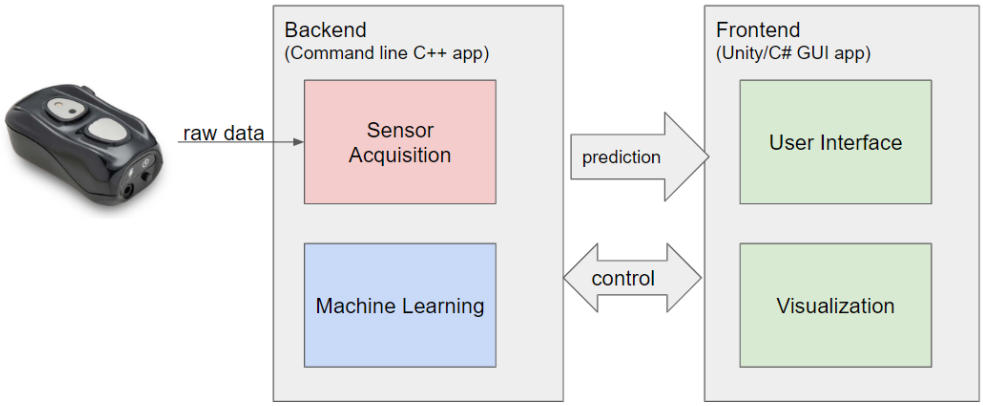
Johnty Wang: Selected Technical Projects Portfolio

The Emotional Imaging Composer

The Emotional Imaging Composer (EIC) is a multimedia performance "instrument" that translates biosignals into responsive environments in real time, allowing a user to express themselves using their emotions. A wireless finger sensor (Thought Technologies TPS) captures physiological signals which is sent through a machine learning algorithm (SVM) that is trained using prior labeled data to then predict emotional probabilities for new input. The predicted emotional state is mapped onto a 2D valence-arousal plane, and then used as input to an interactive multimedia system. The goal of the EIC is to then map these into control parameters in an interactive audio-visual environment to create new and expressive manifestations of the person's internal emotional experience.

The project is based on the work by Benovoy, Cooperstock, and Deitcher, titled "Biosignals analysis and its application in a performance setting"



Initially called in to troubleshoot the Bluetooth sensor, I ended up completing the software integration of the both the frontend and backend applications, including re-implementing the real-time signal processing pipeline from scratch and comparing its behaviour with the Matlab implementation.

Demo video: https://www.youtube.com/watch?v=hrbKF0S7c5Y

Skills: Visual Studio/C++ (Machine learning + Sensor Interface Backend); Unity / C#, Matlab

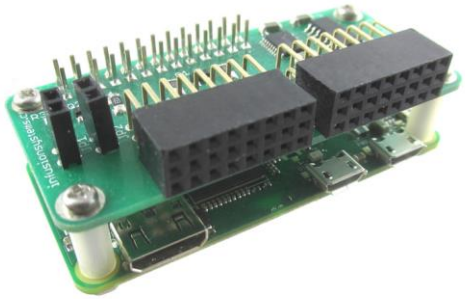
Sensor Interface Design for Interactive Systems

As part of a NSERC/FRQNT Industrial Innovation Scholarship awardee, I worked with Infusion Systems, the maker of the I-CubeX platform of sensors and developed two new products that have since been in active production. After analyzing the existing interfacing solutions from a hardware performance, software interfacing and usability perspectives, I designed, implemented, and tested the PCBs, and produced small quantities before they went into production. Alongside I developed the embedded firmware, interface software and produced examples to demonstrate the capabilities of the devices. For one of the products I also initiated and ran a modest crowdfunding campaign and built the website, produced the promotional materials, managed the community communication and aided in the fulfilment logistics.

The PiShield is an add-on board for the Raspberry Pi series of embedded Linux computers that allows the entire catalog of I-CubeX sensors to be used on the Raspberry Pi platform, providing the ability to implement standalone systems with just a single embedded computer or employ the networking features to retransmit the signals to other devices on a network via various communication protocols.

