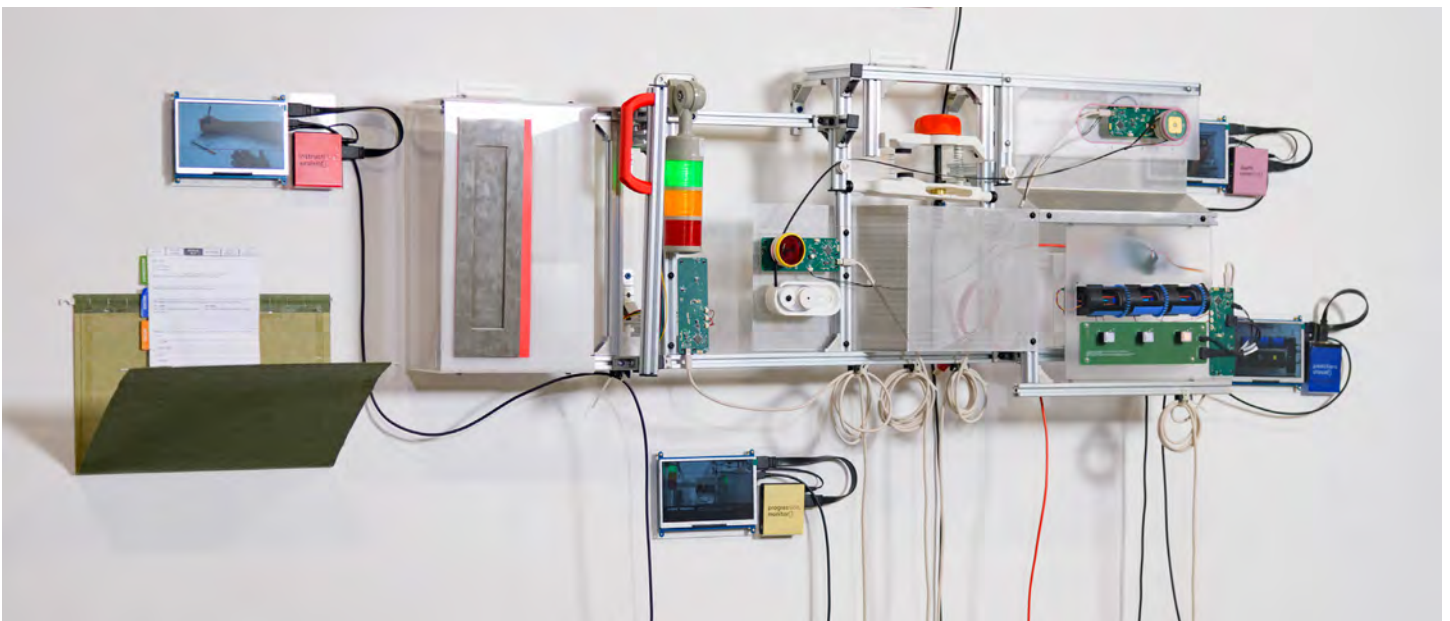


Portfolio of embedded hardware design
Posheng Cheng

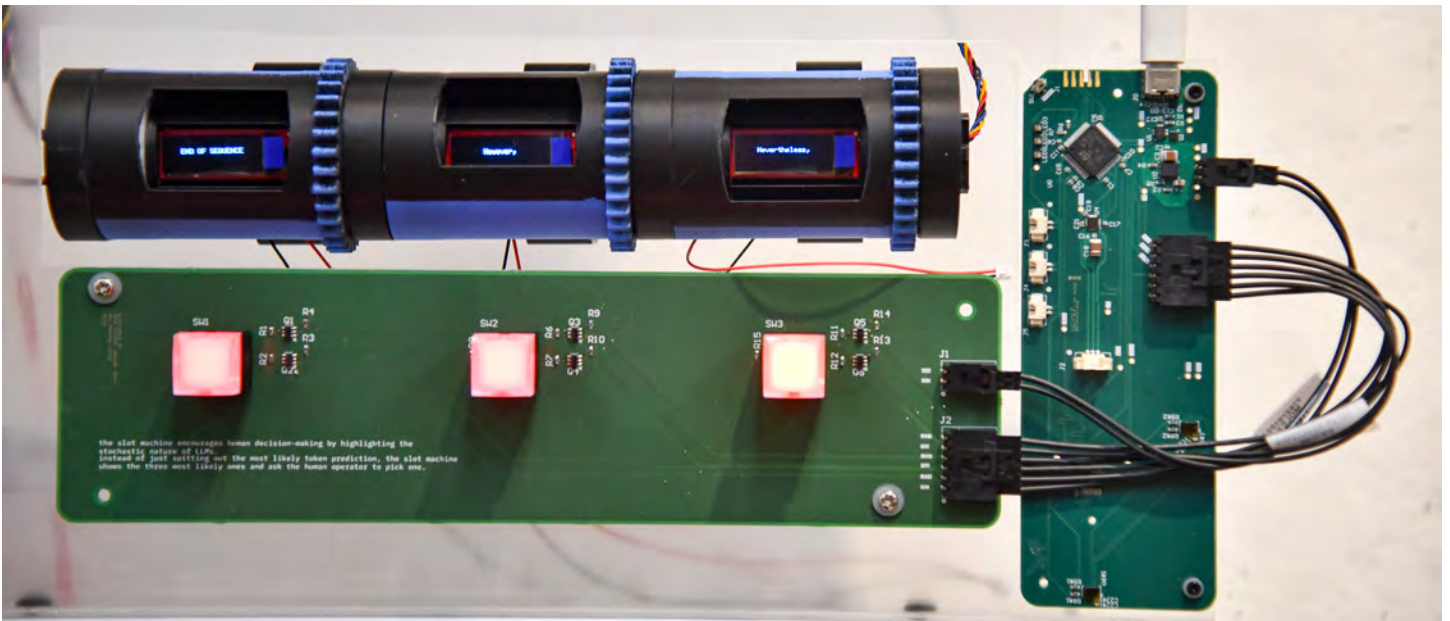
for more work please visit: <https://bencer3283.github.io/art/>

