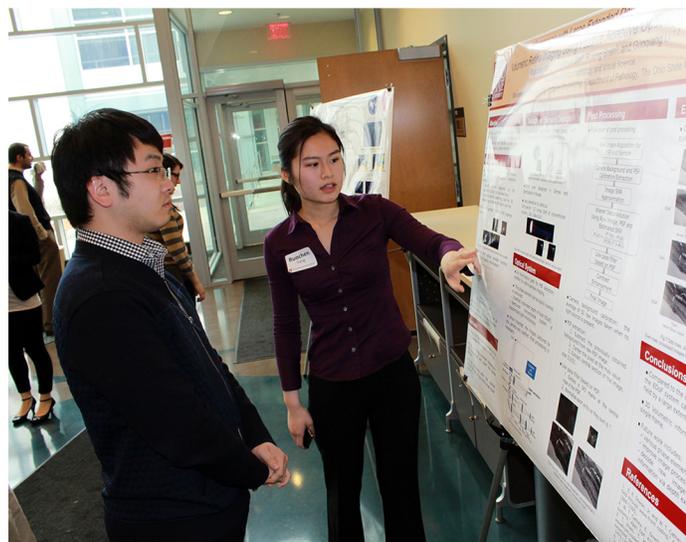
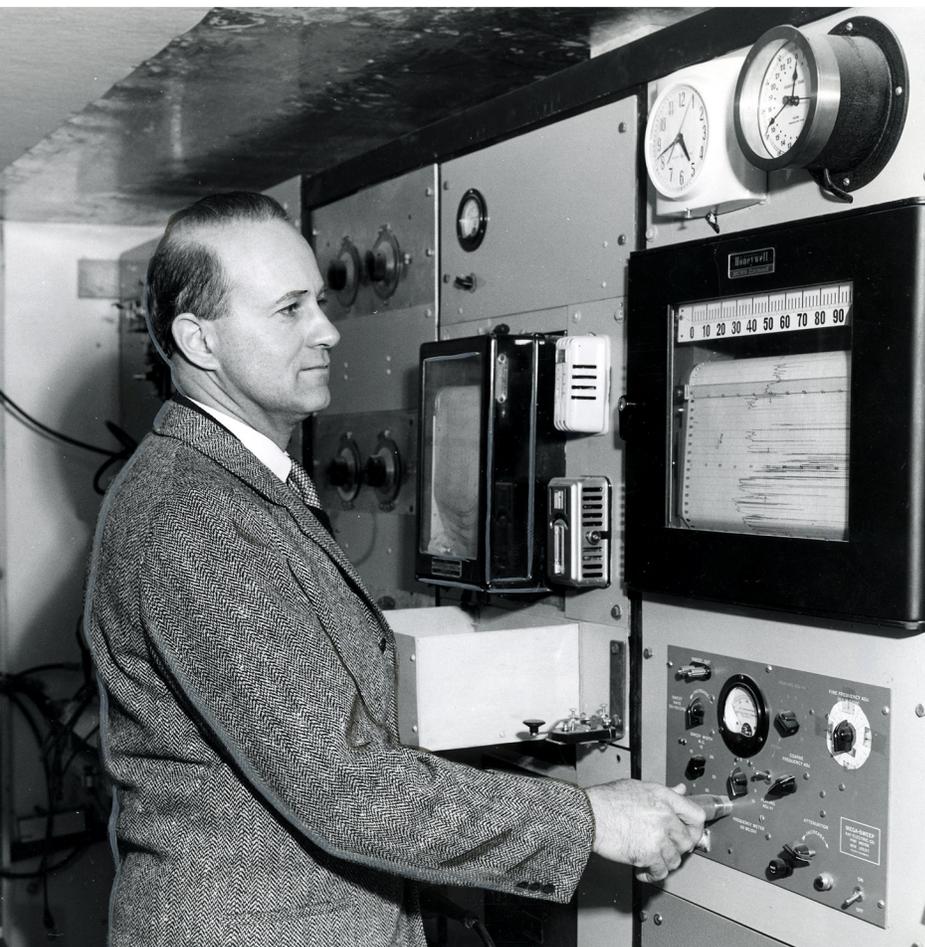


