TAWFIK M. OSMAN

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SUMMARY

Tawfik has three years of empirical research experience in simulating, designing, and prototyping wireless system testbeds using NI-USRPs, Xilinx RFSoC evaluation boards, and mmWave RF front-end devices. He has analyzed and developed machine learning-aided models that leverage real-world sensing information to enhance beam management in mmWave systems.

EDUCATION

Electrical Engineering, Ph.D. **Arizona State University** **Tempe, AZ**
Communication Systems and Signal Processing – Advisor: Prof. Ahmed Alkhateeb. May 2026
Research: Machine Learning Aided mmWave Beam Management and Testbed Prototyping GPA: 3.78

Master of Science in Engineering, Electrical Engineering **Arizona State University** **Tempe, AZ**
Ira A. Fulton Schools of Engineering | Graduation: May 2021

- **Awards**: MasterCard Scholars Foundation Scholarship | Fulton Undergraduate Research Initiative (FURI) Funding | Master's Opportunity for Research in Engineering (MORE) Funding.
- **Relevant Coursework**: Communication Systems, Fundamental of MIMO Communication, Detection and Estimation Theory, Communication Networks, Wireless and Digital Communication, & Python for Rapid Eng. Solutions.

Bachelor of Science, Electrical & Electronic Engineering **Ashesi University** **Accra, Ghana**
Graduation: May 2020

- **Honors:** First Class Honors | Magna Cum Laude
- **Awards:** MasterCard Foundation Scholar.

TECHNICAL SKILLS

Programming: Python | MATLAB | C/C++
Design: GNU Radio Companion | Vivado | Simulink | Linux Scripting
Hardware: NI USRP [B210s, X310s and N321s] | Sivers RF Modules | ZCU216 | RFSoC 4x2 | Raspberry Pi | Jetson Nano & Xavier
Robotic Systems: Agile X Scout Mini | Arlo Complete Robot
Frameworks & Libraries: PyTorch | TensorFlow | NumPy | OpenCV | SciPy | Scikit-Learn | Pandas | pyQt5 & tkinter | Sockets | ROS2.
Certification: Deep Learning Specialization in Coursera by Andrew Ng.

RESEARCH EXPERIENCE

Arizona State University Tempe, AZ
Graduate Research Assistant January 2021 – present
Project: **Digital twin-assisted beam management in mmWave communication.**

- Prototype an over-the-air mmWave testbed and collect mmWave power vectors for different environmental setups, where a mobile receiver is served by a static transmitter.
- Utilize accurate 3D raytracing and DeepMIMO software to model wireless channels and generate beam power vectors.
- Develop evaluation metrics to compare and analyze wireless data from a real-world testbed and its digital replica.
- Develop a beam tracking algorithm that leverages wireless channels derived from the digital replica to assist in beam selection for real-world systems with minimal or no overhead.
  Tools: Python, Remcom's 3D raytracing simulator, Blender, Matlab

Project: **Leveraged the open-air interface (OAI) 5G RAN project to build and validate over-the-air links in both sub-6 GHz and mmWave bands.**

- Integrate an end-to-end 5G SA setup using the OAI open-source code and software defined radios from Ettus Research.
- Conduct calibration, integration, and control of the mmWave evaluation kits [Sivers RF Evaluation Modules].
- Explore the modification and integration of signal processing blocks within the physical layer of the OAI 5G stack.
- Validate the configuration and control of a reconfigurable intelligent (RIS) using cloud-native software and control commands from a near real-time RIC (Radio Intelligent Controller) and xApp.
  Tools: Python, C/C++, Signal Generator, Spectrum Analyzer.

