporates Arduino Mega 2560, distance and speed sensors, and three vehicles made of Lego parts was built. We assumed that the vehicles are driven on the highway and lined up in one lane such that the central one is in communication with its front and back neighbors. The results showed that the proposed control method reacts fast and provides accurate measurements of the speed and relative distance of the vehicle when the separating distance between the central vehicle and its surrounding neighbors is not larger than 4 feet.

Real-Time Dynamic Gesture Recognition based on Boundary-Constraint Dynamic Time Warping, Chunling Cheng, *Nanjing University of Posts and Technology, PRC*
Natural human-computer interaction technology based on gestures has received broad attentions in many fields recently, which requires better performance of gesture recognition algorithms. To address this issue, in this paper, we propose a real-time dynamic gesture recognition algorithm based on boundary-constraint dynamic time warping (BC-DTW). The proposed algorithm reduces the recognition time from the calculation times and the amount of DTW distance. To reduce the calculation times of varies DTW distance between the gesture sequences, the proposed algorithm transforms a gesture sequence from two-dimensional of unequal-length to one- dimensional of equal-length. Moreover, to find the paired range of each gesture data in a sequence during the process of DTW distance calculation, we propose a method based on Freeman chain to determine the boundary width of gesture data. The experimental results show that the proposed BC-DTW algorithm can speed up the recognition.

Control-Theoretic Methods of Dynamic Resource Allocation and Digital Beamforming for MIMO over Satellite, Khanh Pham**,** *AFRL Space Vehicles.*
This work explores control-theoretic autonomy for multibeam multicast satellite systems for assured communications. Advanced control-theoretic approaches to physical-layer security and interference reduction will be highlighted for: i) power allocation in the uplink of satellite communications subject to maintaining the required quality of service for all terminal users and their limited transmit powers and ii) MIMO (multi-input multi-output) satellite digital beamforming supporting user-specific signal-to-noise-plus-interference ratios. The expected results in the work herein will also help to reveal new insights for device-to-device underlaying uplink cellular networks and secure satellite communications in the presence of interbeam and intrabeam interferences.

Optimized Guidance Methods for Smooth Transitions in UAS Path Following, Thomas Le Pichon, *University of Kansas*
Traditional guidances produce over-aggressive commands in sharp turns, especially longitudinally, resulting in stall. Optimized longitudinal guidance laws are developed using aircraft dynamics, observing trim and constraining rates. New navigation is introduced eliminating step-inputs in turns. Results show the aircraft can track the path, while producing more reasonable reactions to errors.

Thursday Track Abstracts

Autonomy IV & V

Detecting Anomalies in Dismount Tracking Data, Holly Zelnio, *AFRL*
This effort develops an approach for detecting behavioral anomalies using tracks of pedestrians in video data. Physically understandable features are developed which can be used with standard classifiers such as the one class support vector machine that is used in this research. Results are provided using hand-tracked measured video data.

Autonomous Algorithm Development and Flight Test Using Unmanned Systems Autonomy Service (UxAS), Steven Rasmussen, *Miami Valley Aerospace LLC*
The Unmanned Systems Autonomy Service (UxAS) multiagent control software framework was designed to facilitate implementation of algorithms that control teams of autonomous vehicles. This paper describes the methods, simulations, hardware, and flight experiments that we use to ensure safe and correct implementation of these algorithms leading to successful testing/demonstration.

Towards high-level, verifiable autonomous behaviors with temporal specifications and persistent goals, Sagar Pundit, *Virginia State University*
We present a software framework to produce high-level autonomous behavior for UAV search and tracking from the robot model and task specification. High level autonomous the behavior of the UAVs permits minimum centralized control and verifiable properties such as safety and liveness of the robot. The proposed framework uses linear temporal logic (LTL) to express desired UAV behaviors such as search, tracking, and survival. The LTL rules are further interpolated by a rule-based agent architecture to control the behavior of UAVs. In addition, our framework introduces an explicit conflict checking and resolution mechanism to address potential conflicts of the multiple-task specification. The behavior controller is evaluated in a realistic search and tracking scenario using physics-based simulation and real flight controller.

Engage or Retreat Differential Game with Two Targets, Zhachariah Fuchs, *University of Cincinnati*
We examine a two player, engage or retreat differential game, in which one player represents a mobile attacker and the opposing player represents a defender protecting two static, high-value targets. The Attacker chooses to terminate the game either by capturing one of the two high-value targets or retreating to a defined retreat surface. The Defender's sole goal, is to protect the high-value targets. It attempts to persuade the Attacker into retreat by manipulating the integral cost within the Attacker's utility function. We pose this scenario as a non-zero sum differential game and show that the solution of this game can be constructed from the solutions of two related optimization problems. The complete solution of the game divides the state-space into two regions with different qualitative agent behaviors.

Design and Implementation of an Unmanned Aerial and Ground Vehicle Recharging System, Nansong Wu, *Arkansas Tech University*
This paper provides the design and implementation of a UAGVR (Unmanned Aerial and Ground Vehicle Recharging) system. We present a cooperative mission planning algorithm for the system. A proof of concept system is developed using a ground vehicle and a miniature quadcopter. Experimental results confirm the validity of our design.

Computational Thinking Curriculum for Unmanned Aerial Systems, Christopher Stewart**,** *Ohio State University*
Unmanned aerial systems (UAS) can explore common, vast and unsafe places at low cost. They could transform multiple sectors from photography to city planning. However, the software underlying UAS is complex and requires multiple distinct programming skills, e.g., AI, machine learning and flight control. Few programmers encompass these skills, hampering software development and dampening the impact of UAS. We contend that early exposure to UAS software could help align workforce skills. However, early exposure requires curriculum that (1) captures the breadth of UAS software, (2) supports multiple levels of depth for diverse programming backgrounds and (3) fits within resource and institutional challenges. We propose a computational thinking framework. In our approach, lessons fit within 20-30 minute instructional blocks, making them usable in short workshop and extended classroom settings. Teachers trade breadth for in-depth coding and vice versa. Early work was received well.

