VAISHNAVI NATTAR RANGANATHAN
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RESEARCH EXPERTISE AND INTERESTS

1. Sensing for healthcare and environment
2. Wireless power transfer and energy harvesting
3. Low-power backscatter wireless communication
4. Ultralow-power sensing and signal analysis
5. Sensor networks and data fusion
6. Energy-optimized computation platforms for wearable and implantable devices

EDUCATION

Graduate Degrees:

1. PhD. In Electrical Engineering
   University of Washington (UW), Seattle, WA
   Sept 2013 –Dec 2018.
   Thesis topic: Wireless Biomedical Sensing
2. MS. in Electrical Engineering and Computer Science
   Case Western Reserve University (CWRU), Cleveland, OH
   August 2011 – June 2013.
   Thesis topic: Silicon Carbide NEMS Logic and Memory for Computation at Extreme: Device Design and Analysis

Undergraduate Degree:

1. B.Tech distinction in Electronics and Instrumentation Engineering
   Amrita Vishwavidyapeetham University, Coimbatore, India
   June 2007 – July 2011.

PROFESSIONAL EXPERIENCE

1. Senior Researcher: Mobility and Networking at Microsoft Research, Redmond, WA. **Current**
2. Research Consult: Low power wireless physiological sensing. Microsoft Research, Medical Devices Group. Sept2017 – May 2018.
3. Research Intern: Low power physiological sensing, Microsoft Research, Medical Devices Group. June 2016 – Sept 2016.
4. Research Intern: Study of sensors and control systems in the Cellular phone manufacturing unit of *PERLOS (BPO of NOKIA)*. Dec-2009.
5. Research Intern: Study of the power production process and process monitoring sensors at *Neyveli Thermal Power station* (Expansion 1). June 2009.

HONORS AND AWARDS

1. Madrona prize runner up for “greatest commercial potential” graduate work, 2018.
2. Received the **Washington Research Foundation** (WRF-UWIN) **Graduate Innovation Fellowship in Neuroengineering** 2017.
3. Presented research at the iREDEFINE workshop for PhD candidates at ECEDHA 2017.
4. Among top three global finalists of the **‘Bioelectronics Innovation challenge’ by Galvani Bioelectronics**. Designed a Wireless Implantable Peripheral Nerve Recorder/Stimulator. 2017

5. Selected with a travel award to present my research at the **MIT Rising Stars** in EECS. 2015
6. Awarded by the Indian Graduate Student Association at CWRU for outstanding contributions in student management, as the New Students' Committee Chair (2012).
7. Awarded by Young Students' Support Program at the Design Automation Conference (2011).
8. Awarded for standing 2nd in the department of Electronics and Instrumentation Engineering at Amrita University (2011).

RESEARCH EXPERIENCE

Project Eclipse: Urban Innovation Initiative, Microsoft Research

Hyperlocal and low-cost air quality sensing for cities. Support environment sensing and public health scenarios. Poor air quality is a silent killer that is linked to several ailments like asthma, COPD and, more recently, increased vulnerability to COVID-19. Project Eclipse aims to gain a better understanding of urban air quality and its implications at a granular level in cities around the world.

Brain-Computer-Spinal-Interface (BCSI): A Fully Wireless Neural Interface

Restoration of motor function in patients with paralysis caused by spinal cord injury. I am developing a closed-loop BCSI implant with neural recording, wireless power delivery, low-power communication and power-aware computation capabilities. I designed a fully wireless printed circuit device for recording neural potentials/stimulation. As a part of this project I also developed and adapted the low-power backscatter communication protocol for implementation of an RFIC in 65nm CMOS technology. I also developed a closed-loop neural platform (**NeuralCLIP**) with low-power signal acquisition and computation on device for LFP-induced nerve stimulation.

