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Engineering & Scientific Consulting

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Professional Profile

Dr. Umunnakwe is trained in electrical and computer engineering with expertise in enhancing the resilience and security of the power grid, including reducing the risk of cyber and physical threats. She received her Ph.D. in Electrical Engineering from Texas A&M University, where she researched and developed models and tools for reducing risk and applying next-generation energy management techniques to the grid. Motivated by effective deployable solutions for real-world problems, she uses her skills in computer science including machine learning, deep learning, image analysis, and reinforcement learning to develop data-driven and spatio-temporal models that improve power system techniques. She has worked on threats of adversary intrusion and false data injection attacks on the grid, as well as the development of digital twin models for power system communication networks to facilitate risk studies. She has expertise in extreme threats of wildfires, where her models enable utilities and other critical infrastructure to quantify their wildfire risks and increase grid resilience. She has also developed software tools that integrate computer vision to enable critical infrastructure to respond resiliently to wildfires while mitigating threats accurately in real-time.

Dr. Umunnakwe has industry experience in energy and natural resources creating techniques for clients that improve the sustainability and load shedding schemes for power plants, as well as experience in optimizing power systems operations and other electrical engineering processes. Her experience spans the following fields and sub-fields:

Electrical engineering: power system economics, security and optimization, electrical fault forensics.

Computer Science: machine learning, deep learning (convolutional, artificial, graph, recurrent neural networks) deep reinforcement learning, data science, network security, pattern recognition, stochastic processes, image analysis, geospatial information systems (ArcGIS), big datasets.

Programming Languages: Python (TensorFlow, Keras, PyTorch, etc.), C++, MATLAB, GAMS (General Algebraic Modeling Language).

Academic Credentials & Professional Honors

Ph.D., Electrical Engineering, Texas A&M University College Station, 2023

M.S., Electrical and Computer Engineering, University of Utah, 2020

B.Eng., Electronic Engineering, University of Nigeria, 2015

Alfred P. Sloan Foundation + PSERC IAB Travel Award: Transformation School held in Tempe, AZ (July 2022)

Top 10% on the Kaggle Leaderboard Machine Learning Competition
(https://www.kaggle.com/competitions/uofu-ml-fall-2018/leaderboard)

Institute of Electrical and Electronic Engineers Volunteer award: Attended, presented work, and competed
the 3rd IEEE Power and Energy Society Student (2018) in Brazil.

EducationUSA Opportunity Fund Award by the Consulate General of the United States of America
(2016):

Young African Leaders Initiative through the Bureau of International Information Programs U.S.
Department of States on "Focus on: Understanding the Rights of Women and Girls" (Certificate Awarded,
2016).

Nneji Foundation, Ifeyinwa Ezechukwu Memorial, and The University of Nigeria, Prizes to the Best
Graduating Student in Electronic Engineering (2016)

Chevron/NNPC Agbami Medical and Engineering Professional Scholarship Award (2011/2012-2015)

Academic Appointments

Graduate Teaching Assistant, Electric Energy Conversion, Texas A&M University, 2022

Teaching Assistant, Introduction to Engineer Electronics II, The University of Utah, 2018

Teaching Assistant, Electrical and Computer Engineering Design, The University of Utah, 2018

Teaching Assistant, Introduction to Electric Circuits (Circuits & Systems II), The University of Utah, 2017

Teaching Assistant, Electrical Forensics and Failure Analysis, The University of Utah, 2017

Short Courses Delivered

Developed and instructed in a four-day tutorial for GridSecCon on "Cyber Physical Grid Training: Cyber-
Physical Electric Grid Analysis of Threats, Impact and Defense," Oct 2021 with about 190 attendees

Texas A&M Engineering Experiment Station Smart Grid Center public webinar on "Cyber-Physical
Resilient Energy Systems: A Secure Foundation for Next-Generation Energy Management," Jan. 14,
2021, with 75 attendees.

Developed and instructed in a four-day virtual short course on "Cyber, Physical, and Cyber-Physical
Electric Grid Analysis of Threats, Impact, and Defense," Sept/Oct 2020 with about 40 attendees.

Developed and instructed in a three-day short course on "Cyber, Physical, and Cyber-Physical Electric
Grid Analysis of Threats, Impact, and Defense," Feb. 18-20, 2020.