tangible interfaces for frictional ai

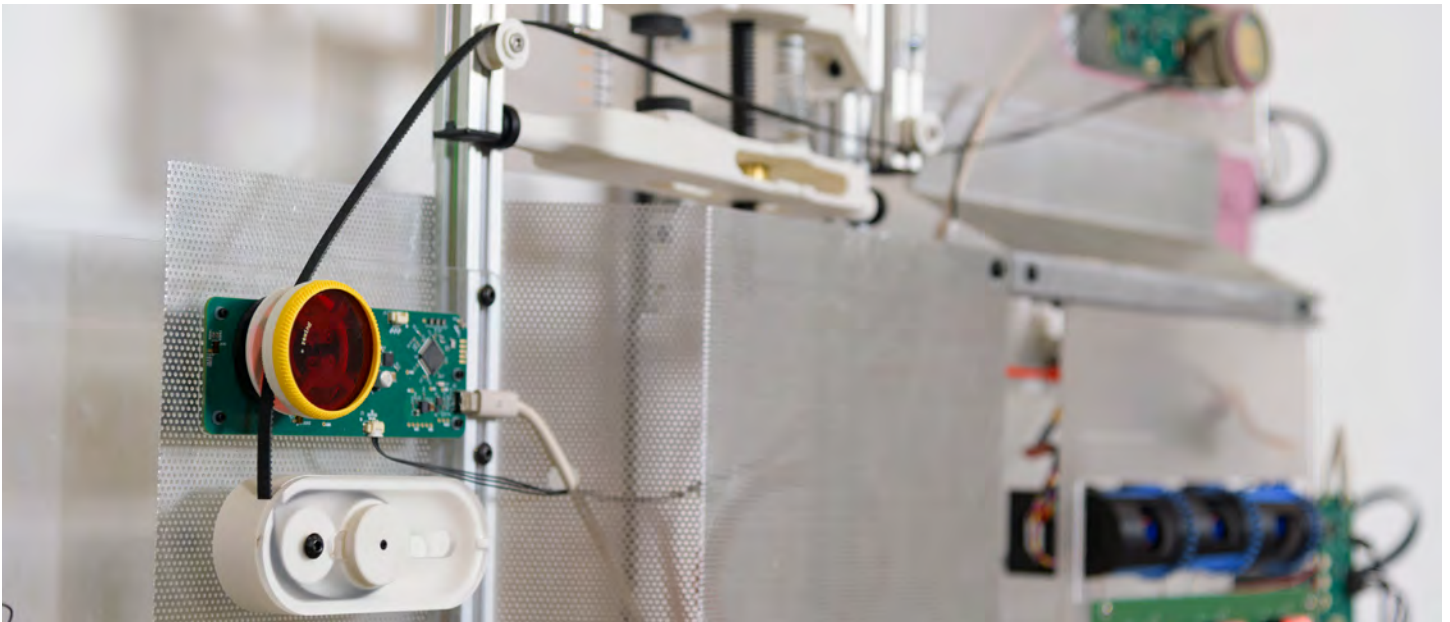
a series of HMI systems that integrates USB-PD, BLDC control, proximity and touch sensing.



This project explores a different paradigm of human interface design for AI -- imagining AI as a tool-like machine, instead of anthropomorphizing it.

