ALI NAJAFI

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SUMMARY

I build low power wireless networks, devices and sensing systems for Internet of Things and Medical applications. I am also experienced in analog/mixed-signal/RF IC design. My skillset in embedded system prototyping and integration, signal processing, sensing and integrated circuit design and deep understanding of applied physics enables me to tackle challenging new applications. Currently, I am a Ph.D. candidate working with Shyam Gollakota in the Networks and Mobile Systems Lab. I am looking for full-time opportunities for Fall 2020/Winter 2021 time-frame.

EDUCATION

University of Washington, Seattle, WA — *Sep. 2014 to Oct. 2020*
PhD Candidate in Electrical and Computer Engineering
Advisor: Shyam Gollakota
Research: Building wireless networks and sensing systems for IoT and medical applications

Sharif University of Technology, Tehran, Iran — *Sep. 2011 to Sep. 2013*
Master of Science in Electrical Engineering
Advisor: Mehrdad Sharif-Bakhtiar
GPA: 17.78/20 (2^{nd} among Microelectronic Engineering Students)
Research: Designing low power RFID tags for wireless remote sensing applications

Sharif University of Technology, Tehran, Iran — *Sep. 2007 to Sep. 2011*
Bachelor of Science in Electrical Engineering
Advisor: Sina Khorasani
GPA: 17.17/20 (3^{rd} among Electronic Engineering Students)
Research: Analyzing symmetry in gyro-magnetic photonic crystals

WORKING EXPERIENCE

Jeeva Wireless Inc., Seattle, WA — *April. 2018 to Oct. 2018*
Engineering Intern (Part-time and Full-time)
Project: Flexible small form-factor camera tag
Manager: Vamsi Talla

Apple Inc., Cupertino, CA — *Aug. 2017 to Nov. 2017*
Hardware Engineering Intern
Project: Non-linearity compensation in ADC-based SerDes
Manager: Mansour Keramat

Qualcomm Inc., Irvine, CA — *Sep. 2016 to Dec. 2016*
Interim Engineering Intern
Project: Low power crystal oscillator design for IoT Applications
Manager: Rabih Makarem

SKILLS

Embedded Hardware	Microcontrollers (TI, Nordic, PIC), FPGAs (Lattice, Microsemi, Altera), low-power sensors, image sensors, PCB design, EM Simulations, Software-Defined Radios
IC design	Cadence Virtuoso, Calibre, Assura, HSpice, Agilent ADS, IC Compiler
Software	Python, C/C++, Android, JAVA, Verilog, Verilog-A, MATLAB, Machine Learning

PUBLICATIONS

- **A. Najafi***, J. Chan*, S. Gollakota, "Measuring Middle Ear Function Using a Smartphone-based Tympanometer" In preparation (*Co-primary student authors).
- **A. Najafi***, V. Iyer*, J. James, S. Fuller and S. Gollakota, "Low-Power Insect-Scale Wireless Steerable Vision" Submitted to *Science Robotics* (*Co-primary student authors).
- **A. Najafi***, M. Hessar*, V. Iyer and S. Gollakota, "TinySDR: Low-Power SDR Platform for Over-the-Air Programmable IoT Testbeds," *USENIX Symposium on Networked Systems Design and Implementation (NSDI)*, Feb. 2020 (*Co-primary student authors).
- **A. Najafi***, M. Hessar* and S. Gollakota, "NetScatter: Enabling Large-Scale Backscatter Networks," *USENIX Symposium on Networked Systems Design and Implementation (NSDI)*, Feb. 2019 (*Co-primary student authors).
- V. Talla, M. Hessar, B. Kellogg, **A. Najafi**, J. R. Smith, and S. Gollakota. "LoRa Backscatter: Enabling The Vision of Ubiquitous Connectivity," *ACM Interact. Mob. Wearable Ubiquitous Technol. (Ubicomp)*, Sept. 2017
- T. Zhang, C. Su, **A. Najafi** and J. C. Rudell, "A Wideband Dual-Injection Path Self-Interference Cancellation Architecture for Full-Duplex Transceivers," in *IEEE Journal of Solid-State Circuits*, June 2018.
- T. Zhang, **A. Najafi**, C. Su and J. C. Rudell, "18.1 A 1.7-to-2.2GHz full-duplex transceiver system with > 50dB self-interference cancellation over 42MHz bandwidth," *IEEE International Solid-State Circuits Conference (ISSCC)* Feb. 2017
- T. Zhang, **A. Najafi**, M. Taghivand and J. C. Rudell, "A Precision Wideband Quadrature Generation Technique with Feedback Control for Millimeter-Wave Communication Systems," in *IEEE Transactions on Microwave Theory and Techniques*, Jan. 2018.
- **A. Najafi**, J. C. Rudell, and V. Sathe. "Regenerative Breaking: Recovering Stored Energy from Inactive Voltage Domains for Energy-efficient Systems-on-Chip," *ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED)*, Aug. 2016.
- **A. Najafi**, S. Khorasani, and F. Gholami, "Analyzing Symmetry in Photonic Band Structure of Gyro-magnetic Photonic Crystals," *SPIE*, Aug. 2011.

