Ken Christofferson

Toronto ON | +1 647 906 0455 | +1 206 557 8816 | kenc@cs.toronto.edu

Education

University of Toronto Computer Science — *Ph.D. 2025**
Advised by Professors Alex Mariakakis and Joseph Cafazzo

Tsinghua University Data Science and Information Technology
Advised by Professors Yuntao Wang and Yuanchun Shi — *MSE-DSIT 2021*

University of Washington Technology Innovation — *M.S. 2021*

American University International Studies, Economics (Minor) — *B.A. 2007*

Publications and Projects

A Benchmark Cuffless Blood Pressure Estimation Dataset *(Working Title)*
In Progress: Submission Planned (May 23) - ACM Interactive, Mobile, Wearable and Ubiquitous Technologies
Large datasets comprising synchronous human physiological signals (e.g., electrocardiogram, photoplethysmography) are rare. Those that do exist are typically collected in hospital ICUs and are limited to the sensors and patients available there. This project will collect 14 synchronous cardiac-related physiological signals which have been used in the blood pressure estimation literature from up to 150 healthy participants and up to 75 participants suffering from cardiac illness. Some of these signals are designed to mimic those collected by common consumer devices (e.g., earbuds, smartwatch) to enable research into wearable or ambulatory blood pressure estimation methods.

Beyond Pulse Wave Analysis - Multimodal Blood Pressure Estimation *(Working Title)*
In Progress: Submission Planned (May 23) - ACM Interactive, Mobile, Wearable and Ubiquitous Technologies
Cuffless blood pressure estimation typically relies on expensive equipment that requires expert operation or an analysis of the pulse wave (PWA). However, PWA-based techniques require regular cuffed calibration and very low-noise signals, which can be difficult to acquire in ambulatory settings. This work explores the use of additional cardiac-related signals like phonocardiography and fine-grain demographic and physiological data to improve the robustness and generalizability of cuffless blood pressure estimation.

EarBP: Acoustic Blood Pressure Estimation using Earbuds *(Working Title)*
In Progress: Submission Planned (Nov 23) - ACM Interactive, Mobile, Wearable and Ubiquitous Technologies
This project leverages cardiac cycle-related audio harvested from an ANC earbud's inner microphone to calculate features well known to be correlated with blood pressure (e.g., pulse transit time) and estimate arterial blood pressure.

ReHEarSE: Recognizing Hidden-in-the-Ear Silent Expressions
In Submission - ACM CHI
Moving the mouth and jaw creates small changes in the morphology of the ear canal. This phenomena has been used to enable user identification and command classification (e.g., "Volume up") systems. This project uses ultrasonic sensing techniques to detect changes in ear canal deformation resulting from silent letter articulation and classify these mouthed letters for hands-free silent text input. We found that ReHEarSE recognizes unseen words (i.e., zero-shot learning) with an accuracy of 89.3%.

EarSteth: Phonocardiogram Reconstruction Using Earbuds
In Submission - ACM Digital Health
Using a convolutional neural network and digital signal processing techniques, this project reconstructs phonocardiograms (heart sounds) from audio recorded using a commercial ANC-enabled earbud's feedback microphone. A user study comparing reconstructed and real heart sounds showed that they were perceptually similar. A quantitative analysis showed that the timing of cardiac cycle events (e.g., S1 and S2 sounds) were accurately placed. This project is supervised by Professor Shwetak Patel and Professor Alex Mariakakis.

Quantified Uncertainty in Smartwatch Driven Menstrual Cycle Event Prediction *(Working Title)*
In Progress: Submission Planned (Feb 23) - ACM Interactive, Mobile, Wearable and Ubiquitous Technologies
Many menstrual cycle tracking apps include built-in prediction algorithms that rely on self-reported data to predict future menstrual cycle events. However, users think these algorithms are impersonal and inaccurate because of simplifying assumptions they make. This work collected a dataset comprising heart rate, wrist temperature, hormone levels, continuous glucose, and activity levels for 150 menstrual cycles and designs ovulation and menstruation onset prediction algorithms.

Sleep Sound Event Detection Using ANC-Enabled Earbuds
Published - HCCS Workshop at PERCOM 2022
Under the supervision of Professors Yuntao Wang and Alex Mariakakis, this research developed a lightweight convolutional audio classification algorithm capable of distinguishing between health-related (e.g., teeth grinding, leg movement) sounds made by sleeping humans. Audio data was recorded using both the inner and outer microphones present in ANC-enabled earbuds.

An AI Driven, Mechanistically Grounded Geospatial Liquefaction Model for Rapid Response and Scenario Planning
Published - Soil Dynamics and Earthquake Engineering 2022
This work develops liquefaction risk prediction models using geospatial (e.g., distance to water) and earthquake features (e.g., shear wave velocity). While liquefaction is a phenomenon best predicted by mechanics, subsurface traits lack theoretical links to above-ground parameters, but correlate in complex, interconnected ways.

Induced Acoustic Resonance for Noninvasive Bone Fracture Detection Using Digital Signal Processing and Machine Learning **Primary Author*
Published - IEEE GHTC 2020
This project developed an embedded system capable of noninvasive bone fracture detection. Data was collected from human limb facsimiles created from animal bones and gelatin (simulated flesh). Successfully classified all simulated test limbs (limbs not included in algorithm training) and classified more than 93% of one-second audio segments correctly.

SCIO Rapid Diagnostic Test Reader
Project - GIX Launch Project 2020
This project designed and implemented an end-to-end rapid diagnostic test workflow and computer vision aided interpretation application for Android.

FaceSpace - Face Touching Detection for the Apple Watch
Project - BuiltForCovid19 Hackathon Featured Project
FaceSpace is an Apple Watch application which uses the watch's onboard IMU to detect when users' hands are moving to touch their face.

Work Experience

Computational Health and Interaction Lab, University of Toronto - Toronto, ON ***Sept 2021 -***

Graduate Research Assistant

Centre for Digital Therapeutics, University Hospital Network - Toronto, ON ***Sept 2021 -***
Doctoral Trainee

Smartsheet Inc. - Seattle, WA ***Nov 2015 - Aug 2019***
Lead Technical Solutions Implementation Manager *Dec 2018 - Aug 2019*
Lead Solutions Consultant *Feb 2018 - Dec 2018*
Solutions Consultant *Nov 2015 - Feb 2018*

Corporate Executive Board - Washington, DC ***Mar 2014 - Jun 2015***
Research Analyst

The Language Co. - Puerto Montt, Chile ***June 2013 - Dec 2013***
Regional Manager

Credit Builders Alliance - Washington, DC ***May 2011 - Aug 2012***
Program Associate

Internships
PATH for Global Health - 2021
The United States Senate - 2009
The German Marshall Fund of the United States - 2008