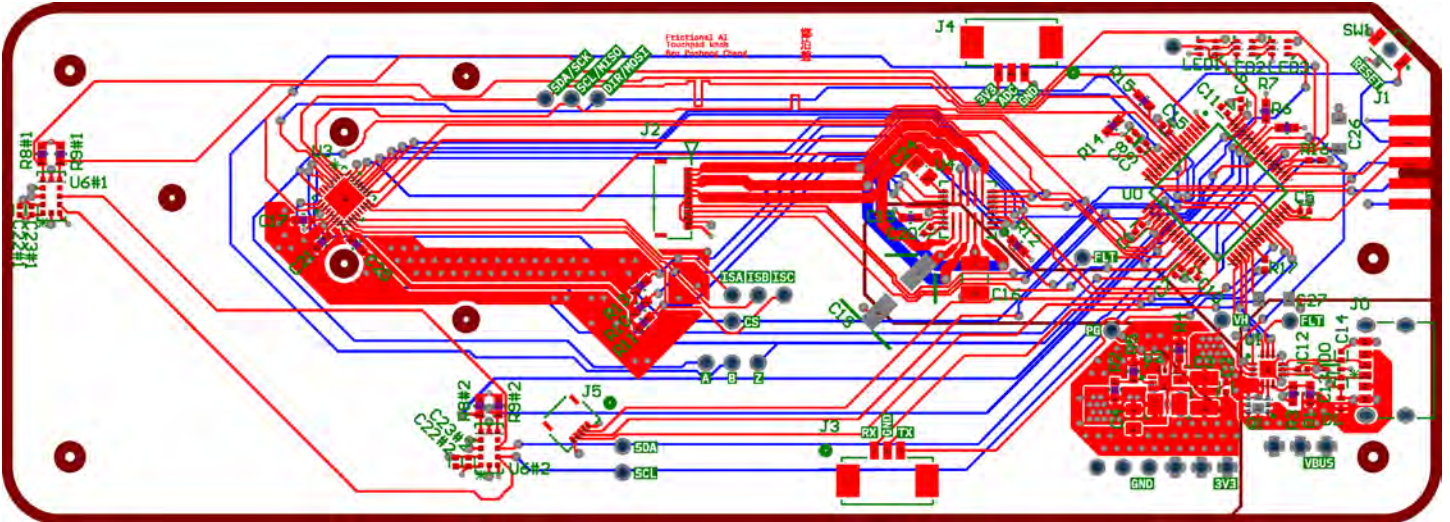


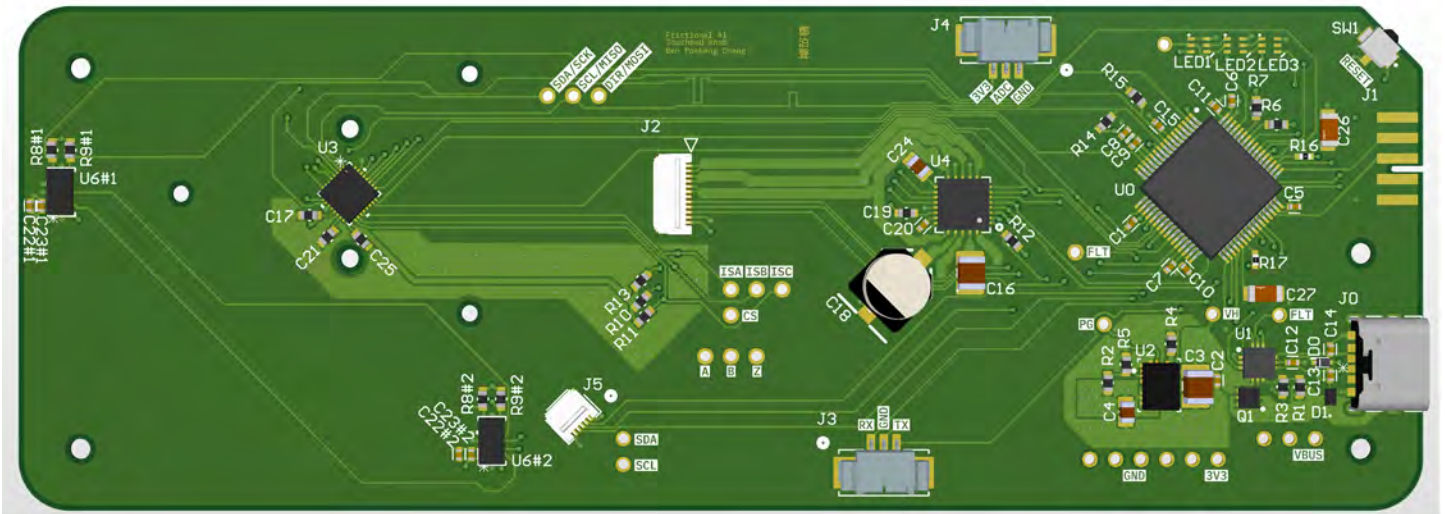
One of the explored tangible interface is this slot machine. It displays the three most likely token predictions in a format that is often associated with randomization to highlight the importance of human decision-making and agency that is lost in the chatbot interface.



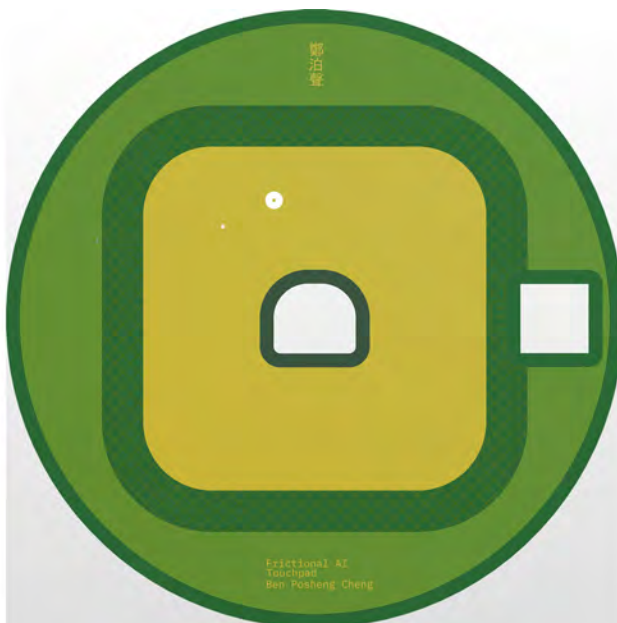
Another one is a collection of scroll wheels. They spin when the model is working and slow down when the user hovers above it -- a behavior that calls for human monitoring and examination. If the user taps the wheel, the model pauses and the user can use the scroll wheel to rewind through generated tokens and ask for revision from a very specific point.

Different revisions of the same circuit board are utilized in different parts of this project. They all support USB-PD so that motors of different voltages can all be used with the same hardware setup. For example, the BLDC driver is used for the scroll wheel but also for the three DC motors of the slot machine.

