Nurani Saoda

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SUMMARY

Computer scientist and engineer with hands-on experience in building real-world sensing systems with a track record of publications in top sensing and networking conferences. I have a unique experience in rapid prototyping end-to-end systems that involve design, development, testing, and deploying new hardware and software systems for computers with extreme resource constraints in respect to energy, memory, and processing capability.

RESEARCH INTEREST

Energy-harvesting and energy-efficient sensor systems, Wireless and Passive sensing, Edge ML, Low power IoT, Sustainable computing

EDUCATION

- **University of Virginia** — Charlottesville, VA
  Ph.D. in Computer Engineering — Aug 2017 – Aug 2023
- **University of Virginia** — Charlottesville, VA
  M.S. in Computer Engineering — Aug 2017 – Aug 2020
- **Bangladesh University of Engineering and Technology (BUET)** — Dhaka, Bangladesh
  B.S. in Electrical and Electronic Engineering — Feb 2011 – Mar 2016

EXPERIENCE

- **Postdoctoral Research Fellow** — Urbana, IL
  University of Illinois Urbana-Champaign — Aug 2023 –Present
- **Graduate Student Researcher** — Charlottesville, VA
  University of Virginia — Aug 2017 – Aug 2023
- **Lecturer, EEE** — Dhaka, Bangladesh
  Uttara University — May 2016 – Jun 2017

SELECTED PUBLICATIONS (**Google Scholar**)

1. An Energy Supervisor Architecture for Energy-Harvesting Applications. **Nurani Saoda**, Wenpeng Wang, Md Fazlay Rabbi Masum Billah, Bradford Campbell. **ACM IPSN'22** (CORE ranking-**A***)
2. SolarWalk: Smart Home Occupant Identification using Unobtrusive Indoor Photovoltaic Harvesters. **Nurani Saoda**, Md Fazlay Rabbi Masum Billah, Victor Ariel Leal Sobral, Tushar Routh, Wenpeng Wang, Bradford Campbell. **ACM BuildSys'2022** (CORE ranking-**A***)
3. RetroIoT: Retrofitting Internet of Things Deployments by Hiding Data in Underused Data Channels. **Nurani Saoda**, Victor Ariel Leal Sobral, Ruchir Shah, Wenpeng Wang, Bradford Campbell. **ACM MobiCom'22** (CORE ranking-**A***)
4. BLE Can See: A Reinforcement Learning Approach for Radio Frequency based Occupancy Detection. Md Fazlay Rabbi Mashum Billah, **Nurani Saoda**, Jiechao Gao, Bradford Campbell. **ACM IPSN'21** (CORE ranking-**A***)
5. UbiTrack: Enabling Scalable & Low-Cost Device Localization with Onboard WiFi. Wenpeng Wang, Zetian Liu, Jiechao Gao, **Nurani Saoda**, Bradford Campbell. **ACM BuildSys'21**
6. Poster Abstract: Fusing Computer Vision and BLE Advertisement Signal for Accurate Sensor Localization in AR View. Md Fazlay Rabbi Masum Billah, Md Mofijul Islam, **Nurani Saoda**, Fateme Nikseresht, Tarique Iqbal, Bradford Campbell **ACM SenSys'22** (CORE ranking-**A***)
7. SolarWalk Dataset: Occupant Identification using Indoor Photovoltaic Harvester Output Voltage **Nurani Saoda**, Md Fazlay Rabbi Masum Billah, Victor Ariel Leal Sobral, Bradford Campbell. **ACM DATA Workshop with SenSys'22**
8. Developing a General Purpose Development Platform for Energy-harvesting Applications. **Nurani Saoda**, Md Fazlay Rabbi Masum Billah, Bradford Campbell. **ACM ENSsys Workshop with SenSys'21**
9. No Batteries Needed: Providing Physical Context with Energy-Harvesting Beacons. **Nurani Saoda**, Bradford Campbell. **ACM ENSsys Workshop with SenSys'19**