Towards a Heterogeneous Swarm for Object Classification, Ross Arnold, *US Army CCDC AC*
Object classification capabilities and associated reactive swarm behaviors are implemented in a decentralized swarm of autonomous, heterogeneous unmanned aerial vehicles (UAVs). Each UAV possesses a separate capability to recognize and classify objects using the You Only Look Once (YOLO) neural network model. The UAVs communicate and share data through a swarm software architecture using an adhoc wireless network. When one UAV recognizes a particular object of interest, the entire swarm reacts with a pre-programmed behavior. Classification results of people and backpacks using our modified UAV detection platforms are provided, as well as a simulated demonstration of the reactive swarm behaviors with actual hardware and swarm software in the loop.

Evaluating the Power Efficiency of Visual SLAM on Embedded GPU Systems, Tao Peng**,** *University of Dayton*
SLAM (Simultaneous Localization and Mapping) on mobile robot requires not only high performance but also low power consumption. This paper evaluates the power efficiency of enabling GPU acceleration for ORB-SLAM on embedded GPU systems. An experimental evaluation system is used to evaluate the performance and power consumption of two NVIDIA embedded GPU systems: Jetson TX2 and Jetson Xavier, based on different power mode settings.

Rotorcraft Obstacle Avoidance Simulation Environment (ROSE), Will Trautman & Zach Smithson, *GTRI*
The Rotorcraft Obstacle Avoidance Simulation Environment (ROSE) research aims toward the implementation and testing of machine learning algorithms to provide auto-navigation and obstacle avoidance capabilities to rotorcraft. The ROSE system includes autonomous navigation algorithms, sensor models, flight models, and a cockpit simulator to support analysis, training, and risk-reduction efforts.

Fast Lane Filtering for Autonomous Driving, Ying Li, *Volvo Cars Test Center*
In this work, we propose a method for lane filtering. The detection result from lane detection is noisy. The lane length and position are often changing, which would introduce noise to later processes. In order to obtain steady lane detection result, we developed a new method to perform lane filtering. We first perform a preprocessing to filter out large lane noise and use four points to represent the lane. For each lane, the two endpoints are first picked, and then the two trisection points are picked. In this way, the lanes have fixed-dimension-vector representation, and the shape of the lanes is kept while maintain a low computational cost. Then Kalman filter is used to perform filtering and estimate the location of the lanes.

Deep Learning & AI IV

FPGA based Multi-core Architectures for Neural Network and Router Configuration Exploration, Yangjie Qi, *University of Dayton*
Neural networks are widely used in many applications, such as image recognition and health care. Some specialized architectures for executing neural networks on FPGA platforms have been proposed recently. However, those designs focus on efficient processing cores, which use low precision data or multiplier-less operations. The routing systems of those architectures are usually generic. In this paper, we propose a heterogeneous multi-core architecture for neural networks. Besides high-efficiency computation cores, we also designed two different kinds of routing systems to effectively communicate data between cores. Two 16 cores architectures with a time multiplexed routing system and a packet switch routing system are synthesized and prototyped on a Stratix IV FPGA board. Based on our experimental results, the time multiplexed routing system shows a 3.5× throughput efficiency and 3.675× energy efficiency over the packet switching system for the neural network accelerator hardware.

Pattern Matching on Neuromorphic Hardware, William Mitchell & Ben Ausdenmoore, *Riverside Research*
Today's compute systems are pushed to perform increasingly complicated tasks with lower size, weight and power (SWaP), especially for autonomous operation. Neuromorphic hardware offers both low SWaP and advanced computational capabilities. This paper demonstrates pattern matching capabilities with a neuromorphic processor suitable for commercial and military application.

Ambiguity Resolution in Direction of Arrival Estimation using Mixed Integer Optimization and Deep Learning, Joel Goodman, *US Naval Research Lab*
In this paper we present two novel approaches to unambiguously estimate the direction of arrival (DOA) of an RF source by an array of receive antennas whose positions can take-on any arbitrary geometry. The first approach employs a simple constrained integer optimization, while the second approach employs deep learning. In both approaches the impact of imperfect array calibration on the performance of DOA estimation is quantified. We demonstrate in Monte Carlo simulations that both approaches are capable of achieving super-resolution performance under imperfect array calibration conditions. It was found that the constrained integer optimization outperforms deep learning when one has an accurate physics model of the receiver imperfections, however deep learning was more robust to significant calibration errors.

Convolutional Neural Networks as Classification Tools and Feature Extractors for Distinguishing Malware Programs, Venkata Salini Davuluru, *University of Dayton*
Classifying malware programs is a research area attracting great interest for Anti-Malware industry. In this research, we propose a system that visualizes malware programs as images and distinguishes those using Convolutional Neural Networks (CNNs). We study the performance of several well-established CNN based algorithms such as AlexNet, ResNet and VGG16 using transfer learning approach. We also propose a computationally efficient CNN-based architecture for classification of malware programs. In addition, we study the performance of these CNNs as feature extractors by using Support Vector Machine (SVM) and k-Nearest Neighbors (kNN) for classification purposes. We also propose fusion methods to further boost the performance. We utilize the publicly available database provided by Microsoft Malware Classification Challenge (BIG 2015) for this study. Our overall performance is 98% for a set of 2174 test samples comprising 9 different classes thereby setting a new benchmark.

Radar-based Object Classification Using An Artificial Neural Network, Dan Pritsker*, Intel Corp.*
We tackle a radar-based objection classification problem using a state-of-art machine learning approach. Our AlexNet-inspired convolutional neural network model recognizes object features in their radar reflection signal. We demonstrate the proposed intelligent classification system on an Intel FPGA-based accelerator and achieve a real-time performance with over 90% of accuracy.

Analog Devices and Signal Processing

Experimental Verification of Microwave Phase Shifters Using Barium Strontium Titanate (BST) Varactors, Guru Subramanyam*, University of Dayton*
In this paper parallel plate varactor based phase shifter circuits using Barium Strontium Titanate (BST) thin films are presented. A cascade of 10; 15; and 20 parallel plate varactors were able to produce (150º, 258º, 378º); (218º, 381º,514º) and (227º, 402º, 692º) phase shift at (5,10,15 GHz) respectively. The 360º phase shift is achieved with small device size, low bias voltages (0-8v) and low

leakage currents. The proposed circuit is very easy to fabricate which uses a CPW transmission line configuration and can be easily integrated with other circuits on chip.