PATENTS

- V. Talla, M. Hessar, B. Kellogg, **A. Najafi**, J. R. Smith, S. Gollakota, "Backscatter Systems, Devices and Techniques Utilizing CSS Modulation and/or Higher Order Harmonic Cancellation" Patent filed with University of Washington and licensed by Jeeva Wireless Inc.
- **A. Najafi**, S. Golara, R. Makarem, S. Moloudi, "Low power crystal oscillator" Patent filed with Qualcomm Inc.

PROJECTS

- **Smartphone-based Tympanometer (Currently On-going).** The primary tool for detecting numerous ear conditions is a machine called tympanometer. However, such machines cost thousands of dollars and are typically bulky and inflexible for use in resource-limited settings. We developed a smartphone-based prototype which costs less than $20. Our prototype uses a microphone, speaker, pressure sensor and pressure pump to change the pressure in the ear canal which are air-sealed together with a piping structure. The microphone and speaker are connected to a smartphone which transmits acoustic signal and measures acoustic immittance in the ear canal.

Our prototype functionality matches the capabilities of a clinic-grade tympanometer. We are currently validating the clinical efficacy of this tool in several clinical settings, and are planning to run a deployment in audiology clinics in resource-constrained environments.

- **Building a Smart Speaker for Medical Research (Currently On-going).** We built a custom smart-speaker for real-time respiratory pattern and cough monitoring with the goal of early detection of infectious diseases like Flu or COVID-19. It transmits an ultrasound (>20 KHz) signal, processes the received microphone array signal reflected from the human body on the Raspberry Pi to extract the real-time respiratory patterns and sends them to the cloud. We deployed 50 of these devices in different homes across Seattle as part of the Seattle Flu study and collecting data over the past few months. For the ground truth of if a person is infected or not, we use the swab test results collected by Seattle Flu study.
- **Low-Power Insect-Scale Wireless Steerable Vision.** Existing power-autonomous insect-scale robots do not have the ability to capture vision data given their power, weight and size requirements. We designed a fully wireless mechanically steerable vision system in a form factor compatible with small robots and live insects. Our system can mechanically steer a camera over a $60°$ angular range using a millimeter scale actuator that is wirelessly controlled from a smartphone. The electronics and actuator weigh 248 mg and can stream 'first person' 160×120 monochrome video at 1–5 frames per second (fps) to a Bluetooth radio from distances of up to 120 m away. Using this system, we built the smallest robot ($1.6 \times 2\ cm$) that can move at speeds of up to 3.5 cm/s, supports a wireless steerable camera and operates for 63–260 mins.
- **TinySDR: Low-Power SDR Platform.** We built a low-power, cheap and small form-factor Software-Defined Radio (SDR) platform suitable for IoT applications. TinySDR supports over the air update for physical layer on FPGA and MAC layer on microcontroller and achieves 30uW of sleep power, 10000 times lower than other SDR platforms. It supports 4 MHz of bandwidth on sub-GHz and 2.4GHz frequencies and provides sensor interfaces. To showcase the functionality of this platform, we implemented chirp spread spectrum (CSS) modulator/demodulator and also Bluetooth beacons and achieved these standard's sensitivities.