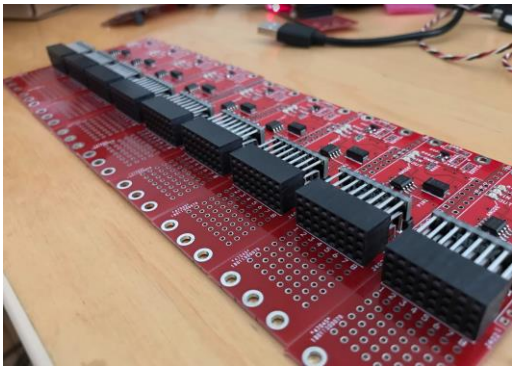
The WiDig was the world's first commercially available general purpose sensor interface that maps data from sensors directly into MIDI via Bluetooth Low Energy, and allows the wide variety of existing I-CubeX sensors to work on a number of desktop and mobile platforms with plug-and-play support on all MIDI-enabled applications. Designed for use by users in the field of interactive digital media, the WiDig is compatible with existing I-CubeX software platform.

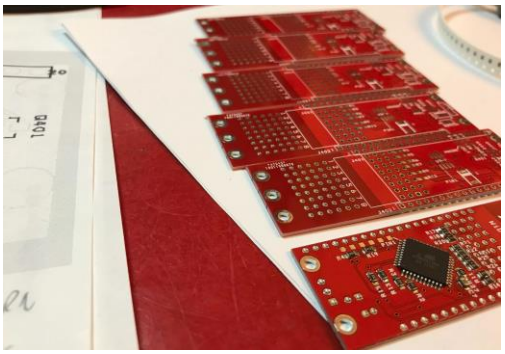
WiDig

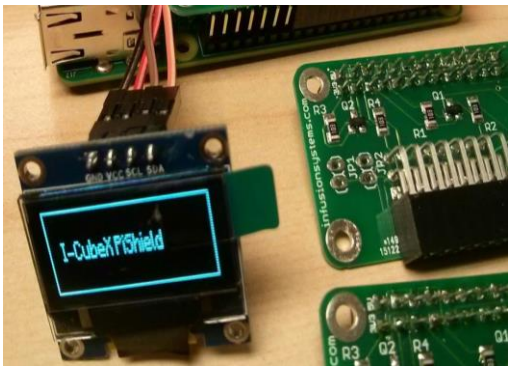


PiShield

Skills: Hardware design and integration, Embedded firmware development, Integration with various software development platforms (C/C++, Java, Python, Max/MSP) running on various desktop and mobile operating systems (Windows, MacOS, Linux, iOS, Android)