A 10-bit 100MS/s SAR ADC for the Hadronic Calorimeter Upgrade, Yuan Mei, *Brookhaven National Laboratory*
This paper presents a 10-bit 100MS/s SAR ADC. This ASIC is to fulfill the requirement of Hadronic Calorimeter upgrade for EIC: custom cost-efficient high sampling digitizer electronics. This ADC achieves peak SNDR of 59.7 dB with power consumption of 3.5 mW, equivalent to the FoM of 45 fJ/conversion step.

Low Noise High Stability Amplifiers over Very High Frequency Range Using Mismatching Approach within Linvill Plane Simulation, Joshua Woodward, *IUPUI*
Linvill plane simulation was utilized to extend the system stability of a device beyond 1GHz. The noise performance was optimized following mismatching approach by adding optimum input and output admittances. A MATLAB script was written to calculate the Y parameters of a BJT amplifier for a wide frequency band.

Unique Compressive Sampling Techniques for Wideband Spectrum Sensing, Andrew Schaefer, *Binghamton University*
Dynamic Spectrum Allocation of 5G networks via direct sampling poses significant processing challenges to embedded processing used in Cognitive Radios. This paper proposes two new compressive sampling techniques to reduce both data throughput and hardware complexity, maximizing the potential of direct sampling for spectrum sensing applications.

Machine Learning, Guidance and Control III & IV

Analytical Science for Autonomy Evaluation, Erik Blasch, *AFOSR*
Current directions in artificial intelligence and machine learning focus on collecting large amounts of data to test, evaluate, verify, and validate system operations. For multi-domain and uncertain scenarios, data sampling may not be adequate to fully explore and represent the entire trade space for verification and validation (V&V). However, leveraging methods from test and evaluation, a hierarchy of analytics can be developed so as to narrow the trade space, while the opportunity cost of the remaining space is a risk-mitigated deployment strategy. Issues in V&V/T&E employ statics but could benefit from analytics, such as the ability to augment data for testing using simulated models. The use of modeling is not new; however as analytics (AI/ML) are designed to only exploit data; then these methods are independent of the data developed from the first-principles physics models. The paper would highlight the need for methods of autonomy evaluation and provide directions and needs.

Multi-Eye Guidance Method for UAVs Path Following, Jeffrey Xu, *University of Kansas*
This paper introduces a novel guidance method; Multi-Eye guidance eliminates the issue of overshoot error in L1 and L2 guidance law while cornering. Multi-Eye makes the aircraft follow multiple reference points to anticipate turns, removing the need for switching distances at corners. Superior performance of multi-eye guidance logic is presented.

An Intelligence Artificial Fish Swarm Optimization Technique, Okechukwu Ugweje, *University of Mount Union*
This paper presents the analysis of intelligent Artificial Fish Swarm Algorithm (AFSA) that properly selects control parameters more effectively. Algorithm is computational intelligent with ability to solve nonlinear high dimensional problems. It addresses problems of conventional AFSA migration into local minima using parameters such as visual distance and step sizes.

Systems-Theoretic Innovation Framework for Machine Learning, Adedeji Badiru, *AFIT*
The push for machine learning has necessitated the development of systems approaches to product development and deployment. This is important for designing work of the future with respect to human-machine cognitive systems. This paper presents a systems-theoretic innovation methodology for integrating machines and humans in the future work environment.

Improved Magnetic Attitude Control, Mohammed Desouky, *Michigan Tech University*
Magnetometer measurements periods are usually different from magnetic rods activation periods, in order to lessen the effect of the rods' generated magnetic field on the measurements. Magnetic field estimation methods are proposed to be utilized in the control feedback, to estimate the magnetic field, at times, instead of real measurement. This proposed approach results in reducing the maneuver time and the power consumption.

Experimental Implementation of an ANN Controller for Quadrotor Trajectory Control in Confined Environment, Ahmed Mekky**,** *Old Dominion University*
This paper presents the experimental results of the trajectory control of a Qball-X4 quadrotor in confined environments and with the presence of model uncertainties. The presented controller utilizes Artificial-Neural-Networks to adjust for aerodynamic and model uncertainties on-line. The provided experimental results show the robustness and effectiveness of the developed ANN controller when applied to the Qball X4 quadrotor.

Dynamic Motion Planning and Control of Autonomous Vehicles, Seyed Raziei, *University of Dayton*
Designing a robust controller for the application of autonomous driving is a challenging problem. Several objectives must be met to safely drive a vehicle autonomously. These objectives have different characteristics, and they cannot be addressed using the same algorithm. A control structure is presented to synchronize data flow between different objectives. Next using this control structure, a time-series trajectory is generated to control an autonomous vehicle toward its destination.

Supervise Learning With Copulas, Xiaoping Shen**,** *Ohio University*
The naïve Bayes classifier play an important role among the classifiers based on supervised learning, although it requires strong condition on the feature independence assumptions. In this paper, we introduce an efficient algorithm to construct copula. These copulas are adapted to feature independence testing for the naïve Bayes classifier in supervised learning.

REEF Estimator: A Simplified Open Source Estimator and Controller for Multirotors, Prashant Ganesh, *University of Florida*
Implementing high-fidelity controllers and state estimators for multirotors is frequently a bottleneck in research projects for which simpler models would suffice. In this work, a simple controller and estimator are presented which allow for stable flight without requiring a high amount of domain-specific knowledge.

Intelligent Collaboration among Humans and Machines (from Natural Language Understanding Perspective), Huan Sun, *Ohio State University* **(Invited)**
In this talk, I will discuss our recent work on human-machine and machine-machine collaboration frameworks from the perspective of natural language question answering and command understanding. In particular, I will focus more on human-machine interactive semantic parsing (in AAAI'19), and machine-machine collaboration for information search, particularly for code snippets search (in WWW'19). Finally, I will conclude the talk with ongoing/future work.