Selected Research Projects

A HW-SW co-designed architecture for energy management using RL-based optimization
- Proposed and designed a new energy-harvesting dynamic power management architecture using reinforcement learning. The design offloads all energy management operations to a dedicated power supply co-processor, achieving modularity, flexibility, and better energy optimization for energy-harvesting sensors. The architecture can be adopted by any application that may benefit from efficient energy management. Work published in ACM IPSN'22.
- <u>Microcontrollers:</u> STM32L010R8, nRF52840 <u>Tools:</u> EAGLE CAD, GNU ARM Embedded toolchain <u>Language:</u> Embedded C, Node.js

Identifying occupants in indoor spaces using pervasive photovoltaic harvesters
- Proposed a novel passive sensing technique to identify occupants in smart homes using the person's shadow pattern reflected on installed solar cell harvesters and achieved 88% accuracy in using a supervised ML model. Work published in ACM BuildSys'22.
- <u>Hardware used:</u> Nordic nRF52840 DK, Raspberry Pi <u>ML Framework:</u> Scikit-Learn <u>Language:</u> Embedded C, Python

Occupancy detection using BLE RF signals and reinforcement learning
- Collaborated in a team to introduce and implement an online occupancy detection system by training a RL model using RF signal features of BLE packets collected from empty and occupied rooms. Work published in ACM IPSN'21.

Localizing IoT devices using resource-constraint WiFi radio
- Contributed in a team project to design a localization system for resource-constraint IoT devices with single antenna by proposing a novel two-way multi-channel ranging technique. Work published as a poster in ACM BuildSys'21.

Improving human-IoT interaction by fusing RF signals and computer vision
- Contributed in a team to propose a novel architecture for multimodal data fusion to accurately localize sensors on AR devices by combining BLE signal features and image data from the sensor. The system achieves 75% improvement over state-of-the-art. Work published as a poster in ACM SenSys'22.

Upgrading IoT sensors by encoding data into battery terminals
- Proposed and demonstrated an innovative technique that uses the battery voltage channel of an IoT sensor to transmit new data such as sensor readings, metadata or tag-like information. The system builds on existing devices, gateway, and cloud application without completely replacing them. Work publisehd in ACM MobiCom'22.

Technical Skills

- **Programming Language**: Python, C/C++/C#, Embedded C, MATLAB, Verilog, Java, Javascript (Node.js), Make, ARM Assembly Language
- **Hardware Platforms**: nRF51 and nRF52 SoCs, STM32, MSP430, Arduino, Xilinx Artix FPGA, Raspberry PI
- **Machine Learning tools**: TensorFlow, TensorFlow Lite, Scikit-learn
- **Real-time OS**: Zephyr RTOS
- **Embedded Development**: EAGLE, Altium Designer, Proteus, Keil uVision, STM32CubeIDE, SEGGER Embedded Studio, TI Code Composer Studio, Cadence, PSpice, Xillinx Vivado, Orcad, Quartus II
- **Communication Protocols**: UART, SPI, I2C, JTAG, DMA, USB, Bluetooth Low Energy (BLE), LoRa, UWB
- **Prototyping and Equipment**: Board bring-up, Board debug and validation, Oscilloscope, Source/Load Measure Units, Power Profiler, Spectrum Analyzer, Logic Analyzer

Invited Talks

- *Designing Energy-Harvesting Devices for Sustainable Internet-of-Things*
  Research for Industry Talk, Networking Research Group, Microsoft — Mar 2023
- *Sustainable Internet-of-Things with Batteryless Energy-harvesting Sensors*
  Earth Systems Predictability & Resiliency Group, Pacific Northwest National Laboratory — Jan 2023
- Presented my research on *Broadening the Capabilities of Self-Powered Energy-Harvesting Systems*
  UVA Link Lab Student Seminar Award Series — Nov 2022

Selected Awards and Scholarships

- UIUC Grainger Postdoctoral Fellow and Future Faculty Fellow — 2023
- CPS Rising Star — 2023
- UVA Link Lab Student Seminar Award — 2022
- ACM SIGBED SRC Winner, Second Runner-up — 2022
- Finalist of NCWIT Collegiate Award — 2022
- N2Women Young Researcher Fellowship, SenSys'19 — 2019
- **Best paper award**, ICCIT'16 — 2016