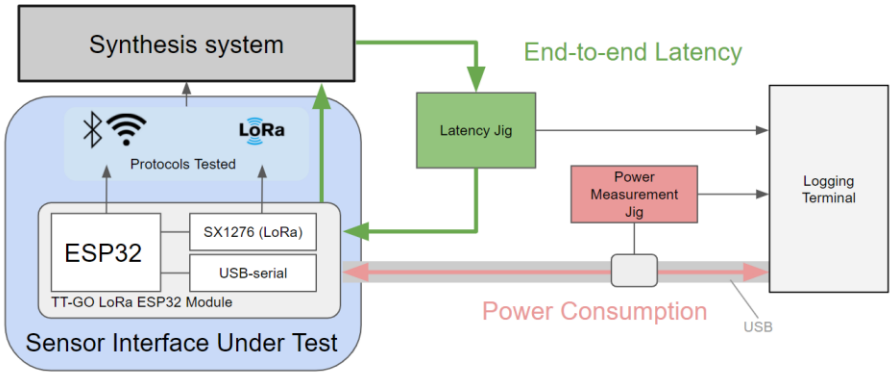


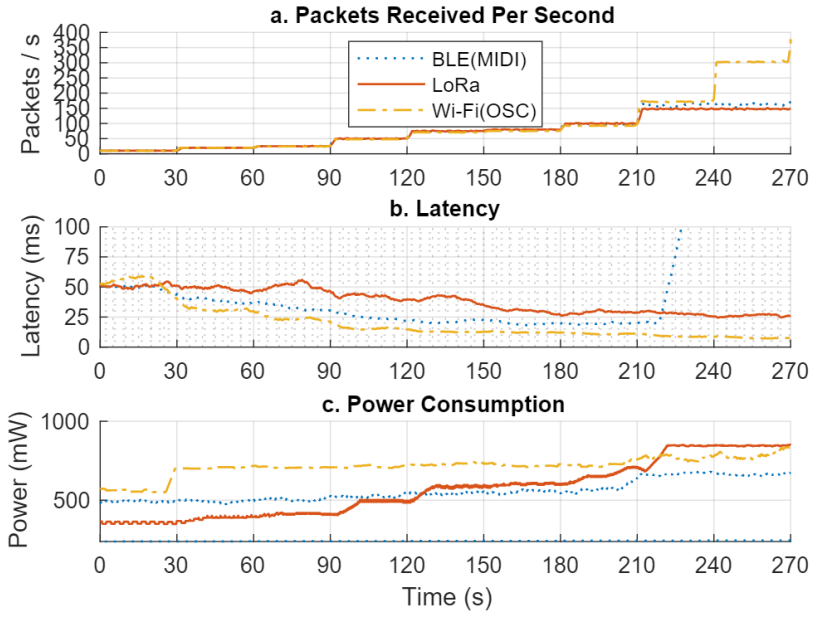

I-CubeX P/Shield

Latency Research for Sensor Interfaces in Digital Musical Instruments

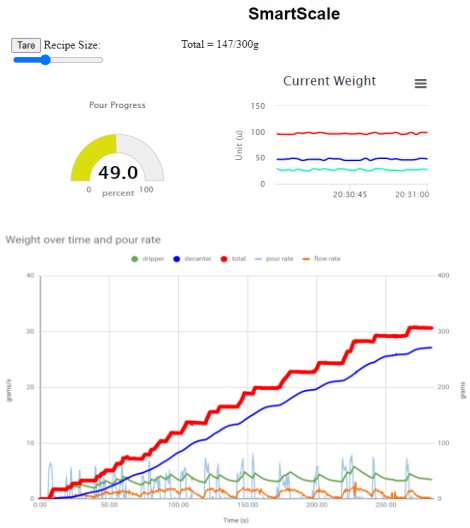
Digital Musical Instruments make use of increasingly accessible sensors and computational technologies to capture real-time signals associated with gestural input data of interest from a performer. While wireless devices offer new possibilities in terms of untethered and portable devices, the latency added by the wireless interface has practical consequences over the responsiveness of the instrument. Through supporting the development of various new sensor interfaces at the Input Devices and Music Interaction Laboratory at McGill and in collaboration with Infusion Systems, the need to formally evaluate wireless performance was addressed through the implementation of a test platform for quantifying the event to sound latency of a sensor interface.

The system has been used in four publications at international conferences, and a recent journal submission (under review) characterizing the latency and power consumption behaviour of three wireless protocols: BLE, LoRa, and Wi-Fi implemented on a single microcontroller platform (ESP32):