POSTER SESSION (see Poster Map for Room Locations)

Aerospace Power Systems and Avionics

1. Flexible High-Efficiency Monocrystalline Silicon Solar Cells for Small Unmanned Aerial System Application, *Muhammad Mustafa Hussain, UC Berkeley*
In this work, we demonstrate the fabrication of corrugated flexible and high-efficiency monocrystalline silicon solar cells and their application in UAVs. We also calculate the expected additional hours of flight per day when our corrugated solar cells vs. commercially available ones are attached on the “SoLong” UAV in different cities.

2. Comparison of Traditional and Switched-Capacitor Dc Balancers for Aerospace Applications, *Jeff Hensal, The Ohio State University*
This paper compares magnetic and magnetic-less voltage balancers is presented. Specifically, switched-capacitor balancers were investigated, as they can potentially offer increased voltage regulation capability alongside increased power density. Selected balancers were compared using Switching Device Power (SDP), component counts, passive component ratings, and analytic equations for switching current and voltage.

3. Autonomous DC-DC Power Conversion Process Control Design and Simulation, *Frank Li, Youngstown State University*
This paper presents an autonomous bidirectional DC-DC power controller that provides high efficient, reliable, fault-tolerant, and intelligent power conversion between a DC source and sink. Real-time sensor information is processed inside a Xilinx Artix-7 field programming logic array (FPGA) chip. The digital controller automatically adjusts gate pulses of the power electronic devices to allow proper bidirectional power flow.

Analog Devices and Processing

4. Analysis of Lithium Niobate Memristor Devices for Neuromorphic Programmability, *Ayesha Zaman, University of Dayton*
This paper describes the fabrication and characterization process used to develop a series of lithium niobate memristors. A common approach for the development of memristor-based neuromorphic circuits is to store synaptic weight values within memristors as resistance values. Therefore, memristors for these systems must be stable, symmetric, and programmable with a significant bit resolution. In other words, a continuous resistance range must be available in these memristors to store the weight matrix produced by a learning algorithm. This paper describes the fabrication and characterization results for six different memristor wafers. These results are used to decide which device composition is the best for neuromorphic computing through the properties of symmetry, reliability, stability, and programmability. Once the best device for neuromorphic programmability was selected, we show the potential programming resolution available in this device using a voltage pulse characterization.

Autonomy

5. A Review of Over 20 Years of Autonomous Vehicle Designs at Cedarville University, *Clint Kohl, Cedarville University*
This paper will review the research and development efforts of students and faculty at Cedarville University since 1997. The engineering department has entered approximately 50 autonomous vehicles in eight different competitions over the last 20 years. In addition several senior design teams worked on additional autonomous vehicles that were not involved in a collegiate competition. A variety of sensors, controllers and systems have been deployed with many successes and numerous failures. This paper will attempt to summarize these efforts.

Cybersecurity and Trusted Systems

6. Building and Evaluating Privacy Filter Framework for High-Dimensional Data, *Zahir Alsulaimawi, Oregon State University*
The objective of the proposed research is to develop a novel data release mechanism called privacy filter (PF).
PF can prevent adversaries from mining private information from the released data while maximizing the amount of information revealed about the utility data. Our framework can be adapted to another tradeoff between privacy and utility situations, privacy funnel and information bottleneck. We prove that under these three approaches the resulting design problem of finding the optimal privacy-preserving can be formulated as an adversarial machine learning technique.

7. Safety and Human Factors of Electronic Flight Bag Usage in General Aviation, *Pranay Bhardwaj, School of Electrical Engineering and Computing Systems, College of Engineering and Applied Science, University of Cincinnati*
Paper checklists are being replaced by software on a tablet computer, i.e., an Electronic Flight Bag (E.F.B.). We focus on what effects this can have on the human pilot and on safety and security. We define practical E.F.B. modifications, implementable in an app, to improve trustworthiness, especially for general aviation (GA).

8. An Asynchronous MPGA THx2 Cell and Architecture for Mitigating Side-Channel Attacks, *John Emmert, University of Cincinnati*
To mitigate side-channel attacks (SCAs), we propose a unique mask programmable gate array (MPGA) architecture based on a new THx2 threshold cell. We describe the operation of the THx2 cell, show how THx2 forms a complete set of logic, show minimum sized layouts for THx2 cells, describe the area optimized MPGA layout, show how other threshold functions and logic gates are created using the THx2 cell, and present an area comparison of our MPGA to a comparable ASIC null convention logic (NCL) circuit. It should be noted that our THx2 cell is suitable for MOSFET or FinFET implementation, is Trojan proof, and can take advantage of split manufacturing as an added safeguard against tampering.

9. Performance Analysis of XOR-Inverter based Ring Oscillator PUF for Hardware Security, *Noor Ahmad Hazari, The University of Toledo*
Ring Oscillator Physical Unclonable Function (ROPUF) has been the preferred choice for embedding hardware-oriented security and trust in FPGA based systems. Parameters such as uniformity, uniqueness, bit-aliasing, and reliability have been used to measure the performance of PUFs. In this paper, we present an XOR-Inverter based ROPUF which has improved uniformity, uniqueness, and bit-aliasing when compared with other designs.

10. A Blockchain Technology Approach for the Security and Trust of the IC Supply Chain, *Akshay Kulkarni, University of Toledo*
The outsourcing of fabrication of integrated circuits (ICs) for economic reasons has raised concerns over the quality and authenticity of these chips. In this paper, we propose a blockchain technology enabled 'smart contract' approach for ensuring the security and trust of these ICs by tracking down the stage of alteration at which the chip may have been compromised in the IC supply chain.

11. Formal Development and Statistical Analysis for Software in Larger Trusted Embedded Systems, *Jonathan Lockhart, University of Cincinnati*
Trusted embedded systems utilizing software are being investigated to address limitations of hardware only designs. Previously we presented a development and testing methodology, which provided benchmarks of reliability for completed software systems. Now we look to expand the benchmark to larger, complex software designs and investigate how our design techniques are applicable to making them reliable.