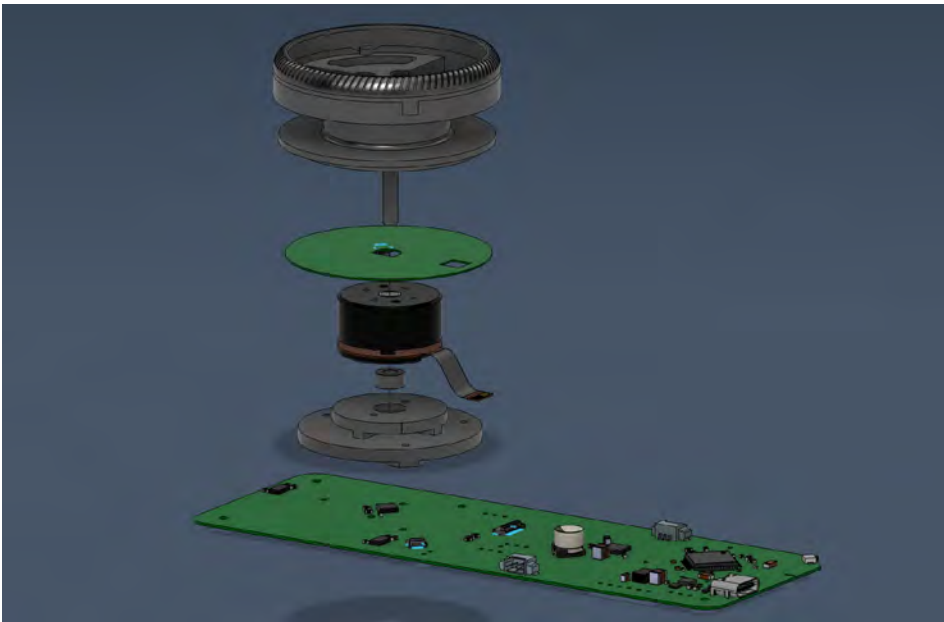




The STM32U5 mcu was chosen because it includes both USB-PD controllers and touch sensing controllers, reducing extra BOM items needed. Complete protection circuit is implemented for the USB-C connector, including OVP, pin-shorting and ESD. The BLDC driver circuit uses a three-bridge driver (MP6540) paired with a hardware-based FOC motion controller (MP6570). The on-board integrated-inductor SMPS (TPSM84338) can handle the entire range of USB-PD voltage range.



Robust touch-sensing layout is also implemented, including driven shield, sampling capacitors, clamping diodes, and careful considerations for trace width and ground plane.



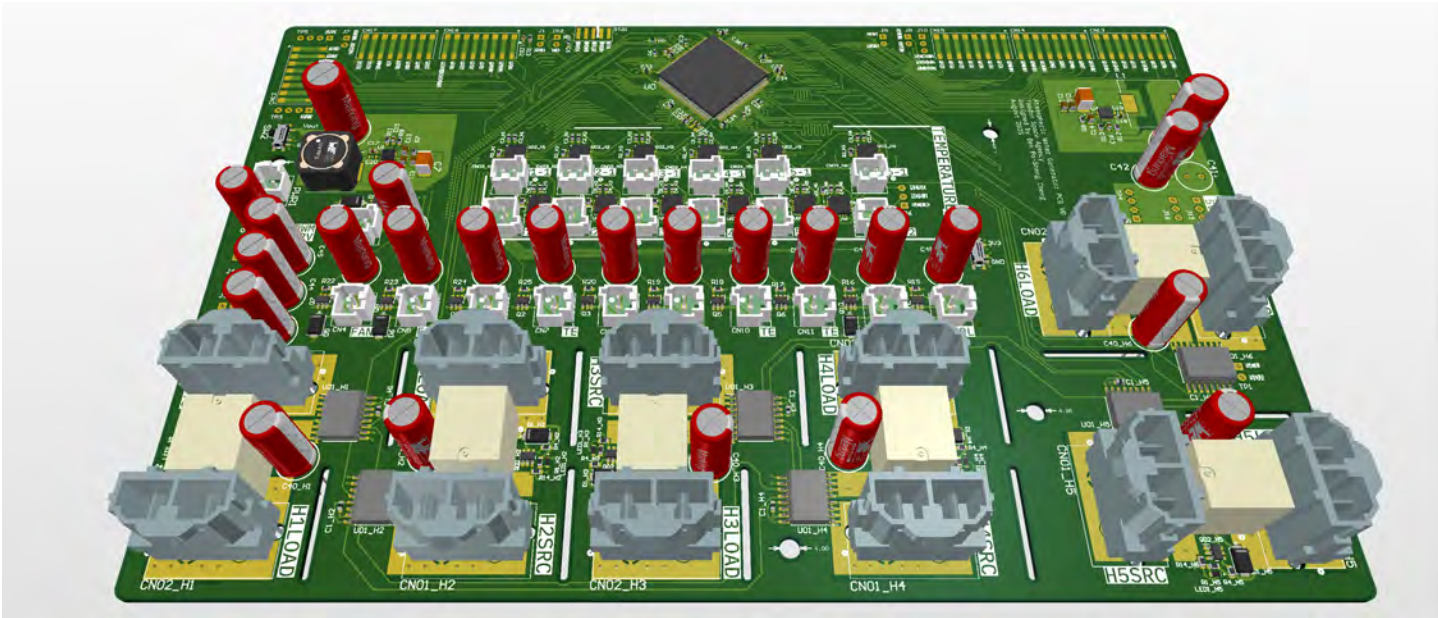
The locations of the connectors and screw holes, and touchpad-motor assembly are determined with precise MCAD-ECAD codesign.