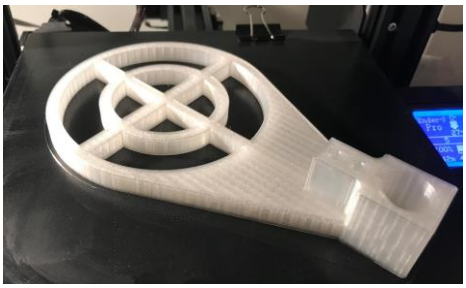


Smart Pourover Coffee Stand

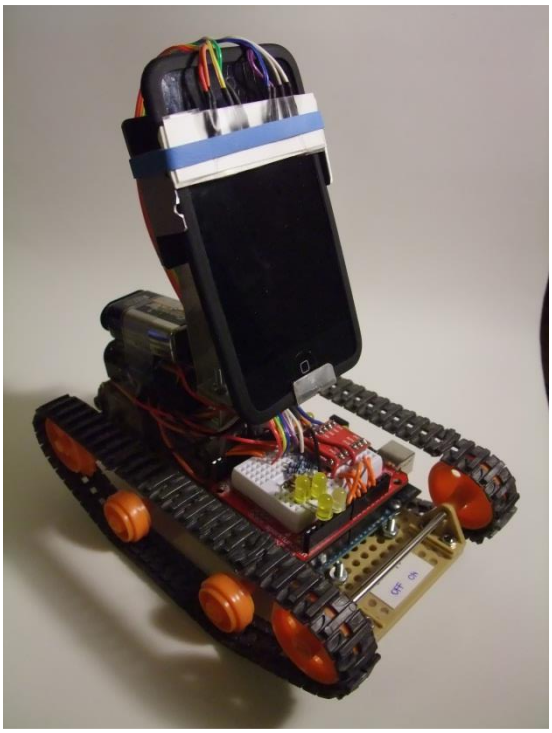


A weekend project involving 3D printing, rapid embedded prototyping and web interface design yielded in a tool to quantify the hand-pouring technique for brewing pourover coffee. A dual HX711 strain gauge interface was used to measure the real time weight changes in both the dripper cone (top) and decanter (bottom), resulting in a record of pouring (input), flow (brew) and output (total) rates over time. After prototyping Bluetooth Low Energy and Wi-Fi implementations, the latter was chosen for its ability to serve a self-contained web interface with a dashboard that can be easily accessed across desktop and mobile platforms through the browser, using html requests for data polling and javascript charting libraries for visualizations. This eliminates the need for desktop/mobile apps to interface with the device.

Skills: Rapid prototyping, embedded C/C++ (Arduino/ESP32), HTML/javascript, Fusion 360 (3D Models)



Tippy the Teleconferencing Robot

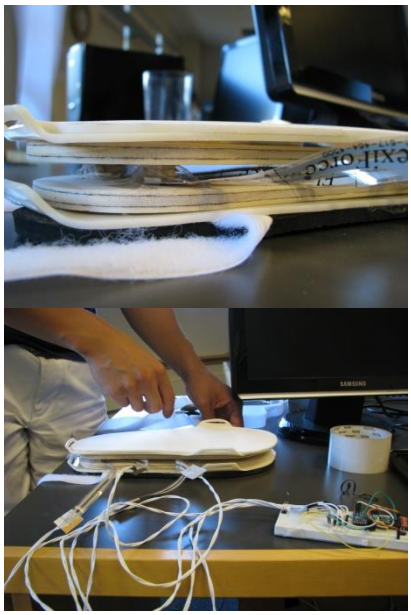


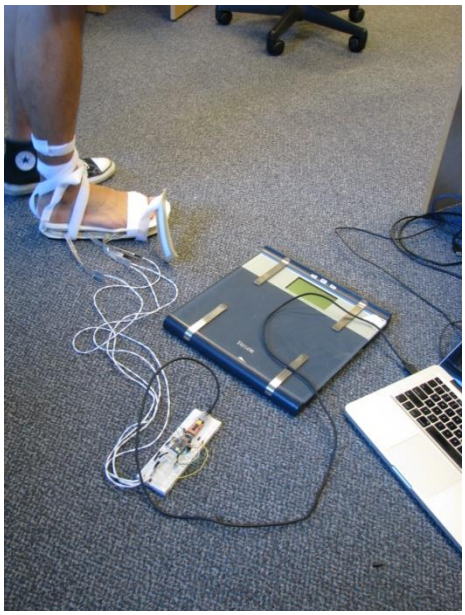
Started off as a fun side project. It resulted in a conference paper at the International Conference in Entertainment Computing and a 2nd place award at the IEEE UBC Project Fair. (w. Vincent Tsao, Benny Chan)

We built an iTouch/iPhone based telepresence robot without implementing any iOS software or custom drivers using optical coupling between the mobile device display and the robot control hardware Visual commands from the remote caller were encoded as bright boxes within a black bar at the top of the outgoing video stream that are picked up by optical sensors placed along the top of the screen, rendered with the incoming video. This allowed the user to use any existing video conferencing software and control application to operate the mobile system.

