Parker Ruth

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Education

University of Washington, Seattle, WA   GPA 3.96   Expected graduation: June 2021
B.S. in Computer Engineering, B.S. in Bioengineering
Interdisciplinary Honors Program, Lavin Entrepreneurship Honors Program
Advisor: Dr. Shwetak N. Patel

Research Experience

My research includes prototyping **mobile health systems** to measure medical vital signs and risk factors, building wearable sensors to perform continuous **physiological sensing**, and designing computing tools to support **population health** and assay automation. I am fortunate to work closely with colleagues in computer science, electrical engineering, and bioengineering, in addition to several outstanding clinical collaborators from University of Washington Medicine.

Below are the research projects I have been directly involved in with author-level contributions.

Mobile Health Systems

Smartphone-Based Ischemic Stroke Screening   3/2020 – Present
  • Design algorithms for detecting facial pulse delay indicative of internal carotid stenosis
  • Mentor students on building smartphone-based remote photoplethysmography system
  • Collaborate with clinical and engineering colleagues from UW Medicine and Bioengineering

Mobile Ultrasonic Sonar Exercise Sensing   (Project Lead)   6/2019 – Present
  • Design smartphone activity sensing system using frequency modulated ultrasound sonar
  • Collaborate with UW Sports Institute to perform patient validation study
  • Mentor two high school students on signal processing and machine learning
  • Shadowed at UW Sports Medicine clinic to identify clinician and patient needs
  • Preparing to submit manuscript as lead author [2]

Cough Detection on Mobile Devices   3/2020 – 6/2020
  • Adapted cough detection model to run in real-time on smartphones and smartwatches
  • Implemented efficient audio processing algorithms for mobile devices

Ubiquitous Non-Invasive Osteoporosis Screening   (Project Lead)   6/2018 – 4/2019
  • Designed and built hardware for measuring tibial natural frequency
  • Wrote Android application for real-time natural frequency sensing
  • Designed and coordinated patient study at regional retirement communities
  • Presented work at UW Undergraduate Research Symposium, May 2019 [T-3]

Real-time Smartphone Pulse Transit Time Measurement   (Project Lead)   2/2018 – 5/2018
  • Wrote open-source Android application for real-time pulse wave velocity measurement
  • Demoed application at annual CEO tech summit hosted at Allen School
  • Presented talk, demo, and poster at annual Allen School Industry Affiliates Research Day [T-4]

Smartphone Screening for Sleep Apnea 10/2017 – 1/2018
- Explored use of smartphones for wakeful sleep apnea screening
- Collected data at Harborview Sleep Clinic to test technology
- Implemented cardiac signal processing algorithms in MATLAB
- Presented work at UW Undergraduate Research Symposium, May 2018 [T-5]

Wearable Physiological Sensing

Wearable Ultrasonic Sensing for Embolic Stroke Screening   (Project Lead) 5/2020 – Present
- Design wearable ultrasonic blood flow sensor to detect microemboli predictive of stroke
- Build prototype circuitry and ultrasound phantom for controlled device testing
- Collaborate with clinicians and scientists in UW Medicine Neurological Surgery

Earbud Physiological Sensing 4/2020 – Present
- Prototype signal processing algorithms for in-ear physiological sensing
- Advise and support study design, data collection, data analysis, and paper writing

Wearable Sensing for Postural Orthostatic Tachycardia Syndrome 1/2020 – Present
- Advise on embedded systems design and fabrication for wearable pulse sensing system
- Support study design for continuous ambulatory sensing
- Study hemodynamic mechanisms for rare syndrome of cardiovascular dysregulation

Multi-Channel Facial Photoplethysmography   (Project Lead) 1/2019 – 3/2020
- Built face-worn system for measuring PPG at multiple locations and optical wavelengths
- Collaborated with UW Medicine anesthesiologist for patient validation study
- Supervised and mentored two undergraduate research assistants
- Presented at UW Undergraduate Research Symposium [T-2] and EMBC 2020 conference [T-1]
- Submitted manuscript to EMBC 2020 as lead author [3]

Population Health and Assay Automation

Near Point-of-Care Assay for HIV Drug Sensitivity 7/2020 – Present
- Apply image processing to reduce human error in colorimetric assay interpretation
- Collaborate with researchers from UW Bioengineering and Seattle Children's Hospital