Prior Experience

Graduate Research Assistant, Texas A&M University, 2020 – 2023: Research areas covered data-driven
spatio-temporal assessment and modeling for cyber and physical critical systems, design and
development of software models enabling visualization and situational awareness in critical infrastructure
response to wildfires, and resilience-oriented risk analysis to make critical infrastructure more robust with
respect to cyber and physical threats. Some projects she has worked on include:

· Deep cyber-physical situational awareness for energy systems: A secure foundation for next generation

energy management

· Deep learning-based detection of stealth false data injection attacks in large-scale power grids

· Application of Texas A&M electric grid control center testbed

· Enhancing the modeling, simulation, and visualization of large-scale electric grids utilizing detailed synthetic power grids and datasets

· Part of the Texas A&M team that contributed to several proposal efforts subsequently funded by the Department of Energy and the National Science Foundation.

· Led Texas A&M's proposal efforts on Cyber Agents for Security Testing and Learning Environments, responding to the broad agency announcement by the Defense Advanced Research Projects Agency, Information Innovation Office. This summarily entailed proposing novel methods, models and technique that use artificial intelligence to improve the cybersecurity of critical networks and infrastructure against advanced persistent threats.

Graduate Research Assistant, The University of Utah, 2017 - 2019

Electrical Engineering Intern, RioTinto Kennecott, South Jordan, Utah, 2019

Energy and Natural Resources Audit Engineer, KPMG Professional Services, 2017

Electrical Engineer Research, University of Lagos, May 2016 – March 2017

Electronic Engineering Intern, Transsion Holdings, 2014: Worked on mobile phones hardware.

Project Lead, The University of Nigeria, 2015: Worked on the design and construction of a remotely controlled video capturing vehicle with Arduino system.

Professional Affiliations

Member, IEEE (Women in Engineering, Power and Energy Society, Young Professionals)

Member, Energy and Power Group (EPG) at Texas A&M University

Member, Power Systems Engineering Research Center (PSERC)

Member, The Institute for Operations Research and the Management Sciences (INFORMS)

Technical Program Committee for:

North American Power Symposium (NAPS 2021) Volunteer committee

Texas Power and Energy Conference 2021, 2022, 2023

Volunteering and Mentorship Activities

Voluntary Services Overseas (VSO) (April 2016 - March 2017):

· Reached into communities, creating spaces and clusters to educate and help less privileged children in these communities.

· Sensitization and information awareness (Health, Child Abuse and Child Protection) of less-educated adults in underprivileged communities.

· My team helped raise funds through VSO to help about 30 children get back to school on the "Back to School Project"

Mentor for Women in STEM, Professional Women Engineers, People in STEM.

· Teaching courses in STEM

· Research mentor for women in STEM

· Research mentor for people in STEM

Publications

Journals

Umunnakwe, H. Huang, K. Oikonomou, K. Davis, "Quantitative Analysis of Power Systems Resilience: Standardization, Categorizations, and Challenges," Renewable and Sustainable Energy Reviews, 2021.

O. Boyaci, A. Umunnakwe, A. Sahu, M. Narimani, M. Ismail, K. Davis, E. Serpedin, "Graph Neural Networks Based Detection of Stealth False Data Injection Attacks in Smart Grids," IEEE Systems Journal, 2021.

M. Narimani, H. Huang, A. Umunnakwe, Z. Mao, A. Sahu, S. Zonouz, and K. Davis, "Generalized Contingency Analysis Based on Graph Theory and Line Outage Distribution Factor," IEEE Systems Journal, 2021.

Sahu, K. Davis, H. Huang, A. Umunnakwe, S. Zonouz and A. Goulart, "Design of Next-Generation Cyber-Physical Energy Management Systems: Monitoring to Mitigation," in IEEE Open Access Journal of Power and Energy, doi: 10.1109/OAJPE.2023.3239186.

Umunnakwe, M. Parvania, H. Nguyen J. Horel, K. Davis, "Data-Driven Spatio-Temporal Analysis of Wildfire Risk to Power Systems Operation," IET Generation, Transmission & Distribution, 2022.

Umunnakwe, A. Sahu, M. Narimani, S. Zonouz, K. Davis, "Cyber-physical Component Ranking for Risk Sensitivity Analysis using Betweenness Centrality," IET Cyber-Physical Systems: Theory and Applications, 2021.

Hosseini MM, Umunnakwe A, Parvania M, Tasdizen T. Intelligent damage classification and estimation in power distribution poles using unmanned aerial vehicles and convolutional neural networks. IEEE Transactions on Smart Grid. 2020 Jan 28;11(4):3325-33.

Conferences

Umunnakwe A, Wlazlo P, Sahu A, Velasquez J, Davis K, Goulart A, Zonouz S. OpenConduit: A Tool for Recreating Power System Communication Networks Automatically. In2022 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm) 2022 Oct 25 (pp. 141-147). IEEE.