visit the project website to learn more: <https://objectified-ai.netlify.app>

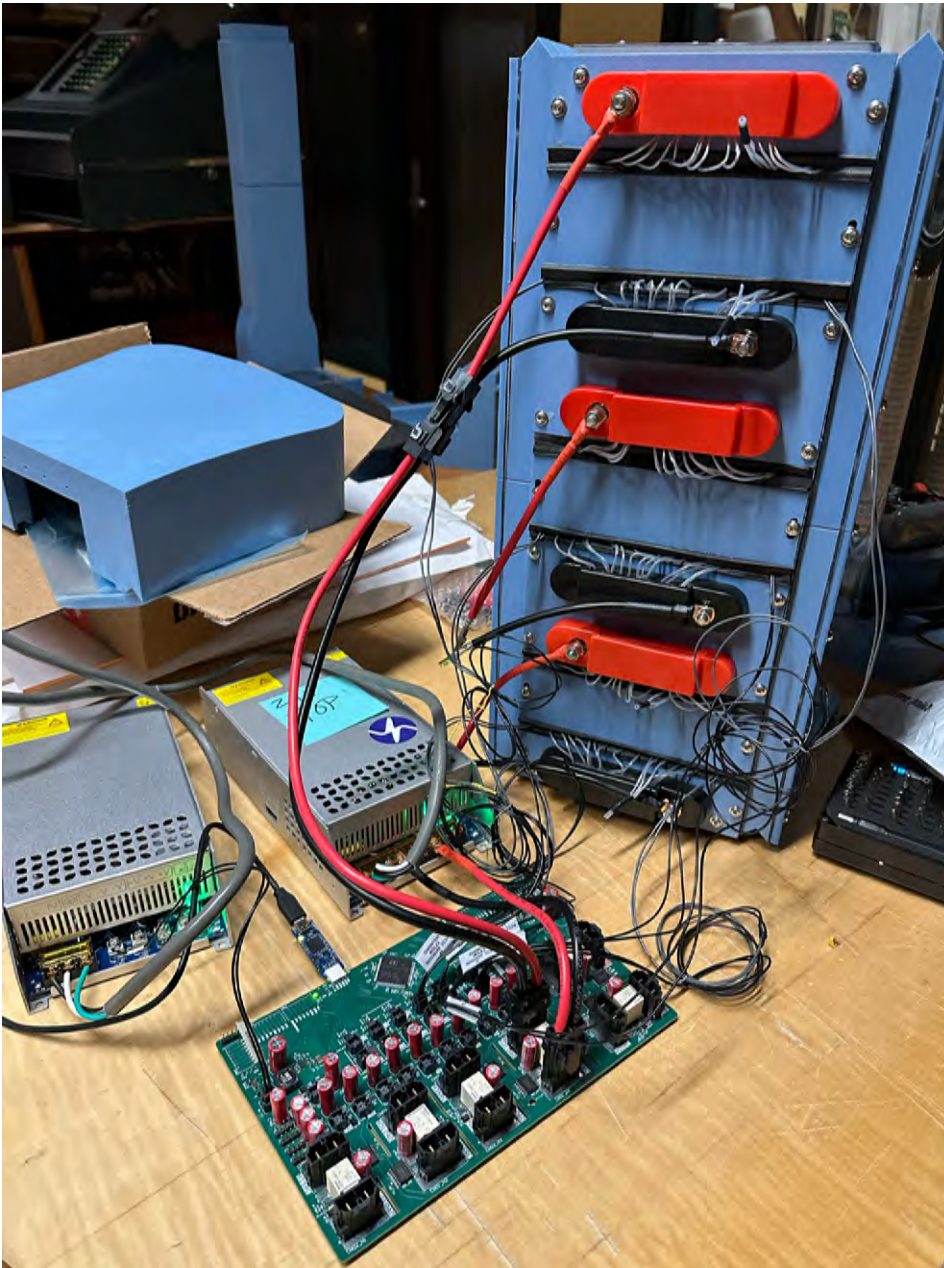
This is my master's degree project. It's an individual project since Sep. 2025.
I am the sole contributor to the schematics, layout, firmware and MCAD.

atmospheric water generator

high-power heating element control

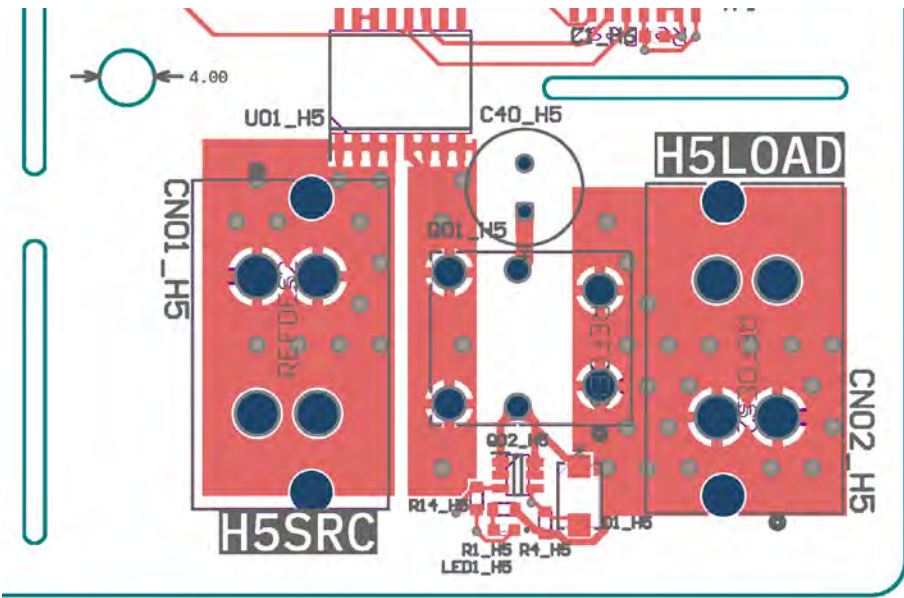


This board controls six nichrome wire heating elements for an atmospheric water generator. Inside the generator are biomaterial sheets that absorb or release water with the change of temperature.