SARS-CoV-2 Screening in Public Transportation Air Filtration 4/2020 – Present
- Participate in design of environmental sampling and viral detection protocols
- Support spatiotemporal analysis of detection results with public transportation datasets

Streamlining SARS-CoV-2 Molecular Assays 4/2020 – Present
- Build image processing software for smartphone-enabled fluorescence measurements
- Implement server backend for remote data collection on patient samples
- Perform data analysis on patient data from clinics in the US and Zimbabwe
- Contributed text, data, and figures for manuscript submission [1]

Image Processing for HIV Drug Resistance Lateral Flow Assays 5/2017 – 9/2018
- Built image processing software for OLA-Simple colorimetric HIV drug resistance tests
- Collaborated with researchers and clinicians to analyze patient data
- Integrated code with lab automation code for deployment in Kenya clinic
- Provided text, figures, and data analysis for research papers [4], [5]
- Presented as invited speaker for UW ACM Student Tech Talk [T-6]

Synthetic Biology Protocol Automation 12/2016 – 3/2018
- Wrote Ruby programs to automate synthetic biology lab protocols
- Contributed to consortium for the study of *Hydra* neural self-organization

Publications and Talks

In Submission

[1] Nuttada Panpradist, Qin Wang, **Parker S. Ruth**, Jack H. Kotnik, Abraham Miller, Samuel W A. Stewart, Justin Vrana, Ingrid A. Beck, Lisa M. Frenkel, and Barry R. Lutz. Simpler and faster COVID-19 testing: strategies to streamline SARS-CoV-2 molecular assays. Submitted to *EBioMedicine* on July 6, 2020

In Preparation

[2] **Parker S. Ruth**, Richard Li, Libby Lavitt, Jacob Peplinski, Abhinav Bandari, Anshita Saini, Cindy Lin, Sara Mosiman, Sam Browd, and Shwetak N. Patel. SEUSS: Sensing Exercises Using Smartphone Sonar. In preparation for submission

Peer Reviewed Publications

[3] **Parker S. Ruth**, Jerry Cao, Millicent Li, Jacob E. Sunshine, Edward J. Wang, and Shwetak N. Patel. Multi-Channel Facial Photoplethysmography Sensing. In *42nd Annual International Conference of the IEEE Engineering in Medicine Biology Society (EMBC)*, pages 4179–4182, July 2020

[4] Nuttada Panpradist, Ingrid A. Beck, **Parker S. Ruth**, Santiago Ávila-Ríos, Claudia García-Morales, Maribel Soto-Nava, Daniela Tapia-Trejo, Margarita Matías-Florentino, Hector E. Paz-Juarez, Silvia del Arenal-Sanchez, Gustavo Reyes-Terán, Barry R. Lutz, and Lisa M. Frenkel. Near point-of-care, point-mutation test to detect drug resistance in HIV-1: A validation study in a Mexican cohort. *AIDS*, 34(9):1331–1338, July 2020

[5] Nuttada Panpradist, Ingrid A. Beck, Justin Vrana, Nikki Higa, David McIntyre, **Parker S. Ruth**, Isaac So, Enos C. Kline, Ross Milne, Ruth Kanthula, Annie Wong-On-Wing, Jonathan Lim, Daisy Ko, Theresa Rossouw, Ute D. Feucht, Michael Chung, Gonzague Jourdain, Nicole Ngo-Giang-Huong, Laddawan Laomanit, Jaime Soria, James Lai, Eric E. Klavins, Lisa M. Frenkel, and Barry R. Lutz. OLA-Simple: a software-guided HIV-1 drug resistance test for low-resource laboratories. *EBioMedicine*, 50:34–44, December 2019

Pre-Prints

[6] **Parker S. Ruth** and Herbert M. Sauro. A commentary on the linearity and time-invariance of ODE-based systems. *arXiv*, December 2019

Conference Posters

[7] Nuttada Panpradist, Ingrid A. Beck, **Parker S. Ruth**, Santiago Avila-Rios, Claudia García-Morales, Maribel Soto-Nava, Daniela Tapia-Trejo, Margarita Matias-Florentino, Hector E. Paz-Juarez, Silvia del Arenal-Sanchez, Gustavo Reyes-Teran, Barry R. Lutz, and Lisa M. Frenkel. Development and evaluation of a low-cost drug resistance test "OLA-Simple" for non-nucleoside-based ART for Mexico's HIV population. In *International AIDS Society Conference on HIV Science*, July 2019