Umunnakwe A, Davis K. A Modeling Approach to Quantify Wildfire Risk in Power Systems Operations Using Data Availability and Deep Learning Techniques. In 2022 IEEE Power & Energy Society General Meeting (PESGM) 2022 Jul 17 (pp. 1-5). IEEE.

A. Umunnakwe, Abolaji Alimi, Katherine Davis, and Karen Butler-Purry, "Improving Situational Awareness in Power Grids of Developing Countries: A Case Study of Nigerian Grid" IEEE Innovative Smart Grid Technologies North America (ISGT NA) Conference 2023.

Hosseini MM, Umunnakwe A, Parvania M. Automated switching operation for resilience enhancement of distribution systems. In2019 IEEE Power & Energy Society General Meeting (PESGM) 2019 Aug 4 (pp. 1-5) IEEE.

A. Umunnakwe, A. Sahu, K. Davis, "Multi-Component Risk Assessment Using Cyber-Physical Betweenness Centrality," PowerTech 2021. Submitted and Pending Multi-Component Risk Assessment Using Cyber-Physical Betweenness Centrality: Presented at PowerTech 2021, Madrid, Spain.

Submitted and Pending Publication

Umunnakwe, Amarachi, and Katherine, Davis. "Lean Forward: On Proactive Cyber-Physical-Human Risk Assessment in Power Systems".

Umunnakwe, Amarachi, and Katherine, Davis. "On Defining Power Systems Resilience Against Wildfires".

Umunnakwe, Amarachi, and Katherine, Davis. "Spatio-Temporal Wildfire Ignition Predictor for Power Systems Operation and Planning: A Novel Dataset and Deep Learning Modeling Approach".

Umunnakwe, Amarachi, and Katherine, Davis. "A Data-Driven Automated Mitigation Approach for Resilient Wildfire Response in Power Systems", peer review under IEEE Open Access Journal of Power and Energy.

Umunnakwe, Amarachi, and Katherine, Davis. "An Optimization of UAV-Based Remote Monitoring for Improving Wildfire Response in Power Systems" peer review under IEEE Open Access Journal of Power and Energy.

Umunnakwe, Amarachi, and Katherine, Davis. "Economic Viability Analysis of A Data-Driven Approach for Resilient Wildfire Response".

Presentations

Amarachi Umunnakwe, "Improving Situational Awareness in Power Grids of Developing Countries: A Case Study of Nigerian Grid", presented at the IEEE Innovative Smart Grid Technologies North America (ISGT NA) Conference 2023, Washington DC, USA.

Amarachi Umunnakwe, "OpenConduit: A Tool for Recreating Power System Communication Networks Automatically". Presented at IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm) 2022, Singapore.

Amarachi Umunnakwe, "A Modeling Approach to Quantify Wildfire Risk in Power Systems Operations Using Data Availability and Deep Learning Techniques", Presented at IEEE Power & Energy Society General Meeting (PESGM) 2022, Denver Colorado, USA.

Amarachi Umunnakwe, "Multi-Component Risk Assessment Using Cyber-Physical Betweenness Centrality", Presented at PowerTech 2021, Madrid, Spain

Amarachi Umunnakwe, "A Deep Learning Approach for Spatio-Temporal Impact Analysis of Power Grids Against Wildfires", Presented to Texas A&M University's Energy and Power Group (https://smartgridcenter.tamu.edu/wpcontent/uploads/2020/02/Amarachi-Umunnakwe-2-28-20.pdf) 2020, College Station, Texas, USA.

Amarachi Umunnakwe, "High-Level Integration of Electric Vehicles and Associated Harmonics", presented at the 2018 Environment and Sustainability Research Symposium at the University of Utah, Salt Lake City, Utah, February 15, 2018.

Amarachi Umunnakwe, "High-Level Integration of Electric Vehicles and Associated Harmonics", presented at The Intermountain Sustainability Summit (ISS), Weber State University, Utah, held Feb. 28th - March 2nd, 2018.

Invited Speaker and Presenter

Invited Speaker and Presenter at session titled "Wildfire Risk Management for Electric Power Systems" at the 2023 INFORMS Annual Meeting, in Phoenix from Oct 15-18.

Peer Reviews

IEEE Transactions on Smart Grid

IEEE Transactions on Neural Networks and Learning Systems

IEEE Transactions on Power Systems

Hawaii International Conference on System Sciences (HICSS)

Texas Power and Energy Conference (TPEC)

North American Power Symposium (NAPS)

IEEE Innovative Smart Grid Technologies (ISGT) Conference

IEEE Power & Energy Society Grid Edge Technologies

IEEE Power & Energy Society General Meeting (2022 and 2023)