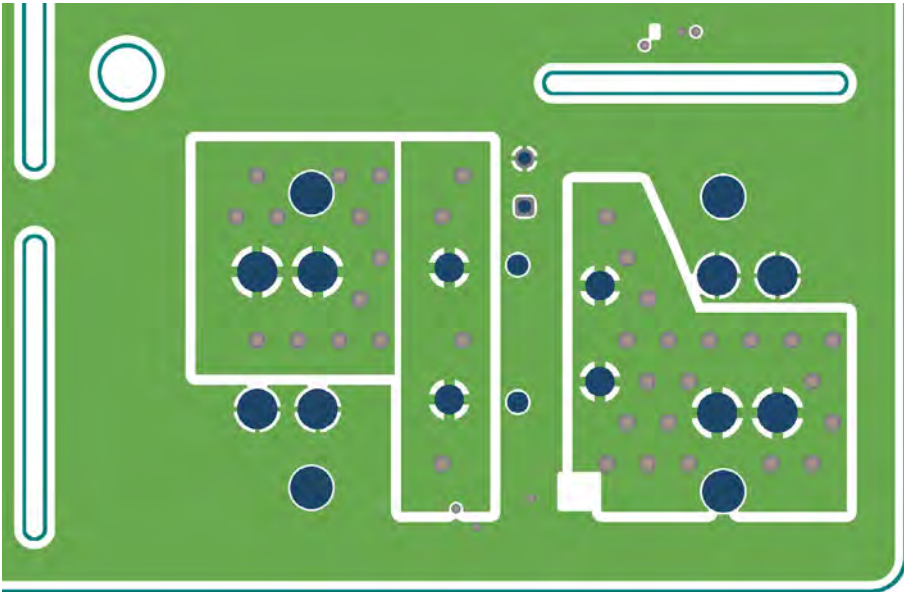
Each heating element can consume up to 30A of current. The chosen relays and connectors are all rated at or above this value.

(the biomaterials are patent-pending so I can't really show it.)

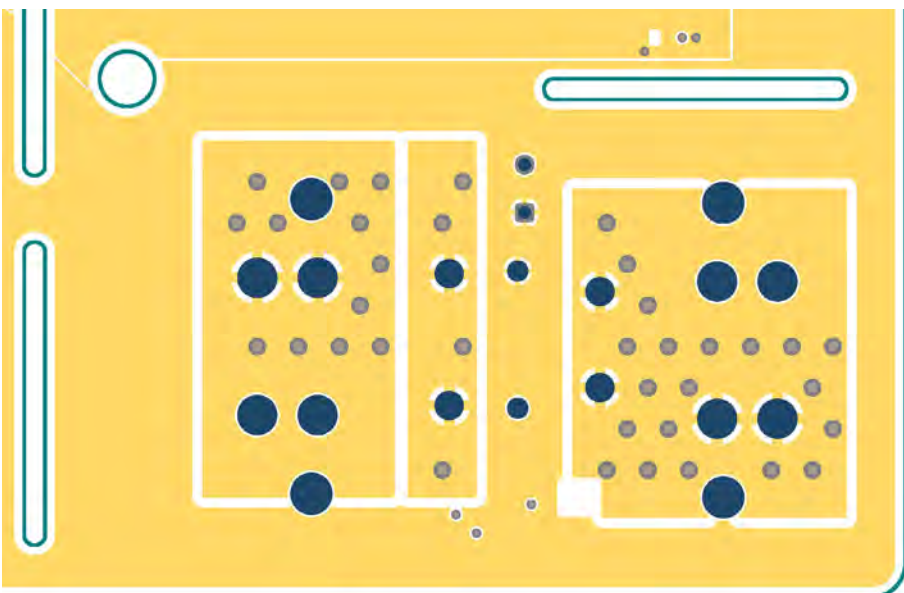


multi-layer high current power path and board cutout slots are implemented to ensure ideal thermal performance.