[8] Nuttada Panpradist, Ingrid A. Beck, Justin Vrana, Nikki Higa, David McIntyre, **Parker S. Ruth**, Isaac So, Enos Kline, Ross Milne, Ruth Kanthula, Annie Wong-On-Wing, Jonathan Lim, Daisy Ko, Theresa Rossouw, Ute Feucht, Michael Chung, Gonzague Jourdain, Nicole Ngo-Giang-Huong, Laddawan Laomanit, Jaime Soria, James Lai, Eric Klavins, Lisa M. Frenkel, and Barry R. Lutz. OLA Simple: a software-guided assay that novices can perform to genotype HIV DNA and RNA subtypes A, B, C, D and E for detection of drug resistance. In *International Workshop on HIV Drug Resistance and Treatment Strategies*, October 2018

Talks

[T-1] **Multi-Channel Facial Photoplethysmography Sensing** July 2020
    42nd Annual International Conferences of the IEEE Engineering in Medicine and Biology Society (EMBC)

[T-2] **Multi-Channel Facial Photoplethysmography Sensing** May 2020
    Undergraduate Research Symposium, Seattle, WA

[T-3] **OsteoApp: Towards Ubiquitous Osteoporosis Screening** May 2019
    Undergraduate Research Symposium, Seattle, WA

[T-4] **Seismo: Blood Pressure Monitoring using Built-in Smartphone Sensors** November 2018
    Allen School Industry Affiliates Research Day, Seattle, WA

[T-5] **A Ubiquitous Screening Technology for Sleep Apnea** May 2018
    Undergraduate Research Symposium, Seattle, WA

[T-6] **Image Processing for HIV Drug Resistance Testing** April 2018
    UW ACM Student Tech Talk, Seattle, WA

[T-7] **Quantum Spot Academy: Accessible Introductory Modern Physics Videos** April 2016
    Pacific Northwest Association for College Physics, Portland, OR

Awards and Honors

National Awards and Honors

CRA Outstanding Undergraduate Researcher Award Nominee (results pending)	2020
Barry Goldwater Scholarship	2020
CRA Outstanding Undergraduate Researcher Award Finalist	2020
Davidson Fellows Scholarship Honorable Mention	2016
National Merit Scholarship	2016

University of Washington Awards and Honors

Annual Dean's List	2020
Husky 100 Award	2020
Mary Gates Research Scholarship	2020
Levinson Emerging Scholars Award	2019
Microsoft Endowment Scholarship	2019
Annual Dean's List	2019
Patricia G. Lynch and Theodora & Eugene Russell Memorial Scholarship	2019
Tau Beta Pi Engineering Honors Society	2018
Washington Research Foundation Fellowship	2018
Annual Dean's List	2018
Mary Gates Research Scholarship	2018
Mary Gates Leadership Scholarship	2018
Mary Gates Achievement Scholarship	2017
Annual Dean's List	2017

Leadership

Bioengineering Department Curriculum Committee 9/2018 – Present
- Selected to represent undergraduate cohort on department curriculum committee
- Discuss improvements to department curriculum and student programs
- Collect student feedback and propose solutions to improve the academic experience
- Represented BioE and CSE programs during ABET accreditation site visit

BioExplore Founder/Lead 6/2017 – 8/2018
- Fostered community of students excited about research in bioengineering-related fields
- Organized presentations, panels, and lab tours for students in biosciences

Bioengineering Journal Club Founder/Lead 12/2016 – 5/2017
- Organized biweekly bioengineering journal club meetings
- Coordinated guest presentations and paper discussions

Teaching Experience

Instruction

Co-instructor, CSE 590U Ubiquitous Computing Graduate Seminar 9/2019 – 6/2020
- Led weekly discussion section with guest presenters and paper critique
- Topics included interaction techniques, wearables, novel sensing, and pervasive computing

Co-instructor, BIOEN 217 MATLAB Fundamentals For Bioengineers 9/2019 – 12/2019
- Co-instructed seminar introducing programming in MATLAB with biomedically relevant examples
- Prepared and delivered lectures, graded coding assignments, and supported course development