12. Monitoring and Preventing Data Exfiltration in Android-hosted UAS Applications, *Akshat Malik, Virginia Polytechnic Institute and State University*
Data exfiltration risks have increased with large amounts of sensitive information stored on mobile devices. This has led the U.S. DoD to ban the use of all commercial off-the-shelf Unmanned Aircraft Systems (UAS). We discuss current methods to limit data exfiltration and describe a more fine-grained and application-specific solution based on system call interposition.

Deep Learning and Artificial Intelligence

13. Classification of Skin Cancer using Deep Learning Approaches, *Hesham Alghodhaifi, University of Michigan - Dearborn*
Skin cancer is a major public health problem with over 123,000 newly diagnosed cases worldwide each year. Skin cancer is the most common form of cancer, globally accounting for at least 40% of cases. Skin cancer is essentially diagnosed visually, beginning with a clinical screening and followed potentially by dermoscopic analysis, a biopsy and histopathological examination. Automated classification of skin lesions using images is a challenging task. With the great advancement in deep learning, many scientists believe that they will be able to find potential results when using deep convolutional neural networks (CNNs) for classification of skin cancer. Here we study the classification of skin cancer using different approaches such as MobileNet network, stepwise approach, ResNet 50, and FastAI. We train our model using a dataset of 100015 dermatoscopic images which are released as a training set for academic machine learning purposes.

14. Fused Deep Convolutional Neural Networks Based on Voting Approach for Efficient Object Classification, *Redha Ali, University of Dayton*
Object classification has been one of the main tasks in computer vision. With the fast development of deep learning, its performance in image classification and object recognition has presented dramatic improvements. In this paper, we propose a new deep convolutional neural network (CNN) architecture for robust objects classification. The proposed model is fused with three traditional CNN approaches, Densenet201, Resnet50, and our proposed residual CNN. The fused network architecture allows parallel processing of the multiple networks for keeping the system speed up. A single shot deep convolution network is trained as an object detector to generate all possible candidates of different object classes. The output of each neural network is representing a single vote that used in the classification process. 3-to-1 voting criteria are applied in the final classification decision between the candidate object classes.

15. Ultrasonic Flowmeter Diagnosis by Classification, *Sudarshan Chawathe, University of Maine*
Modern ultrasonic flowmeters provide routine diagnostic information that may be used to infer their health. This inference task is modeled as a classification problem and studied experimentally using a publicly available dataset. A few classifiers, such as Bayesian Networks, provide good accuracy and also suggest relationships among the diagnostic variables.

16. Convolutional Neural Network for Classification of Histopathology Images for Breast Cancer Detection, *Barath Narayanan Narayanan, University of Dayton*
One of the most common subtypes of all breast cancers is Invasive Ductal Carcinoma (IDC). Pathologists typically focus on regions which contain IDC to determine whether a patient suffers from breast cancer or not. We make use of publicly available Breast Histopathology Images dataset provided at the Kaggle for classification. In this dataset, images are delineated to extract the exact regions of IDC. This dataset contains of 277,524 patches among which 198,738 belong to the negative class and 78,786 belong to the positive class (images with IDC). We present a novel deep convolutional neural network architecture for classification. Our performance in terms of area under the receiver operating characteristic curve for the detection of IDC is 0.94 on a set of 27753 test images.

17. Medical Image Denoising with Recurrent Residual U-Net (R2U-Net), *Mst Shamima Nasrin, University of Dayton*
Deep learning (DL) approaches have been applied in different sectors of medical imaging applications, i.e. classification, segmentation and detection tasks and shown superior performance. In case of medical image analysis, image denoising is one of the most crucial pre-processing steps. Recently, there are various DL approaches are applied in image denoising problems and achieved state-of-the-art performance. In this work, we apply recurrent residual U-Net (R2U-Net) based autoencoder model for medical image denoising which is applied for digital pathology, demos copy, magnetic Resonance Imaging (MRI) and Computed Tomography (CT) images denoising tasks. The performance of R2U-Net model is also evaluated for Transfer domain (TD) between MRI and CT scan images. The experiments have conducted on different publicly available medical image datasets and shows promising denoising results which can be applied in different medical imaging applications.

18. Aggregate Channel Features Based on Local Phase, Color, Texture, and Gradient Features for People Localization, *Redha Ali, University of Dayton*
Detection of human beings in a complex background environment is a great challenge in computer vision. For such a difficult task, most of the time no single feature algorithm is rich enough to capture all the relevant information available in the image. To improve the detection accuracy, we propose a new descriptor that constructed from the channels of image gradients, texture features, local phase information, and the color features. This information is fused together to build one descriptor named as “Channels of Chromatic domain, local Phase with Gradient and Texture features (CCPGT)”. The image gradients, and local phase information based on phase congruency concept are used to extract the human body shape features. Local binary pattern approach (LBP) is used to capture the texture features, and additional significant information for the human detection are added by the color channels.

Digital Signal and Image Processing

19. A Novel Methodology for License Plate Detection Using KNN Classifier, *Abdulrahman Alturki, Qassim University*
License plate recognition plays a more important role in the traffic control and security management framework which needs to be handled with more concern for the increased security level. Recognition of license plate number of moving vehicle is more difficult task due to presence of noise and varying illumination and angles. It is required to implement the system with improved techniques and methods for accurate and reliable detection of license plate numbers. In the proposed research method, accurate recognition of license plate is ensured by introducing the methodology namely Automated Vehicle License Plate Detection using KNN (AVLPD-KNN) method. In this method initially preprocessing is done by using median filtering approach. After preprocessing license plate extraction is done from the image based on characteristics of license. From the extracted license plate, license numbers are identified by using character segmentation approach which is then learned and recognized accurately

20. Comparison of Image Processing Techniques for Infared Images of Laser-Powder Bed Fusion using Neural Networks, *Dimitri Papazoglou, Monica Yeager, Sam Rennu, University of Dayton*
Process monitoring is the verification of geometries and identification of defects for verifying defect-free parts produced via additive manufacturing. To verify ideal image processing techniques, infrared images are input into a convolutional neural network with the same training data and compared.

