Embedded Systems Engineer
Project Portfolio

ALEJANDRO ASTUDILLO

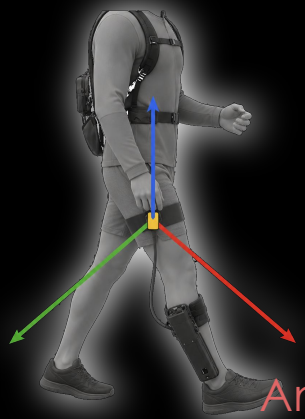
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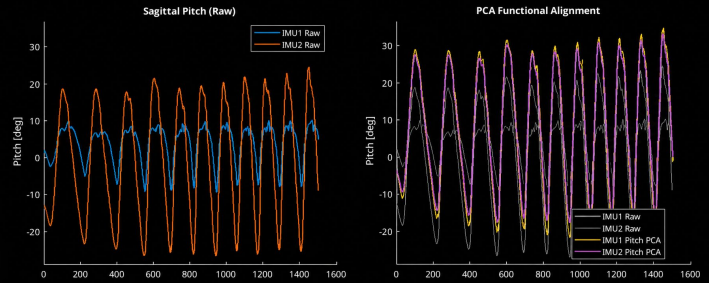
Robotic Exoskeletons @ Harvard

- Experimentally validated and replaced exoskeleton IMUs saving the project **1000s of dollars.**
- Developed and implemented **alignment algorithms** for robust sensing in **real-world** conditions.

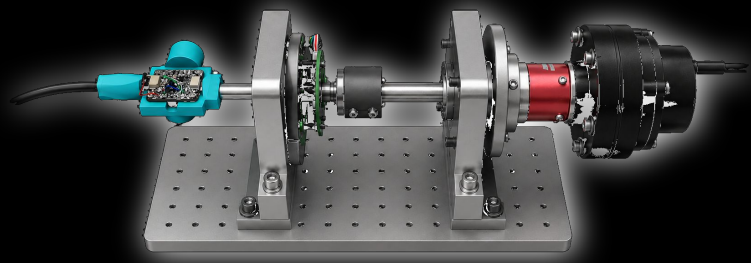


The exoskeleton





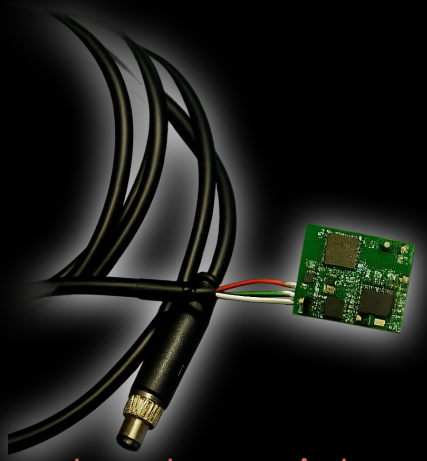
Anatomical axes estimation and alignment



Testbench setup for IMU evaluation

Robotic Exoskeletons @ Harvard

- Integrated **new sensors** into the exoskeleton platform at **hardware + firmware** level.
- Researched novel **sensor fusion** and gait segmentation **algorithms** to remove complexity and physical sensors.



Sensor hardware integration

Biggest challenges:

Real-world sensor data is noisy and difficult to predict, so I had to design sensing algorithms that could cope with that.

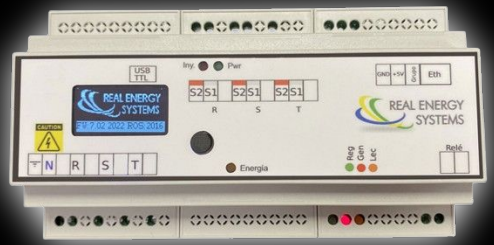
I had to redesign and integrate legacy firmware nobody understood, doing hardware debugging along the way.

Technologies

Embedded C
Matlab and Simulink
Fusion360
Embedded Linux, ROS2
CAN, SPI, UART, I2C
Python

Embedded Systems for Solar Power

- **Led development** of line of communication gateways for **industrial settings** (Modbus). Designed and implemented firmware and drivers. The company is **still selling** these products.
- Developed and maintained **embedded firmware** for advanced **inverter and relay controllers**.
- Designed **custom interpreted programming language** for PLC orchestration.



PRISMA solar inverter controller

Biggest challenge:

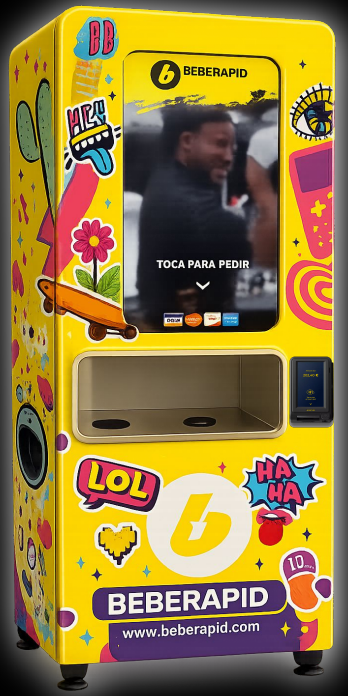
Bare-metal programming for devices with severely limited memory meant I had to use techniques like C++ template and macro metaprogramming to offload as much processing to flash memory at compile time.