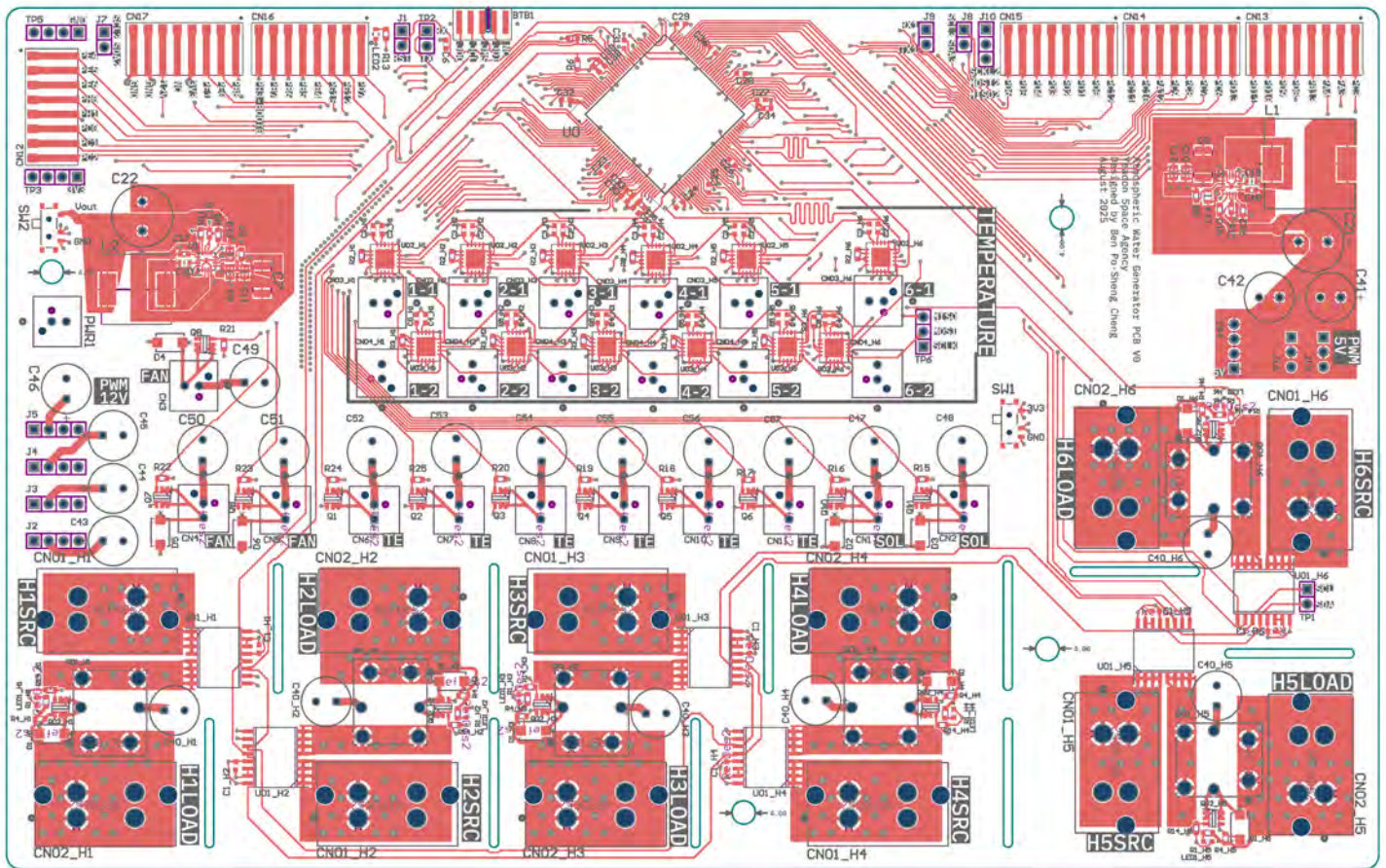
top layer



layer 1



layer 2

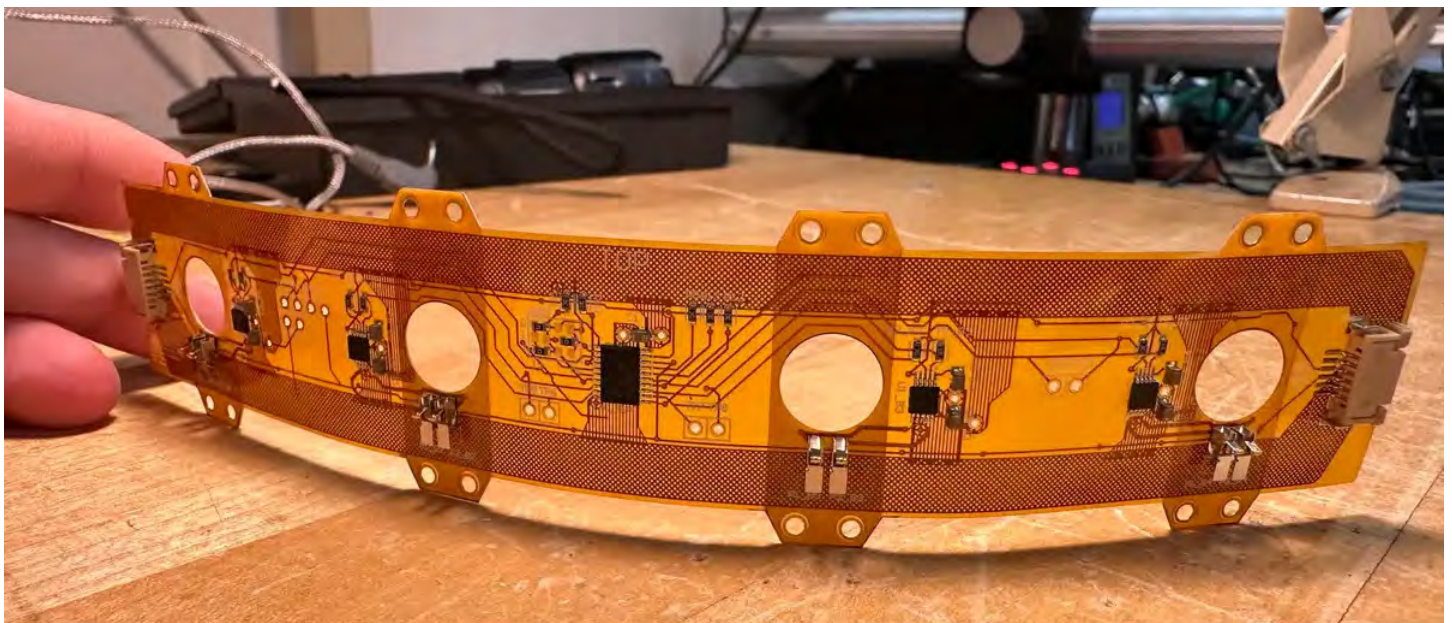


Precise temperature measurement inside the heating chambers is realized with 12 RTD sensors and precision ADCs (MAX31865). Operational safety is ensured by an isolated current monitoring IC (ACS37800) for each heating element.