21. Wideband Programmable Gaussian Noise Generator on FPGA, *Dan Pritsker, Intel Corporation*
Gaussian Noise Generators are common in various applications of Electronic Countermeasures and Low Probability of Intercept radar. The key requirement for such a generator is an ability to operate in wide spectral band, but still have very fine resolution over the suppressed and unsuppressed spectral frequencies. It should be able to reconfigure its spectral content agilely, when operational conditions or power considerations changes. This paper would present proposed implementation on FPGA that achieves such key metrics. The implementation would be based on efficent pair of Analisys and Synthesis filter bands, implemented using fixed and floating point precisions on FPGA.

Emerging Electronics and Microsystems

22. Towards Automated Positioning of Ultrasonic Probes, *Sanjeevi Karri, Prixarc, LLC*
This paper focuses on acquiring high-quality biomedical images, analyzing them, and applying an appropriate therapeutic regimen. In particular, we consider the problem of image-guided neuromodulation of the vagus nerve (VN). A robust template-matching method locates the VN from B-mode ultrasound images, with the nearby carotid artery (CA) being used as a bio-marker. This information can be used by operators to correctly orient and position the probe.

23. Utility Transformer Health Monitoring using a Single Chip Impedance Analyzer, *Birhanu Alemayehu & Akash Kota, University of Dayton*
Dissolved gas analysis and oil sample analysis have been established as effective ways of determining the transformer oil health. In this paper, we present a new approach to diagnose the oil condition towards utility transformer health monitoring based on using the AD5933 single chip impedance analyzer from Analog Devices. We propose an integrated smart infrastructure monitoring with the results from the impedance analyzer transmitted, logged, and processed via a cloud computing interface.

24. An Open-Source Ultrasound Imaging System with Wearable Active Probes, *Vida Pashaei, Case Western Reserve University*
Many emerging ultrasound-based imaging modalities depend on operation in the low signal-to-noise ratio (SNR) regime. This paper discusses the design, simulation, and development of a compact and wearable autonomous ultrasound imaging system for such applications. The system uses a novel 64-element wearable active probe design with on-board high voltage (HV) multiplexers, transmit/receive switches, and pre-amplifiers for improving the SNR of small received echo signals. The analog front-end is implemented as a custom transceiver board, while a miniaturized system-on-chip (SoC) platform is used to implement the digital back-end. Built-in high-efficiency switching power converters enable the system to operate from a single 12 V battery. The improved functionality and power efficiency of the system is confirmed through simulation and measurement results.

25. 32-Element Array Receiver for 2-D Spatio-Temporal ΔΣ Noise-Shaping, *Jifu Liang, Case Western Reserve University*
The concept of two-dimensional (2-D) space-time ΔΣ noise-shaping for radio frequency (RF) array processing systems has been proposed in earlier work. This approach can provide supralinear improvements in the overall noise figure (NF), linearity, and resolution of an N-port receiver at the cost of a linear increase in the number of elements. This paper describes a proof-of-concept 32-element array receiver that is suitable for driving first-order spatio-temporal ΔΣ noise-shaping analog-to digital converters (ADCs). The design has been realized using board-level components. It operates at a center frequency of 2.6 GHz and uses an on-board dense sleeve monopole antenna array with a spatial oversampling factor of 4. Calibration is used to decrease the mismatch between channels, resulting in mismatch reduction by a factor of 5.7. Over-the-air measurement results prove the functionality of the proposed array receiver.

26. Chip Scale Tunable Nanosecond Pulsed Electric Field Generator for Cell Electroporation, *Akash Kota, University of Dayton*
Electroporation uses high voltage pulsed electric field to permeate cell membrane for drug infusion. Modifying the pulse parameters changes the treatment effects. This paper describes a miniaturized high-power pulsed electric field generator that reduces the size of the system to a single chip, and allows customization of the pulse frequency and duty cycle. The circuit was design in CMOS, XDH10 1µm process. The schematic simulation showed a duty cycle variation from 12.5% to 34.9%, with a 466 kHz, 500V square wave.

Machine Learning, Guidance and Control

27. Machine Learning to Predict the Freeway Traffic Accidents, *Rabia Almamook, Western Michigan University*
The main aim of this research is to evaluate and compare different approaches to modeling crash severity as well as investigating the effect of risk factors on the fatality outcomes using machine learning based driving simulation. We developed prediction models to identify risk factors of traffics crashes can be targeted to reduce accident. The Random Forest model demonstrated the best performance from among the five different techniques with accurate 82.6%.

28. Methods of Machine Learning for Space Guidance and Control, *Genshe Chen, Intelligent Fusion Technology Inc*
Space Situation Awareness focuses on object tracking and characterization. Inherently, the SSA environment requires assessment of sensor measurements, environment conditions, and target behaviors. A complication with SSA is that not all information is continuously available, so advances in Deep Learning are not easily applicable. One solution is to use the Dynamic Data Driven Applications Systems (DDDAS) paradigm that leverages first-principle models for data augmentation that can be used to supplement knowledge for machine learning methods. The paper will highlight recent developments in DDDAS ML-based approaches for SSA to bound the requirements for the employment of ML methods to perform SSA.

29. Maximum Correntropy Criterion Kalman Filter with Adaptive Kernel Size, *Seyed Fakoorian, Cleveland State University*
Kernel size plays a significant role in the performance of the maximum correntropy Kalman filter (MCC-KF).
Kernel size is usually chosen by trial and error. If the kernel size is large, the MCC-KF reduces to the Kalman filter (KF).
However, if the kernel size is small, the MCC-KF may diverge, or converge slowly. We propose a novel method for adaptive kernel size selection. We calculate kernel size as a weighted sum of the innovation term and the covariance of the filter indicated estimation error at each time step. We call this filter the ‘‘MCC with adaptive kernel size filter’’ (MCC-AKF). We analytically prove that the true mean square error (TMSE) of the MCC-AKF is less than or equal to that of the MCC-KF under certain conditions. An illustrative example is provided to verify the analytical results.

