Mehrdad Hessar

I work on low-power wireless networks and embedded devices for Internet of Things applications. I have experience in low-power backscatter communication, signal processing, machine learning and hardware integration. Currently, I am a Ph.D. candidate working with Shyam Gollakota in the Networks and Mobile Systems Lab. As part of my Ph.D., I designed TinySDR which is the first ultra-low-power SDR platform with over-the-air update capabilities for IoT testbeds. I earned my M.Sc. in Electrical Engineering from ECE Department at University of Washington. Before coming to UW, I received my B.Sc in Computer Engineering from Amirkabir University of Technology.

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Education

University of Washington (Seattle, WA) *2017-Winter 2021*
PhD student at Paul G. Allen School of Computer Science and Engineering
Supervisor: Prof. Gollakota
Research: Communication system design towards the vision of low-power IoT networks.

University of Washington (Seattle, WA) *2015-2017*
M.Sc. in Electrical Engineering (GPA: 3.84/4.0)
Supervisor: Prof. Gollakota
Research: On-body communication, low-power embedded system design.

Amirkabir University of Technology (Tehran) *2011-2015*
B.Sc. in Computer Engineering (GPA: 3.86/4)

Research and Professional Experience

Networks and Mobile Systems Lab, Seattle, WA **Research Assistant**
Low-power communication system for IoT devices, ubiquitous computing and connectivity. *2015-Present*

OctoML, Seattle, WA **Research Intern**
Deep learning optimization on low-power hardware platforms using TVM comiler stack. *March 2020-Present*

Sound Life Sciences, Seattle, WA **System Engineer Consultant**
Designing smart-speakers with ultrasound capabilities for medical research. *Jan-March, 2020*

Microsoft Research Lab, Redmond, WA **Research Intern**
A scalable long-range IoT network in VHF narrowband wireless technology. June-September, 2018

Selected Publications

- **M. Hessar**, A. Najafi, V. Iyer, S. Gollakota, "TinySDR: Low-Power SDR Platform for Over-the-Air Programmable IoT Testbeds", NSDI 2020.
- C. Gao, **M. Hessar**, K. Chintalapudi, B. Priyantha, "Blind Distributed MU-MIMO for IoT Networking over VHF Narrowband Spectrum", MobiCom 2019.
- A. Saffari, **M. Hessar**, S. Naderiparizi, J. R. Smith, "Battery-Free Wireless Video Streaming Camera System", *13th Annual International Conference on RFID*, 2019.
- **M. Hessar**, A. Najafi, S. Gollakota, "NetScatter: Enabling Large-Scale Backscatter Networks", NSDI 2019.
- S. Naderiparizi, **M. Hessar**, V. Talla, S. Gollakota, J. R. Smith , "Low-Power HD Video Streaming", NSDI 2018.
- **M. Hessar**, V. Talla, B. Kellogg, A. Najafi, J. R. Smith and S. Gollakota, "LoRa Backscatter: Enabling The Vision of Ubiquitous Connectivity", Ubicomp 2017 (**Distinguished Paper Award**).

- **M. Hessar**, V. Iyer, and S. Gollakota, "Enabling On-Body Transmissions with Commodity Devices", Ubicomp 2016.

Posters and Demos

- **M. Hessar**, A. Najafi, V. Iyer, S. Gollakota, "Demo: TinySDR, A Software-Defined Radio Platform for Internet of Things", MobiCom 2019.
- **M. Hessar**, S. Naderiparizi, Y. Wang, A. Saffari, S. Gollakota, J. R. Smith, "Poster: Wireless Video Streaming for Ultra-low-power Cameras", MobiSys 2018.
- "Poster: Long-Range Backscatter Communication", *MSR Summer Institute, Unpacking the Future of IoT*, August 2017.
- **M. Hessar**, V. Iyer, S. Gollakota, "Poster: Enabling On-Body Transmissions with Commodity Devices", MobiCom 2016.

Patents

- S. Gollakota, S. Naderiparizi, **M. Hessar**, V. Talla, J. R. Smith, "Image and/or video transmission using backscatter devices".
- V. Talla, **M. Hessar**, J. R. Smith, S. Gollakota, A. Najafi, B. Kellogg, "Backscatter systems, devices, and techniques utilizing css modulation and/or higher order harmonic cancellation".

Teaching Experience

- TA, "**CSE461: Introduction to Computer Communication Networks**", UW, 2018.
- TA, "**Microprocessors**", Amirkabir University of Technology, 2014.
- TA, "**Computer Architecture**", Amirkabir University of Technology, 2014.
- TA, "**Advanced Programming**", Amirkabir University of Technology, 2013.

Professional Services

- **Program Committee** ACM S3 Workshop, in conjunction with MobiCom 2019.
- **External Reviewer** of MobiCom, 2019.
- **Reviewer** of IEEE Transactions on Wireless Communications.
- **Program Committee** International Conference on Sensor Technologies and Applications, SENSORCOMM, 2018.
- **Program Committee** International Conference on Ambient Computing, Applications, Services and Technologies, AMBIENT, 2017-2018.