Project PIs: Dr. Joshua R. Smith (EE, UW) and Dr. Chet Moritz (Physiology and Biophysics, UW)

RF Bandaid: Fully-Analog Passive Wireless Interface for Wearable Sensors

Developed a small, passive, wireless wearable sensor interface for continuous physiological signal monitoring. The device is designed to operate with a maximum power consumption between 40 uW to 160 uW. It harvests energy from transmitted continuous wave UHF signals and sends recorded data to a base station using RF backscatter communication. It is a modular plug and play platform that has so far been demonstrated to measure heart rate, breathing rate, temperature, audio/sounds. (**Patented**)

Project PIs: Dr. Sidhant Gupta and Dr. Jonathan Lester (Medical Devices Group, Microsoft Research - Seattle)

Biocompatible Packaging: Design of a Liquid Crystal Polymer Package for Neural Implants

I visited the *University College London* in October 2016 to work with ***Professor Nick Donaldson***, a prominent biomedical-packaging expert, to study and develop a miniaturized Liquid Crystal Polymer package to house the neural signal recording and stimulation device that we are developing.

Localization of Receivers in a Phased-Array Wireless Power Transfer (WPT) System

I present a novel idea for localizing receivers in a HF WPT system, inspired by how animals in nature use sound wave reflections to localize objects. Analyzing the signals reflected, by a resonant receiver, back to a phased-array of two or more transmitters can be used to autonomously localize the receiver. The concept helps move the overhead for localization

from the receiver to the transmitter side. This is particularly useful in miniaturized devices with size, computation and power resource restrictions.
Project PI: Dr. Joshua R. Smith (EE, UW)

Heart Rate and Pulse Oximetry Sensing

Developing small, battery-free optical sensor platform for detecting heat rate and blood oxygen saturation. The two versions I have developed are based on NFC and RFID technology to harvest wireless power and communicate to an external base station (cellphone for NFC) to perform periodic monitoring of the physiological parameters. The goal for these is to develop open source platforms that can be used for research involving heart rate and pulse oximetry measurements and other kinds of battery-free sensing.
Project PI: Dr. Joshua R. Smith (EE, UW)

Nano Electromechanical Switches for Extreme Condition Operation

Design and fabrication of low-power SiC NEMS switches for high temperature (>600°C) logic.
Project PIs: Dr. Swarup Bhunia and Dr. Philip Feng (EECS, CWRU)

Miniaturized Ultrasonic Device for Detection and Monitoring of Cancer Recurrence

Design and testing of the electronics for an implantable ultrasonic assembly for early detection and monitoring of cancer and subsequent treatment planning.
Project PI: Dr. Swarup Bhunia (EECS, CWRU)

Bio-MEMS based Instrumentation for Glucose and Urea Sensing

As an undergraduate research candidate, I implemented optical sensing circuits and micro-electromechanical systems for projects including enzyme-based glucose and urea sensors.
Project PI: Dr. Rohit Srivastava (NanoBios lab, Indian Institute of Technology, Bombay)

TECHNICAL SKILLS

1. **Design software:** Solid Works, OpenSCAD, AutoCAD, COMSOL, L-Edit, HFSS (RF antenna design)
2. **PCB design:** Altium, Eagle, Encounter
3. **Programming skills:** FPGA, microcontrollers, Verilog, C/C++, Python
4. **Software defined radio:** BladeRF, USRP
5. **Graphical Programming:** LabVIEW, Gnu Radio
6. **Mathematical software:** Matlab, Mathematica
7. **Circuit simulation:** LTSPICE, Cadence
8. **Instrumentation:** Wire bonding, SEM imaging, Semiconductor characterization, Clean-100 fabrication

LIST OF PUBLICATIONS

1. **Vaishnavi Ranganathan**, Jared Nakahara, Soshi Samejima, Nicholas Tolley, Abed Khorsani, Chet T. Moritz, Joshua R. Smith, “Neural Closed-Loop Implantable Platform: A Modular FPGA-Based Neural Interface for Closed-Loop Operation”, International IEEE EMBS conference on Neural Engineering. March 2019.
2. **Vaishnavi Ranganathan**, Sidhant Gupta, Jonathan Lester, Joshua R. Smith, Desney Tan, “RF Bandaid: A Fully-Analog and Passive Wireless Interface for Wearable Sensors”, *Proceedings*

of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (*ACM IMWUT).* Feb. 2018. **(Distinguished paper award, 2019)**