# THE OHIO STATE UNIVERSITY ELECTRICAL & COMPUTER ENGINEERING

## 2020 THE JOHN D. AND ALICE NELSON KRAUS MEMORIAL ECE GRADUATE STUDENT POSTER COMPETITION



## 2020 ECE Kraus Memorial - Graduate Student Poster Competition PROGRAM

### 1. Riazul Arefin

Prof. Shamsul Arafin, Advisor

**Title:** III-N/Si<sub>3</sub>N<sub>4</sub> Based Photonic Integrated Circuits at Blue Wavelengths

**Abstract:** Photonic integrated circuit (PIC) at visible wavelengths are important for numerous military and civilian applications. In this work, we report a PIC platform at 450 nm wavelength. Due to spectral-transparency and CMOS compatibility, the silicon nitride material is chosen for this platform. Different active and passive PIC component such as III-nitride blue lasers, edge- and vertical-grating coupler (VGC) and their integration schemes are designed. A maximum coupling efficiency (CE) of 83% and 51% is obtained for edge coupler and VGC, respectively. To efficiently couple the light from on-chip active to passive component of the PIC, two integration schemes including flip-chip based hybrid integration and evanescent coupling based heterogeneous integration are proposed and designed. A calculated CE of 40% is achieved in both cases. In the heterogeneous case, we have proposed a novel technique of light coupling by tapering both III-nitride lasers and the passive waveguide. Our work reports the design of PIC platform at the shortest wavelength.

### 2. Shashank Chinnakkagari

Prof. Wladimiro Villarroel, Advisor

**Title:** Honeybee Activity and Health Monitor Using Doppler Radar

**Abstract:** Traditionally beekeeping was practiced for honey harvesting. In recent years, due to huge demand of other bee products, like beeswax and bee venom there is a huge increase in beekeepers and bee colonies. Lately, due to human activities and parasites the bee colonies are collapsing at an alarming rate. A parasite named Varroa mite is identified as a major factor in the fall of bee colonies. In this report, a method is proposed to detect the wing deformation and wing-beat rate alteration of honeybees at early stages, using a doppler radar. Initially, the frequency of operation of the radar is determined, based on the estimation of the radar cross-section of a typical honeybee. Then, a doppler radar is designed, fabricated, and tested in the field. The average wing beat frequency for a healthy bee using the doppler radar is measured to be between 180Hz and 260Hz.

### 3. Jacob Compaleo

Prof. Inder Gupta, Advisor

**Title:** Application of Sparse Representation to Bartlett Spectra for Improved Direction of Arrival Estimation

**Abstract:** For decades, obtaining accurate direction of arrival (DOA) estimation of the signals incident on an array of antenna elements has been an area of great interest. In this poster presentation, our new technique for high-resolution direction of arrival estimation is presented. The method utilizes the traditional Bartlett spectra and sparse representation to locate emitters in single and multiple emitter scenarios. Using Monte Carlo simulations, we show that our approach achieves accurate DOA estimations that are unbiased and a variance that approaches the Cramer-Rao lower bound. We show

that our method outperforms the popular MUSIC algorithm when angular separation between emitters is small, signal SNR is low, and a small number of snapshots are used in DOA estimation.

#### 4. **Palmore DeGrath**

Prof. Cardin Yardim, Advisor

**Title:** Refractivity-from-Clutter Capable, Software-Defined, Coherent-on-Receive Marine Radar

**Abstract:** Remote sensing of lower atmospheric conditions, coupled air-sea processes, and the variations in the atmospheric index of refraction using sea surface backscattered radar signal (sea clutter) is referred as refractivity-from-clutter (RFC) technique. Due to the high clutter-to-noise ratios needed for RFC, typical RFC-capable marine radars are very large and expensive systems that use peak transmit powers larger than 1 MW.

The LATPROP (Lower ATmospheric PROPagation) radar is a RFC-capable, software-defined, coherent-on-receive radar that was designed and built by modifying a low-cost, commercially off the shelf incoherent fishing radar. Some of the notable modifications includes addition of a 10 ft diameter high gain dish antenna, a stable local oscillator for coherent processing, and a high speed analog-to-digital card. Here we will explain in greater detail the basic RFC radar design principles, hardware and software modifications, and demonstration of the system.