Curriculum Development

Biosignal Processing Textbook 8/2018 – 9/2020
- Wrote 140-page course textbook for Signals and Sensors for Bioengineers course
- Covers signal acquisition, Fourier analysis, digital and analog filters, and linear systems
- More information available at parkersruth.github.io/biosignal-processing

Python for Chemists Worksheets 11/2019 – 2/2020
- Made worksheets to accompany assignments for Honors Chemistry course
- Wrote Jupyter notebooks introducing scientific computing with NumPy, SciPy, and Pandas
- Topics include curve fitting, reaction kinetics, and wavefunction visualization

Service

- Mentor, Lavin Entrepreneurship Program 6/2020 – Present
- Tutor, Bioengineering Study Center 4/2019 – 6/2019
- Research Lab Tour Leader, Transfer Student Research Seminar 12/2018
- Mentor, ACM New Student Welcome 9/2017, 9/2018

Volunteer Experience

Davidson Institute Pacific Northwest Regional Events 6/2013 – 3/2020
  - Assisted in organizing and running local community events of academically minded families
  - Engaged children ages 5-12 in creative tactile and intellectual activities

Physics Education Service Project 6/2013 – 9/2016
  - Wrote, filmed, edited, animated, and published educational videos about modern physics
  - Developed educational website www.quantumSPOTacademy.org
  - Presented project at educational conferences and local outreach channels [T-7]

Outreach Volunteering
  - Computer Science Student Advisory Council Research Panelist 5/2020
  - Poster presenter, Allen School Annual Industry Affiliates Research Day 11/2018, 11/2019
  - Presenter, Allen School CS4Teachers outreach event 7/2019
  - Entrepreneurship Panelist, Allen School Admitted Students Preview Day 4/2019
  - Volunteer, UW Engineering Discovery Days 4/2018
  - Volunteer, Pacific Northwest Brain Bee 2/2017, 1/2018

Industry Experience

Associate, Alsop Louie Partners 6/2020 – Present
  - Prospect technologies and business ideas for potential venture capital investments
  - Advise on emerging trends and opportunities in disruptive technologies

Projects

Electromyograph   (BIOEN 327 Project)   Partners: Nate Linden, Frances Ingram-Bate 9/2018 – 12/2018
  - Built analog filtering and amplification circuit to capture EMG signal
  - Implemented Arduino signal capture and Python real-time display

Pulse Oximeter   (BIOEN 317 Project)   Partners: Parker Grosjean, Yihan Wang 4/2018 – 5/2018
  - Built pulse oximeter using transmitted IR light to measure blood volume in finger
  - Built analog filtering and amplification circuit with output to oscilloscope

Heart Monitor   (CSE 474 Project)   Partner: Tarkan Al-Kazily 1/2018 – 3/2018
  - Built mobile electrocardiogram heart monitor with LCD touchscreen
  - Wrote real-time filtering and signal processing code in C++
  - Used I2C, SPI, and Bluetooth Low Energy interfaces to communicate with peripherals

Amorphous Computing   (Independent Project) 7/2015 – 9/2016
  - Researched prior amorphous computing literature
  - Created novel programing language for expressing amorphous algorithms
  - Programmed source-to-source compiler from amorphous language to Python
  - Built integrated development environment for amorphous computer programming
  - Implemented interactive graphical simulation of thousands of amorphous cell interactions
  - Wrote, animated, filmed, and produced educational video (youtu.be/N-jZSdn5gtY)
  - Designed amorphous algorithms to produce emergent behavior

Related Coursework

Embedded Systems, Digital Logic Design, Signal Processing, Data Structures and Parallelism, Operating Systems, Distributed Systems, Hardware-Software Interface, Honors Java Programming, Neuroengineering

Skills

Ordered by familiarity

Coding Languages: Python, MATLAB, C, C++, System Verilog, HTML, CSS, JavaScript, Java, Ruby

Tools and Systems: NumPy, SciPy, Pandas, LaTeX, TikZ/PGF

Fabrication Skills: Arduino, MSP430, circuit prototyping, soldering, PCB layout, 3D printing

Design Skills: Graphic design, 2D motion graphics animation, videography