Technologies

Modern C++, Make, Cmake
FreeRTOS
ATMega, STM32, ESP32
Modbus, CAN, TCP/IP
Python

Automatic Beer Machine

- Developed **all electronics and software** for a self-serve beer kiosk.
- Integrated **all systems** including: Payment terminal, custom beer tap controller, cup dispenser, LED strips, touchscreen, interface.
- Built the machine in my garage. Sold the prototype to an events company and the V2.0s are **currently being developed** and will be **installed in concert venues** in Spain this year.



Biggest challenge:

Making a working prototype is easy, but getting from there to a viable product is 100x harder. I had to cover dozens of edge cases and build in extensive fault-tolerance.

Technologies

Modern C++ (Controller)
Svelte (Interface)
.NET C# (Payment integration)
RP2040

See a DEMO! https://youtube.com/shorts/2y3snCkt2ao

Wireless Gamified Rehabilitation Device

- My **bachelor's thesis** project.
- Heavily modified a cheap handheld dynamometer to add **bluetooth capabilities.**
- Developed Android app with **games and patient monitoring**.
- The project was **evaluated and validated** by medical and rehabilitation **professionals**.



Handheld rehabilitation device

Biggest challenge:

In order to control a game using real-time bluetooth input, I had to develop my own rudimentary game engine in Kotlin, with sprite painting, frame control, game events…

Technologies

Modern C++
BLE
Kotlin (Android)

RF video streaming for URSA rocket

- Developed **video streaming** system for the URSA rocket for the European Rocketry Challenge.
- Tested with long range and a variety of **RF modules**.
- Developed **custom video encoding** and **transmission pipelines** between Raspberry Pis.



URSA rocket and transmission modules



Biggest challenge:

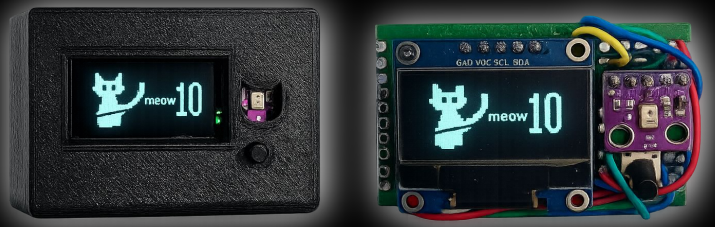
Transmitting real-time video over 3km+ from a rapidly moving target proved to be quite difficult. While streaming worked during ground tests, we lost the feed during the competition due to a power failure.

Technologies

Embedded C
Embedded Linux
ffmpeg

Acoustic Event Detection with Embedded ML

- Bedside digital clock using on-device **convolutional networks** to detect **real cat meows**.
- Integrated **microphone**, **screen**, and **interface** in a small package.
- Trained **TensorFlow Lite** model and applied **TinyML** concepts for **efficient inference**.



The “Meowcrophone” Digital clock

Biggest challenge:

Neural net performance can vary when quantizing and embedding on small microprocessors, so I had to finetune it with specific data acquired with the device microphone.

Technologies

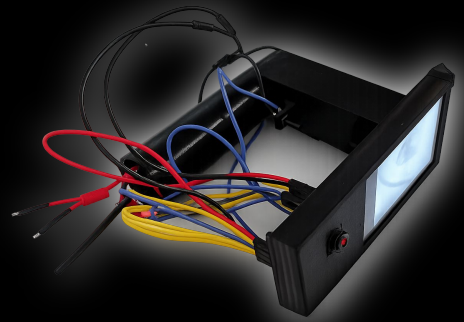
C++
RP2040
CNNs
TensorFlow Lite
I2C

And many more...

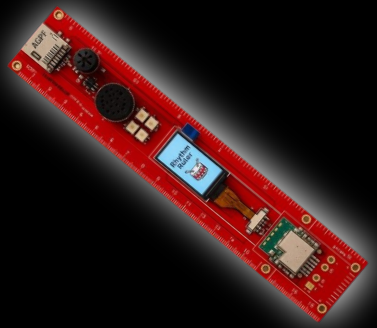
Click titles for links!



Revenge of the Dinos Game



Voodoo Gun (Sci-fi concept prototype)



Rhythm Ruler (Educational Music Game)



RescueCV: Embedded Prototype for Victim Triage



Uli Game



Wavelength (Interactive Mechanical Art Installation)

Who Am I?

- 24 years old.
- **BSc** Computer Science.
- **MSc** Embedded and Distributed Systems.
- Experience in **research** and **industry**.
- Passion for software that interacts with the **real world**.
- Worked successfully with **international** teams (**Japan**, **US**, **Spain**).
- Great **communication** skills.
- **Adaptable, autonomous.**
- My hobbies outside building things are **reading**, **photography**, **singing** and **cats**!