- **NetScatter: Large-Scale Backscatter Networks.** We developed the first wireless protocol that scales to hundreds of concurrent transmissions from backscatter devices using a distributed coding mechanism based on chirp spread spectrum that works below noise floor. We implemented the baseband of backscattering devices using IGLOO Nano FPGA and MSP430 microcontroller. The access point algorithm was implemented using X-300 USRP and MATLAB.
- **LoRa Backscatter: Long-Range Ubiquitous Connectivity.** We developed the first ultra-low-power wide-area backscattering tag. To achieve this, we implemented Chirp Spread Spectrum (CSS) modulation on the tag. The baseband section of the tag is implemented on an IGLOO Nano FPGA and generates switching signal for the RF switch which is connected to the antenna. We showed that with our system and having Semtech LoRa SX1276 as receiver, we can achieve several hundred meters of wireless communication range.
- **Full-duplex radios and self-interference cancellation system.** We designed and fabricated a transceiver front-end integrated circuit including a dual-injection path self-interference cancellation architecture for full-duplex wireless communication using 40nm TSMC CMOS technology achieving state of the art cancellation depth and bandwidth and presented the measurement results.
- **Precision Wideband Quadrature Generation Technique for Millimeter-Wave Communication Systems.** We built an integrated two-stage polyphase filter (PPF) with feedback control for quadrature local oscillator generation at millimeter-wave frequencies that minimizes the in-phase and quadrature-phase mismatch. We fabricated an integrated circuit using 28nm CMOS process and showed that we can minimize the in-phase and quadrature-phase mismatch

using this PPF design.

- **Regenerative Breaking: Recovering Stored Energy from Inactive Voltage Domains.** We presented an approach to leverage existing voltage regulators to recover the otherwise wasted energy of the significant output capacitance of the disabled voltage-domain back into the supply using a low-overhead all-digital run-time control system. We have implemented this technique on 65nm CMOS using synthesis, auto-place and route design-flow and show that we can recover over 90% of the stored energy across a range of operating system voltages.

- **Microprocessor IC design.** We designed a semi-custom 16-bit microprocessor with 2-stage pipeline using our own designed logic standard cells in 65nm CMOS technology and ran post-layout simulations to confirm the functionalities.

- **Passive sensing tag design.** We designed a low-power passive backscattering tag integrated with a temperature sensor for wireless remote sensing applications using 180nm CMOS process and ran post-layout simulations to confirm the functionalities.

HONORS

- Distinguished paper award for *ACM Interact. Mob. Wearable Ubiquitous Technol. (Ubicomp)* 2017.

- Honorary admission to graduate program in microelectronics at Sharif University of Technology.

SELECTED PRESS

- Economist. A clever way to transmit data on the cheap

- MIT Tech Review. A New Mobile Chip Beams Data for Miles Using Almost No Power

- IEEE Spectrum. Low-Power Devices Use Backscatter to Transmit Data Several Kilometers

TEACHING EXPERIENCES

- **University of Washington.** Teaching Assistant for “Computer Communication and Networks”, “Introduction to Computer Communication Networks”, “Linear IC Design”, “Analog Circuit Design”, "Switched-cap circuit design”

- **Sharif University of Technology.** Teaching Assistant for “Pulse Technique and Digital Circuits”, “Principles of Electrical Engineering”, “Principles of Electronic”, “Energy Conversion 1”