#### 5. **Burak Civek**

Prof. Emre Ertin, Advisor

**Title:** Bayesian Sparse Blind Deconvolution Using MCMC Methods Based on Normal-Inverse-Gamma Prior

**Abstract:** Bayesian estimation methods for sparse blind deconvolution problems conventionally employ Bernoulli-Gaussian (BG) prior to model the sparse sequences. However, discrete nature of the BG model creates computational bottlenecks, preventing efficient exploration of the probability space. To address this issue, we propose an alternative model based on the Normal-Inverse-Gamma (NIG) prior and transfer the problem into a completely continuous framework. We build an effective Gibbs sampler from scratch, incorporating additional frequency and time domain constraints. We demonstrate the effectiveness of the proposed method using numerical simulations.

#### 6. **Nidhin Kalarickal**

Prof. Siddharth Rajan, Advisor

**Title:** Electrostatic Engineering Using High Permittivity Materials for Ultra-wide Band Gap Transistors

**Abstracts:** Maintaining high average fields between the gate and drain terminals is imperative in achieving near theoretical performance in ultra-wide band gap semiconductors like  $\beta$ -Ga<sub>2</sub>O<sub>3</sub>. Peak electric fields occurring at the corner of gate/field plate makes this highly challenging. In this poster, we report on a field management strategy to reduce the peak electric field at the drain side corner of the gate by using a composite dielectric layer consisting of a high-k/low-k heterojunction overlapped over the gate electrode. Utilizing this strategy in  $\beta$ -Ga<sub>2</sub>O<sub>3</sub> modulation doped double heterojunction field effect transistor, helped achieve a record average breakdown field of 5.7 MV/cm at a gate-drain spacing of 1.15  $\mu$ m along with an improved power figure of merit of 586 MW/cm<sup>2</sup>. The reported works

shows the effectiveness of integrating high-k dielectrics with ultra-wide band gap materials in significantly improving breakdown performance.

## 7. Sree Subiksha Madhavan Reshikeshan

Prof. Mahesh Illindala, Advisor

**Title:** Autonomous Voltage Regulation by Distributed PV Inverters with Minimal Inter-Node Interference

**Abstracts:** Reactive power capability of distributed photovoltaic (PV) inverters is exploited to mitigate voltage violations under high PV penetration in the distribution grid. Coordinating the reactive power service of individual PV inverters to obtain desired voltage regulation performance is a major challenge. In this paper, a decentralized method is proposed to enable PV inverters to autonomously regulate terminal node voltages. The proposed method minimizes the effect of a terminal node's reactive power compensation on the voltage profile of its respective parent-to-terminal node. This ensures that the interference between the voltage regulation of terminal nodes by individual PV inverters is minimized. The performance of the proposed decentralized scheme is verified by extensive powerflow simulations of the EPRI Circuit 24 test feeder in open-source distribution system simulation platform OpenDSS.

## 8. Krutant Mehta

Prof. Inder Gupta, Advisor

**Title:** Use of Model Mismatch Statistics in RSS Geolocation

**Abstracts:** Radio Frequency (RF) emitter localization has commercial and military applications. Received Signal Strength (RSS) based geolocation methods are attractive due to the inexpensive hardware requirements and ease of implementation. When RSS measurements are corrupted by noise, one can use Least Square (LS) solution to geolocate an emitter. Often, RSS measurements are hindered by multipath and shadowing effects that do not have noise like characteristics and the accuracy of the LS solution degrades. We present a different cost function that involves estimating the mismatch errors and using the standard deviation of the mismatch vectors as cost function. We consider problem of a UAV flying over a region of interest with a single, grounded emitter. With many Monte Carlo Simulations, we show that both the bias and Root Mean Squared Error (RMSE) are reduced with the proposed method. In future, we will extend the approach to multiple emitter scenes.

