Nurani Saoda

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RESEARCH INTEREST

Energy-harvesting and energy-efficient Sensor Systems, Wireless and Passive Sensing, Edge Machine Learning

EDUCATION

University of Virginia — Charlottesville, VA
- *Ph.D.* in Computer Engineering — Aug 2017 – Aug 2023
  Dissertation: *Designing Batteryless Energy-harvesting Sensors for Sustainable Internet-of-Things*

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
  Supervisors: Dr. Josep Torellas and Dr. Tarek Abdelzaher
  - Working on enabling cognitively-secure Augmented/Mixed Reality interfaces

Graduate Student Researcher — Charlottesville, VA
- *University of Virginia* — Aug 2017 – Aug 2023
  Supervisor: Dr. Brad Campbell

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 Masum 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**

10. IoTell: Multimodal Sensor Fusion for Enhanced IoT Control. Md Fazlay Rabbi Mashum Billah, Nurani Saoda, Viswajith Govinda Rajan, Bradford Campbell. In Submission to ACM IPSN'24

Selected Research Projects

Solar-powered Intermittent Indoor Sensing
- **ALTAIR:** Proposed and designed a new HW-SW architecture and interface for dynamic power management in indoor energy-harvesting applications. Developed a reinforcement learning model for dynamic energy management under varying energy-harvesting conditions. [1][8]
- **PreFarad:** Proposed, designed, and developed a novel energy storage power system architecture for energy-harvesting sensors to improve the accuracy of stochastic indoor event detection under power intermittency.
  MCU: STM32L010R8, nRF52840, nRF52832 **EDA:** EAGLE CAD, GNU ARM Embedded toolchain **Language:** Embedded C, Python, Node.js **ML Lib:** TensorFlow Lite **Board designed:** ALTAIR, PreFarad

Wireless and Passive Sensing using Low Power Protocols
- **BLECS:** Proposed and deployed a system to detect long-term indoor occupancy in dynamic spaces using BLE RF signal features such as RSSI, ToF, and PDE and reinforcement learning [4] **DK:** Nordic nRF52840 DK
- **RetroIoT:** Proposed and developed a wired communication channel using battery voltage ports of an IoT sensor to encode new sensor data and retrofit new applications [3] **DK:** STM32L0 LoraWan Kit, Raspberry Pi **Language:** Embedded C, Python **Board designed:** Polaris PCB
- **IoTell:** Developed a device-free point and control system for human-IoT interaction using UWB and IMU sensors to overcome the limitations of voice assistant-based control [10] **Hardware:** Qorvo DWM1001, Adafruit BNO055, Sparkfun Pro nRF52840

Applied Machine Learning for Intelligent Sensing at Edge
- **SolarWalk:** 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 using a KNN model [2][7]
  Hardware used: Nordic nRF52840 DK, Raspberry Pi **ML Lib:** Scikit-Learn **Language:** Embedded C, Python
- Developing an adaptive model quantization technique to perform on-device inference in compute and memory-limited edge devices to identify auto vehicles using audio and seismic sensor time-series data. **ML Lib:** Pytorch

Scalable and Secure Augmented/Mixed Reality Interfaces
- Understanding, investigating, and addressing the cognitive security vulnerability of the users of augmented reality interfaces. **Device:** Meta Quest Pro, Muse 2 Brain Sensing headband **Platform:** Unity
- **SpotBLE:** Developed a multimodal machine learning model using CNN and signal processing pipeline to accurately localize sensors on AR devices by combining BLE signal features and sensor image data. The system achieves 75% improvement over state-of-the-art [6] **DK:** Nordic nRF52833 DK

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 Frameworks:** TensorFlow, TensorFlow Lite, Scikit-learn, PyTorch
- **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), WiFi, LoRa, UWB
- **Prototyping and Equipment:** Board bring-up, Board debug and validation, Oscilloscope, Source/Load Measure Units, Power Profiler, Spectrum Analyzer, Logic Analyzer

Academic Services

- Reviewer and TPC of ACM EWSN'24, journal reviewer of ACM UbiComp'24, TIOT'24, TAAS'24
- PC Member of ACM SIGCSE TS'24, reviewer of SIGCSE TS'23
- TPC Member and Reviewer of ACM S3'22 Workshop

Selected Awards and Scholarships

UIUC Grainger Postdoctoral Fellow	2023
CPS Rising Star	2023
UVA Link Lab Student Seminar Award	2022
ACM SIGBED SRC Winner, Second Runner-up	2022
ACM MobiCom'22 Travel Grant Scholarship	2022
Finalist of NCWIT Collegiate Award	2022
Grace Hopper Student Scholar, GHC	2019, 2021
CRA-WP Grad Cohort for Women Workshop	2020
N2Women Young Researcher Fellowship, SenSys'19	2019
Best paper award, ICCIT'16	2016