Demo video: https://www.youtube.com/watch?v=3iETcyzzDT4

Footsy





Volunteering at the BC Children's Hospital in the design of a shoe sensor prototype for patients recovering from leg bone lengthening procedures. Honourable mention at UBC IEEE project fair (w. Andrew Ho)

Children recovering from bone lengthening procedures using an Ilizarov apparatus need to put weight on the leg, but are generally reluctant to do so due to pain involved. We are designed a weight sensing shoe with LED's to indicate when there is sufficient weight placed on the leg and "gamify" the rehabilitation process. An on-board data logger provide clinicians with a history of forces exerted.

ChoirMob/Vuzik/Vox Tactum Ensemble

Creating an ecosystem for new ways of composing, playing and performing music using large screen displays and mobile devices (w. Aura Pon, Nicolas d'Alessandro)

Building upon the masters research of Aura Pon (UCalgary) and systems developed at the UBC MAGIC lab, we have created a framework for graphical composition and rendering of visual music scores, surrounded by new instruments employing various gesture recognition and synthesis techniques to be used in ensemble performance. The system has been used for performances at festivals and conferences in Vancouver BC (UBC school of music, Sonic Boom festival), Atlanta GA (Guthman Instrument Competition finalist), Greece (Audio Mostly 2012) and Slovenia (ICMC 2012) featuring works composed by Aura Pon performed by the Vox Tactum ensemble.

PENny: An Extremely Low-Cost Pressure-Sensitive Stylus for Existing Capacitive Touchscreens.

Exploring hardware extensions to mobile user interfaces. Demo/paper at New Interfaces for Musical Expression (NIME2013). (w. Aura Pon, Nicolas d'Alessandro, Sid Fels)
Description: Using the built in audio input and output on a mobile device and hardware combined with custom sensing software, we added an extremely cheap and simple passive pressure sensitive interface to existing touch-screen devices. To minimize the use of new materials, we salvaged components (such as a used battery and phone headset) and the only new materials used was the copper tape and two resistors. This project demonstrates the novel use of the available computation power and software processing to eliminate the need for more complex hardware components that would have been required to implement the same feature.

Other Software Projects

Multi-Track Viewer

Date: 2004 (8 months)
Purpose: Co-op work term project @ Harman/Becker Wavemakers (now QNX Software Systems)
Description: Designed, implemented and tested a multiple waveform viewing and analysis application used by speech recognition/synthesis researchers
Skills: Visual Studio C++ Programming, MFC Framework, Windows Programming, GUI design

XML-based Asset Game Audio Management System

Date: 2005 (4 months)
Purpose: Co-op work term project @ Electronic Arts Canada
Description: Designed and implemented a prototype asset management system for game audio assets. Implemented examples demonstrating proposed usage of system.
Skills: C++ and C# Programming, XML Schema design and validation

Artisynth Probe Editing Interface/Articulatory Text to Speech Synthesizer

Date: 2007 (8 months)
Purpose: Co-op work term project @ Human Communications Lab, UBC
Description: Designed and implemented a graphical editing interface for modifying control probes in the Artisynth modelling environment; Implemented a text to speech interface that generated articulatory controls to drive an articulatory speech synthesizer.
Skills: Java Programming, Introduction to Speech Synthesis and Bio-mechanical modelling

Super Bacteria Tap-a-song

Date: March 2011
Purpose: Entry for the Great Canadian Appathon (w. Roberto Calderon and Vincent Tsao)
Description: Designed and implemented a music-based tapping game in 48 hours with a team of 3 people. Won category prize for best art and aesthetics.
Skills: Game audio design and programming, Soundtrack creation, Windows Phone 7 programming