## 9. Banaful Paul

Prof. Niru Nahar, Advisor

**Title:** Frozen Mode phenomena in Coupled Silicon Ridge Waveguides for True-time delay Applications

**Abstracts:** We propose a photonic waveguide structure that exhibits light propagation modes with vanishing group velocity via mode degeneracy. This enables the stationary inflection point (SIP) dispersion leading to the frozen mode and a true-time-delay device suitable for ultrawide band beamforming for millimeter- wave phased arrays. The structure consists of three Silicon ridge waveguides in proximity with periodic gaps introduced in the outer guides to create a band gap. The structure is CMOS compatible with a very small footprint of only around 14  $\mu\text{m}$  and more resilient to fabrication uncertainties as compared to the previously studied structures. A carefully tuned structure

results in the SIP behavior at 192.7 THz (1556 nm wavelength) with readily achievable coupling of 70% through conventional fiber coupling. Also, it enables unprecedented almost frequency independent bandwidth of around 0.5 THz for RF-mmW–THz beamforming.

#### 10. Saurav Kumaraswami Shastri

Prof. Philip Schniter, Advisor

**Title:** Autotuning Plug-and-Play Algorithms for Magnetic Resonance Imaging

**Abstracts:** For magnetic resonance imaging (MRI), recently proposed "plug-and-play" (PnP) image recovery algorithms have shown remarkable performance. These PnP algorithms are similar to traditional iterative algorithms like FISTA, ADMM, or primal-dual splitting (PDS), but differ in that the proximal update is replaced by a call to an application-specific image denoiser, such as BM3D or DnCNN. The fixed-points of PnP algorithms depend upon an algorithmic stepsize parameter, however, which must be tuned for optimal performance. In this work, we propose a new auto-tuning PnP-PDS algorithm that exploits knowledge of the measurement-noise variance that is available from a pre-scan in MRI. Preliminary experimental results show that our algorithm converges to genie-tuned performance, and does so significantly faster than existing autotuning approaches.

#### 11. Manmeet Singh

Prof. Ayman Fayed, Advisor

**Title:** A Digitally-Assisted Buck-Boost Converter with Seamless Mode Transitions and Fast Dynamic Response for Extending Battery Life in Mobile Devices

**Abstracts:** Operating switching power converters from an input voltage as low as 2.3V in devices operating from Li-Ion batteries can extend the running time of the device by as much as 20% compared to the common practice of shutting down the device when the battery drops to 2.7V. However, since many of these devices require power supplies that are higher than 2.3V but lower than the maximum voltage of a Li-Ion battery (i.e. 5V), designing these power converters becomes challenging. This work presents a noninverting buck-boost converter to address this challenge. The converter uses digital adaptive slew-rate control and hysteretic mode detection to achieve fast dynamic response and seamless/noise-immune mode transition between the buck, boost, and buck-boost modes of operation. The converter is fabricated in 0.13- $\mu\text{m}$  CMOS, and supports 2.3–5V input and 1.5–3.6V output. It achieves 91.7% peak efficiency and over 80% efficiency at 1-mA load across all conditions.

#### 12. Hao Xue

Prof. Wu Lu, Advisor

**Title:** Al<sub>0.65</sub>Ga<sub>0.35</sub>N/Al<sub>0.4</sub>Ga<sub>0.6</sub>N Micro-Channel HFETs for High Power RF Application

**Abstracts:** High Al-content AlGa<sub>N</sub>, as a Ultrawide-bandgap (UWBG) semiconductor with significantly wider bandgap than GaN, have attracted significant research interests in high-power and RF electronics due to its superior figure-of-merits. With high breakdown fields and saturation velocity, AlGa<sub>N</sub> channel transistors are therefore expected to deliver higher power density at high frequencies.

Due to the low electron affinity of high Al-content AlGa<sub>N</sub>, the most challenging part during the development of AlGa<sub>N</sub> RF transistors is to make good ohmic contacts. In this work, we show the challenges of high contact resistance can be mitigated to significant extent by increasing the relative periphery of contacts using multi-constrictions channels. The improved injection from the source enabled an increase of the current density from 480 mA/mm to 910 mA/mm. The increased current density and improved effective contact resistance also enabled state-of-art output power density of 2.7 W/mm at 10 GHz.

***THANK YOU to the following people for their help in making this event possible:***

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