This is a research project directed by Prof. Peter Yeadon. I worked on it from Sep. 2024 to Dec. 2025. I am the sole contributor for the schematics, layout and firmware while other team members designed the mechanical structure and biomaterial.

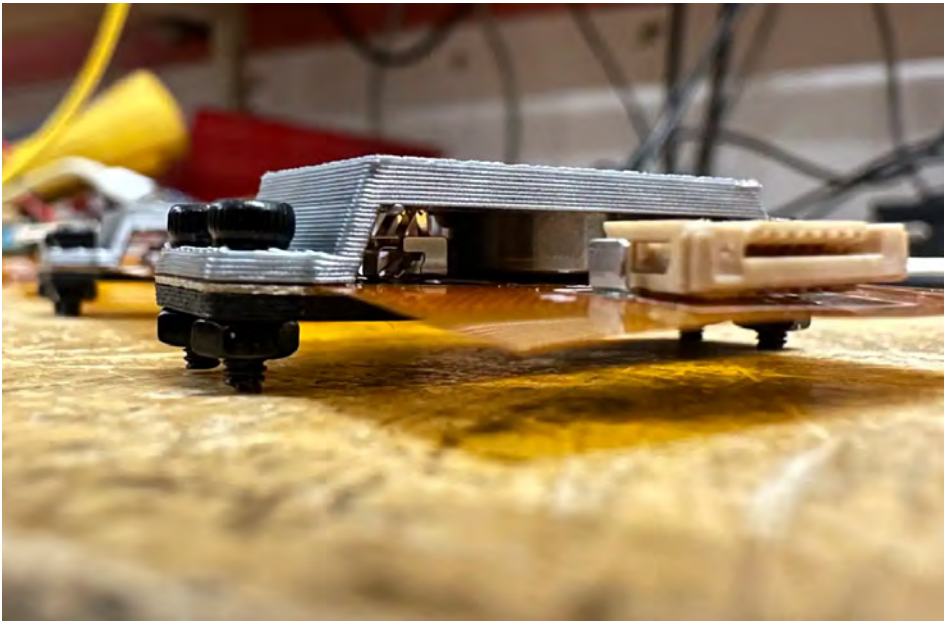
haptic belt

a rigid-flex wearable that uses haptic feedback to provide spatial navigation for visually impaired people.



This device uses LRA (Linear Resonate Actuators) to create localized vibrations around the user's waist to provide spatial guidance. The PCB was designed as a rigid-flex so that part of it can support the mounting of the LRAs while most of it stays flexible to be assembled with the softgoods enclosure.

An I2C multiplexer (TCA9544) is utilized to coordinate the 16 LRA drivers (DRV2605L) across the belt. Layout consideration for the rigid-flex PCB includes voltage drop across the length of the belt, and hatched power plane to maintain flexibility.

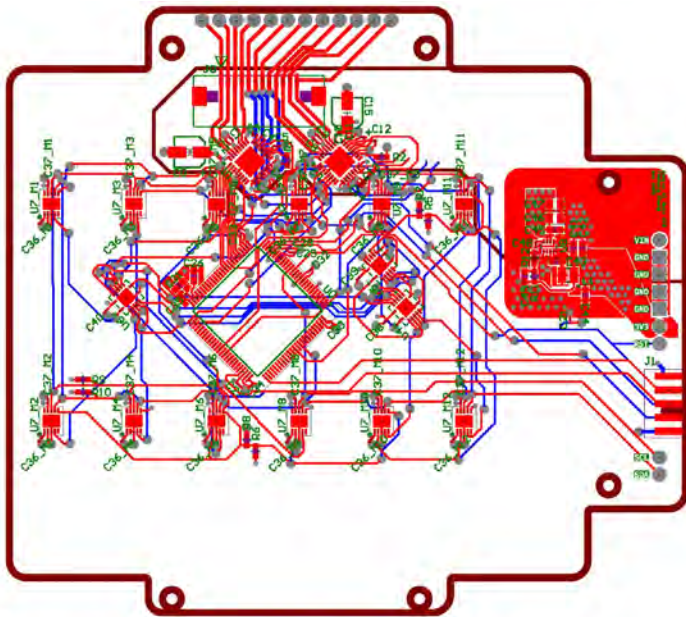


for more info and demo video please visit: <https://bencer3283.github.io/portfolio/hapticBelt/>

This is a two-semester team project with another three contributors. I designed the rigid-flex PCB and implemented the LRA control firmware. Another teammate implemented the central PCB that also contains the mcu.

It's a multi-axis slider that can either be moved by the user or can also move themselves. There can be multiple "bits" in each axis. I call it an automated abacus. (or, a computer.)

The system uses 12 three-dimensional hall-effect sensors (A31301) on one I2C bus to sense the location of each "bit". In order to move the individual bits with one single slider, there are also 2 octo-half-bridge ICs (MAX22200) on the board to activate the 6 electromagnets (for each column) in both polarity.



for more info and demo video please visit: <https://bencer3283.github.io/portfolio/thesis/>

This is a sprint project done in Nov. 2025. I designed the PCB but unfortunately never got the time to finish the programming.