30. Automated Level Crossings – A futuristic solution enabling Smart City Infrastructure, *Kshitij Saxena, WSP*
World over, railway tracks pass through cities and metropolises which creates problem of ubiquitous Level Crossings as they transect roads, highways, etc. The real-time train data, collected through Global Positioning System satellites can be used to calculate crossing envelope distance. A receiver polls the approaching train position and actuates motor that closes the gate.

Photonics Devices and Systems

31. High-index micro-cones for focusing and concentrating light in MWIR focal plane arrays, *Vasily Astratov, Department of Physics and Optical Science, University of North Carolina at Charlotte*

Two types of high-index truncated micro-cones are proposed as concentrators for focusing light on pixels of mid-wave infrared (MWIR) focal plane arrays (FPAs). They can be used to miniaturize the pixels for reducing the thermal noise and, potentially, increasing the operation temperature of FPAs without sacrificing their sensitivity.

32. Improving Cellphone Microscopy Imaging with Contact Ball Lenses, *Grant Bidney, University of North Carolina at Charlotte*

It is shown that the resolution of cellphone-based microscopy can be improved with the use of millimeter-scale ball lenses placed in contact with fluorescent (FL) microspheres. It is demonstrated that this allows the resolution improvement from ~30 μm to ~10 μm over a wide field of view. This, however, does not represent the resolution limit of the proposed technology. Further resolution enhancement can be expected for optimized systems with larger magnifications where the resolution is not limited by the camera pixel sizes.

33. Studying the Probability of Fade of Free Space Optical Communication System, *Elforjani Jera, University of Dayton*

In this work, we will be studying the probability of fade of an optical communication system. The main goal is to quantify that at what threshold level of the mean intensity at the receiver the system starts to fade. This threshold represents the efficiency of the optical system.

34. Self-referencing in Microfluidic with Whispering-Gallery Mode Sensors for Label-Free Detection of Biomolecules, *Vasily Astratov, Department of Physics and Optical Science, University of North Carolina at Charlotte*

We report dye-doped polystyrene microspheres (of approximately equal size) are integrated into the microfluidic channel of a microfluidic chip as a self-referencing (SR) biosensing platform. This SR-biosensing device can be used in biomedical diagnostics due to demand for real time non-invasive techniques.

35. Modeling and Characterization of the Effect of Misalignment between Microsphere-Sensor on the Sensitivity of Microsphere-Lens-Enhanced MWIR SLS Photo-Detectors, *Dalila B.Megherbi, CMINDS Research Center, UMASS Lowell*

A microsphere-lens on top of a photodetector have exhibited an increase in detector sensitivity and more importantly a decrease in Noise-to-Signal-Ratio (NSR), as we showed in our prior work. In this paper, we model and analyze the effect that misalignment, between the microsphere-lens and the photodetector, has on the resulting detector sensitivity. As we show here, microsphere lens-sensor misalignment can result to some varying degrees in reduced spectral responses in microspheres-lens-enhanced MWIR photodetectors. We also model and analyze the effect of such misalignment on multiple photodetector sizes and microsphere material types.

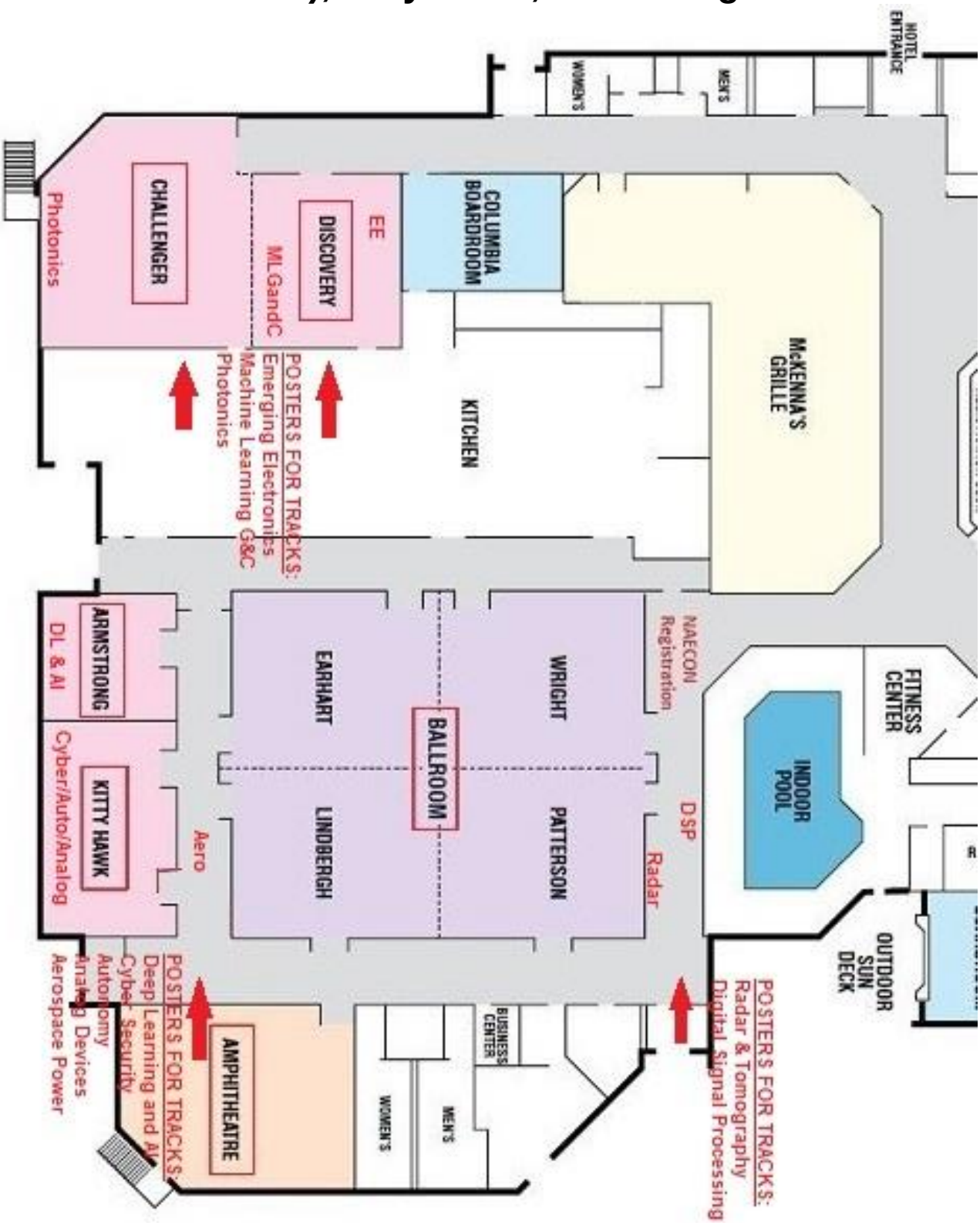
Radar, Tomography and RF sensing

36. Receiving Frequency Diverse Array Antenna for Tracking Low Earth Orbit Satellites, *Issa Elbelazi, University of Dayton*