Selected Courses

- Advanced Computer Programming
- Data Structures and Algorithms
- Algorithm Design
- Electronic Circuits
- Digital Electronics
- Computer Systems Architecture
- VLSI Systems Design
- Introduction to Deep Learning
- Statistical Learning
- Computer Vision
- Wireless Networks
- Computer Networks
- Operating System Design
- Modern Wireless Communication
- Digital Signal Processing

Selected Projects

Hardware and Signal Processing

- **TinySDR: Low-Power SDR Platfrom for IoT**
  We design a low-power SDR platfrom tailored to the needs of IoT networks. TinySDR supports 4 MHz of bandwidth, 2.4 GHz and Sub-GHz RF frequencies and multiple sensor interfaces. TinySDR is a great platform for IoT applications since it has ultra-low-power sleep mode ($30\mu W$), runs on battery and we can reprogram the physical layer on FPGA and MAC layer on microcontrollerr over the air.
- **Custom Smart-Speaker for Medical Research**
  We designed a custom smart-speaker to detect breathing pattern. We built this from off-the-shelf components including Matrix Voice, Raspberry Pi and power amplifier with the capabilities of emitting ultrasound ($>$ 20 kHz) frequencies and recording a the same time in real time. We deployed more than 70 smart-speakers in different households as a part of Seattle Flu study.
- **NetScatter: Large-Scale Backscatter Networks**
  We designed the first wireless backscatter protocol which scales to hundreds of backscatter transmissions using a distributed chirp spread spectrum coding. We deployed a network of 256 backscatter devices and showed that we can improve physical data rate, link layer throughput and latency using NetScatter.
- **Battery-Free HD Video Streaming**
  We design a low-power video streaming system using a hybrid backscatter technique and pulse-width modulation. We show that we can extend the battery lifetime of wearable cameras such as Snap Spectacles by transferring the power-hungry components from the sensor to the access point.
- **LoRa Backscatter: Enabling Ubiquitous Connectivity**
  We design the first low-power long-range backscatter communication. To achieve this, we implement Chirp Spread Spectrum (CSS) coding compatible to LoRa protocol on backscatter tag. We show that LoRa Backscatter can achieve reliable communication in different applications such as a 3 floors house, an office floor across 41 rooms and one acre farm.
- **Acoustic Communication on Android Operating System** *Spring 2016*
  I designed a half duplex communication system with sonar on Android smartphones. I implemented an Android application that is using On-Off keying modulation to transmit/receive data between two smartphones in real time.
- **Satellite Downlink Modulator/Demodulator** *Winter 2016*
  I implemented simulator of the NASA/NOAA transmitter modulator which is able to accept an JPEG image and encode it to APT data format. Also, I implemented the demodulator which accepts a file containing an arbitrary number of lines of APT data and is able to recover the content of the images. This demodulator is evaluated with recorded data from NOAA-18 satellite.

Software and Machine Learning

- **Image Redundancy in Deep Neural Networks** *Fall 2019*
  We explored the redundancy of images in deep neural network model such as ResNet. We used ResNet-110 to train different models using normal images and sub-sampling methods on CIFAR-10 dataset. We show that we can increase the robustness of a ResNet network against Gaussian noise by 24.5% on normal images and 19% on images with 90% drop rate.
- **Data Analytics Acceleration: Performance Implications of Cloud FPGAs** *Spring 2018*
  We investigated the benefits of static FPGA accelerators for database management systems. We specifically focused on accelerators developed by Xilinx for PostgreSQL databases. We implemented accelerators on AWS and analyzed their performance.
- **Image Inpainting Using Convolutional Neural Network** *Spring 2017*
  We used unsupervised visual feature learning to predict missing parts from image. We use context encoder model which is based on CNN to predict missing parts of an image. The architecture includes an encoder to capture the context into a compact feature representation, which uses that representation to produce the missing image content. I evaluate this network on MNIST dataset.
- **Neural Networks Regularization** *Winter 2017*
  We used regularization techniques to reduce overfitting issue in Neural Networks. Specifically, we implemented Knowledge Distillation, Penalizing Output Confidence and Label Smoothing techniques on MNIST and German traffic sign benchmarks datasets.

Awards and Honors

- IMWUT Distinguished Paper Award, 2018.
- USENIX Student Grant, NSDI 2018.
- Awarded honorary **Computer Science and Engineering Research Fellowship** from Microsoft at Paul G. Allen School of Computer Science and Engineering, 2017.
- Awarded honorary **Madrona prize** on "The Next Big Leap in Backscatter Communication" from **Madrona Venture Group**, 2016.
- Awarded honorary **direct admission to graduate school** of computer engineering at **Sharif University of Technology** as a reward of high academic records and achievements, 2015.
- **Ranked as Top 0.5%** among more than 300,000 Participants in National Entrance Exam for Undergraduate State Universities, 2011.

Selected Press

- **TechCrunch:** Technique to beam HD video with 99 percent less power ...
- **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
- **Wall Street Journal:** Can Passwords Be Sent Through the Human Body?
- **IEEE Spectrum:** Sending passwords through your body could be more secure ...
- **Atlantic:** How to Send a Password Through Your Body

Professional Skills

- Low-power system design, backsactter communication and RF PCB design.
- Experienced in IoT wireless communication protocols such as LoRa.
- **Hardware Platforms:** Xilinx FPGAs, Altera DE series, Igloo Nano FPGA, MSP430 series, Arduino, Atmega, NI DAQs, Bluetooth LE, USRP and RTL2830.
- **Hardware Design:** Verilog, VHDL, System Verilog, Modelsim, Cadence ICFB, PCB Layout(Altium), Orcade Capture CIS.
- **Programming:** C/C++, Java, Android, Python, Matlab, Databases.
- **Modeling:** Machine learning, Deep learning (TensorFlow).