3. **Vaishnavi Ranganathan**, Brody Mahoney, Eric Pepin, Michael Sunshine, Chet Moritz, Jacques C. Rudell and Joshua R. Smith, "A high-voltage compliant neural stimulator with HF wireless power and UHF backscatter communication", *Wireless Power Transfer Conference (WPTC), 2016 IEEE*.
4. Vamsi Talla, **Vaishnavi Ranganathan**, Brody Mahoney and Joshua R. Smith, "Dual-Band Wireless Power and Bi-Directional Data Link for Implanted Devices in 65nm CMOS", *ISCAS 2016*.
5. **Vaishnavi Ranganathan**, Benjamin H. Waters, Joshua R. Smith, "Localization of Receivers using Phased-Array Wireless Power Transfer Systems", *IEEE Wireless Power Transfer Conference (WPTC), May 13-15, 2015*.
6. Benjamin H. Waters, Brody J. Mahoney, **Vaishnavi Ranganathan** and Joshua R. Smith, "Power Delivery and Leakage Field Control Using an Adaptive Phased-Array Wireless Power System", *IEEE Transactions on Power Electronics, Special Issue on WPT, February 2015***.**
7. **Vaishnavi Ranganathan**, Srihari Rajgopal, Mehran Mehregany and Swarup Bhunia, "Analysis of Practical Scaling Limits in Nanoelectromechanical Switches", *NEMS, 2014.*
8. Bhunia, Swarup, **Vaishnavi Ranganathan**, Tina He, et al., "Toward ultralow-power computing at extreme with silicon carbide (SiC) nanoelectromechanical logic." In *Proceedings of the conference on Design, Automation & Test in Europe*, p. 233. European Design and Automation Association, 2014.
9. Tina He, Rui Yang, **Vaishnavi Ranganathan**, Srihari Rajgopal, Mary Anne Tupta, Swarup Bhunia, Mehran Mehregany, Philip X.-L. Feng, "Silicon Carbide (SiC) Nanoelectromechanical Switches and Logic Gates with Long Cycles and Robust Performance in Ambient Air and at High Temperature", *IEDM'2013*, Paper No. 4.6, 108-111, Washington DC, December 9-11 (2013).
10. Tina He, **Vaishnavi Ranganathan**, Rui Yang, Srihari Rajgoal, Swarup Bhunia, Mehran Mehregany, and Philip X.-L. Feng, "Time Domain AC Characterization of Silicon Carbide (SiC) Nanoelectromechanical Switches Towards High Speed Operation," *Transducers-2013*.
11. Tina He, **Vaishnavi Ranganathan**, Rui Yang, Srihari Rajgopal, Swarup Bhunia, Mehran Mehregany, and Philip X.-L. Feng, "Time-Domain AC Measurement of SiC Nanoelectromechanical Switches toward High Speed Operations", *Solid-State Sensors, Actuators and Microsystems, 2013 Transducers & Eurosensors: The 17th International Conference, 2013.*
12. Tina He, **Vaishnavi Ranganathan**, et al., "Silicon Carbide (SiC) Nanoelectromechanical Switches and Logic Gates with Long Cycles and Robust Performance in Ambient Air and at High Temperature", *Micro Electro Mechanical Systems (MEMS), 2013 IEEE 26th International Conference, 2013.*
13. **Vaishnavi Ranganathan**, Tina He, Srihari Rajgopal, Mehran Mehregany, Philip X-L Feng and Swarup Bhunia, "Nanomechanical Non-Volatile Memory for Computing at Extreme", *Nanoscale Architectures (NANOARCH), 2013 IEEE/ACM International Symposium, 2013.*

14. Abhishek Basak, **Vaishnavi Ranganathan**, and Swarup Bhunia, "A Wearable Ultrasonic Assembly for Point-Of-Care Autonomous Diagnostics of Malignant Growth," *IEEE EMBS-Point-of-care Healthcare Technologies Conference (PoCHT),* 2013.
15. Abhishek Basak, **Vaishnavi Ranganathan**, Seetharam Narasimhan, and Swarup Bhunia, "Implantable Ultrasonic Dual Functional Assembly Detection and Treatment of Anomalous Growth," *34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, 2012.