The Frequency Diverse Array (FDA) antenna provides range - angle - time dependent beampattern, potentially generating highly directional beams with high gain that may be steered directly and continuously to the desired position. A ground receiving antenna system based on Frequency diverse array antenna is presented for tracking and communicating with Low Earth Orbit (LEO) satellite at ground station. This is required to minimize complexity and cost of ground station. To meet the system figure of merit (G/T) requirement, the radiation characteristics, the gain requirements, the array size, the minimum number of elements and their distribution for several FDA array antenna architectures are calculated and analyzed.

POSTER MAP

Locations: Challenger/Discovery, East Ballroom Foyer (near NAECON Registration), West Ballroom Foyer (Near Kitty Hawk), Kitty Hawk, Armstrong



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NAECON-2019 Agenda At-A-Glance

Start	End				
Day 1– Monday, July 15, 2019		***Coffee Breaks: 15:00 -15:15***			
		Registration (Monday 12:00-4:00; Tuesday, Wednesday 7:45 – 16:00; Ends Thursday at 12:00pm) *Ballroom Foyer*			
1300	1500	**Tutorial A AI-Focused Tools and Hardware Supporting the Future of Autonomy (Ballroom)**			
1515	1715	**Tutorial B Xilinx AI Edge Tutorial and Versal Portfolio (Ballroom)**			
1300	1600	**Tutorial C Hidden Outlier Noise and its Mitigation (Kitty Hawk)**			
1300	1715	**Tutorial D AI, Visual Perception and Deep Learning with Examples (Auditorium)**			
Day 2– Tuesday, July 16, 2019		***Coffee Breaks: 10:30 – 10:45 , 15:30 -15:45***			
0800	0815	**Welcome and Introductions (Ball Room)**			
0815	0900	**Opening Keynote: Alberto Valdes-Garcia, IBM**			
900	10:30	**THz and mmwave I (9:00-10:30) Ballroom**	**Low SWAP (9:00-10:30) Auditorium**	**Aerospace Power I (9:00-10:30) Kitty Hawk**	
1045	1215	**THz and mmwave II (10:45 – 12:15) Ballroom**	**Deep Learning & AI I (10:45 – 12:15) Auditorium**	**Aerospace Power II (10:45 – 12:15) Kitty Hawk**	
1215	1330	**Luncheon;** *Ballroom* **Keynote Speaker (12:45-13:30): Rajesh Naik, Chief Scientist, 711/HPW**			
1345	1745	**Cyber Security & Trusted Systems I & II (13:45 - 15:30, 15:45-17:45) Ballroom**	**Deep Learning & AI II & III (13:45 – 15:30, 15:45-17:45) Auditorium**	**Photonics and EO I & II (13:45 – 15:30, 15:45-17:45) Kitty Hawk**	
		NAECON RECEPTION HOLIDAY INN (1745– 1930)			
Day 3– Wednesday, July 17, 2019		***Coffee Breaks: 10:15 – 10:30 , 15:15 -15:30***			
0830	1200	**Cyber Security & trusted Systems III (8:30-10:15) Autonomy I 10:30-12:00) Ballroom**	**DSP I & II (8:30-10:15, 10:30-12:00) Auditorium**	**Radar & Tomography I & II (8:30-10:15, 10:30-12:00) Kitty Hawk**	
1200	1315	**Luncheon;** *Ballroom* **Keynote Speaker (12:30-13:15): Maj Gen William T Cooley, Commander, AFRL**			
1315	1400	**Keynote Speaker: Shannon Jackson, Director, DOD SBIR Office**			
1415	1700	**Autonomy II & III (14:15 - 15:15, 15:30 - 17:00) Ballroom**	**Emerging Electronics & Microsystems I & II (14:15 - 15:05, 15:30 - 17:00) (Auditorium)**	**Machine Learning I & II (14:15 - 15:15, 15:30 - 17:00) Kitty Hawk**	
1700		**Poster Session Part 1 (17:00-18:00) (Hallways, KittyHawk,Armstrong,Challenger,Discovery)**			
1800	2100	**NAECON BANQUET (6:00 PM – 9:00 PM) Ballroom Keynote Speaker: Lt Col Randy "Laz" Gordon, T&E Lead, AFWERX**			
Day 4– Thursday, July 18, 2019		***Coffee Breaks: 10:15 – 10:30, 15:15-15:30***			
0830	1200	**Autonomy IV & V (8:30 –12:00) Ballroom**	**Deep Learning & AI IV (8:30-10:15)** **Analog Devices and Signal Processing (10:30-12:00) (Auditorium)**	**Machine Learning III & IV (8:30 - 12:00) Kitty Hawk**	
1200	1315	**Luncheon;** *Ballroom* **Keynote Speaker (12:30-13:15): Robert Williams, Director, Discovery Lab Global**			
1315	1515	**Poster Session 2 w/Judging - Ballroom Foyers, Kitty Hawk, Armstrong, Challenger, Discovery**			
1515	1715	**Discovery Lab Global- Special Session (Ballroom)**			
1715	1800	**Closing NAECON 2019 with Best Poster Awards (Ballroom)**			
Day 5– Friday, July 19, 2019		***Russ Research Center - Industry Day 8:00-15:30***			

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