Project: **Sensing-aided mmWave beam tracking in a mobile environment**

- Contributed to the design and building of a vehicle-to-vehicle wireless communication testbed equipped with vision, LiDAR, and radar sensing capabilities.
- Conducted large-scale multi-modal data collection, processing, and feature extraction from wireless and vision data.
- Built an end-to-end machine learning solution that implements a multi-staged mmWave beam tracking algorithm.
  Frameworks: Python, GNU Radio, PyTorch, MATLAB

Project: **Leveraged deep learning models to map sub-6GHz channel information to optimal mmWave beams, using real-world datasets from a co-located dual-band Testbed.**

- Designed and implemented a link-level physical layer for a wireless system, using a standard-compliant Wi-Fi waveform.
- Implemented real-time over-the-air experiments on software-defined radios to validate a co-located dual-band communication testbed.
- Utilized low-level networking modules in application languages to integrate and interface subsystems in the dual-band testbed.
- Assembled and configured off-the-shelf robot systems for field experiments: *Arlo Robot & Agile-X Scout Mini*.
- Developed a machine learning model to learn the spatial correlation between channel state information in sub-6GHz and optimal mmWave beams.

WORK EXPERIENCES

Startup Company (stealth mode) Tempe, AZ

System and Algorithm Engineering Intern **– Summer & Fall Intern** *May 2022 – January 2023*

- Designed and implemented a proof-of-concept wireless system to validate AI algorithms in millimeter-wave communication.
- Built a link-level simulator for OFDM transmission and reception.
- Integrated a Xilinx RFSoC evaluation board with Siver RF boards, to validate a reliable mmWave communication link.

Tools: Signal processing, Software defined radios technologies. Frameworks: Python, MATLAB & C/C++

Startup Company (stealth mode) Tempe, AZ

System and Algorithm Engineering Intern **– Summer Intern** *June 2024 – August 2024*

- Implemented a proof-of-concept wireless system to validate point-to-multipoint(P2MP) millimeter-wave communication.
- Utilized machine learning algorithms to facilitate beam learning and management in the P2MP system.

Tools: Signal processing, Software defined radios, GNU Radio
Frameworks: Python, MATLAB, PyTorch

Arizona State University Tempe, AZ

Graduate Service Assistant *May 2020 - December 2020*

- Facilitated lab activities in the coursework of Digital Design Fundamentals, using an Intel DE10-Lite FPGA board to implement logic circuits.
- Supported the ASU-Sync modality by assisting a faculty member in organizing and controlling the teaching and learning equipment.
- Held up to 2 hrs./week sessions to help students with their assignments and projects in Python and Machine learning.

Undergraduate Teaching Assistant January 2020 - May 2020

- Coordinated and assisted a faculty member in teaching Python for Rapid Engineering Solution (EEE591) for a class of 140 students.
- Exploited the Scikit-learn library and utilized its classification algorithms such as Support Vector Machine, KNN, Logistic regression, and Perceptron to build an optimized model capable of predicting 98% of counterfeit bills.
- Assisted students to build a Tool Driver Program that utilizes the libraries of Python to generate an inverter-chain HSPICE file with an optimized number of inverters and path effort, at a minimum path delay.

PUBLICATIONS AND ACTIVE RESEARCH PROJECTS

1. **T. Osman**, G. Charan, and A. Alkhateeb "Vehicle Cameras Guide mmWave Beams: Approach and Real-World V2V Demonstration". Available on arXiv https://arxiv.org/abs/2308.10362.
2. Y. Zhang, **T. Osman**, and A. Alkhateeb (2022). "Online Beam Learning with Interference Nulling for Millimeter Wave MIMO Systems". Available on arXiv https://doi.org/10.48550/arxiv.2209.04509.
3. G. Chara, **T. Osman**, A. Hredzak, N. Thawdar and A. Alkhaateeb, "Vision-Position Multi-Modal Beam Prediction using Real Millimeter Wave Datasets". Accepted to be presented at IEEE Wireless Communications and Networking Conference (WCNC). Austin TX, United States. 2022.
4. Alkhateeb, A., Charan, G., Alrabeiah, M., **Osman, T**., Hredzak, A., Srinivas, N., & Seth, M. (2021). DeepSense 6G: A large-scale real-world multi-modal sensing and communication dataset. available on arXiv.
5. G. C. Trichopoulos, P. Theofanopoulos, K. Bharath, S. Aditya, M. Anuj, **O. Tawfik**, S. Kumar, A. Sengar, A. Chang, and A. Alkhateeb., "Design and Evaluation of Reconfigurable Intelligent Surfaces in Real-World Environment," in IEEE Open Journal of the Communications Society, doi: 10.1109/OJCOMS.2022.3158310.