Berta Medical — Wearable ECG Development & Startup Journey

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1 Problem Statement

Berta Medical was co-founded to address barriers in accessing affordable healthcare and remote monitoring. **My contribution** focused on designing custom wearable ECG hardware (dev kit PCB, final wearable PCB), writing firmware for secure data transmission and integration for an AWS-based backend with patient/doctor portals. My co-founder, Billy Zhang developed the AWS backend as well as the front-end user interfaces that both the Doctors and Patients will utilize.

2 Requirements & Constraints

2.1 Wearable Device

- Lightweight, comfortable for extended wear.
- Accurate ECG acquisition (AD8232 front-end, electrode interface).
- Wireless communication (ESP32, WiFi).
- Rechargeable Li-ion with safe charging circuitry.

2.2 Custom PCBs

- **Dev Kit PCB**: modular expansion for firmware & comms testing (OLED, microSD).
- **Final Wearable PCB**: integrated ECG front-end, ESP32, fuel gauge (MAX1704x), TP4056 charging.
- Compact form factor; SMD assembly; test points for validation.

2.3 System Architecture

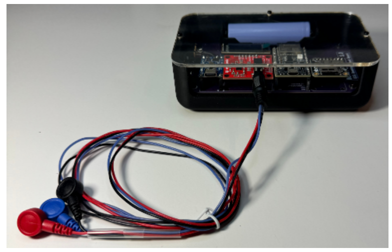
- Encrypted MQTT to AWS IoT Core; secure storage and access.
- Web portals for doctors and patients (real-time + historical data).

2.4 Startup Context

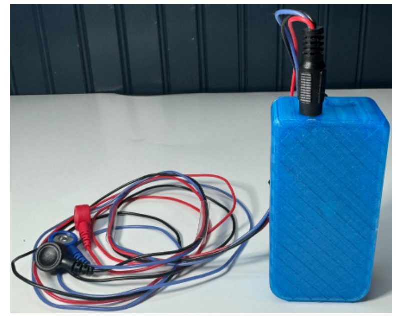
Turn prototypes into a viable medical product concept and pitch to interdisciplinary judges at the Rowan New Venture Competition.

3 Development Timeline

(a) Phase 1: Prototype. Two variants: chest-mount and clip-on.



(b) Phase 2: Dev Kit PCB. Utilizes OLED + microSD; firmware & MQTT iteration.



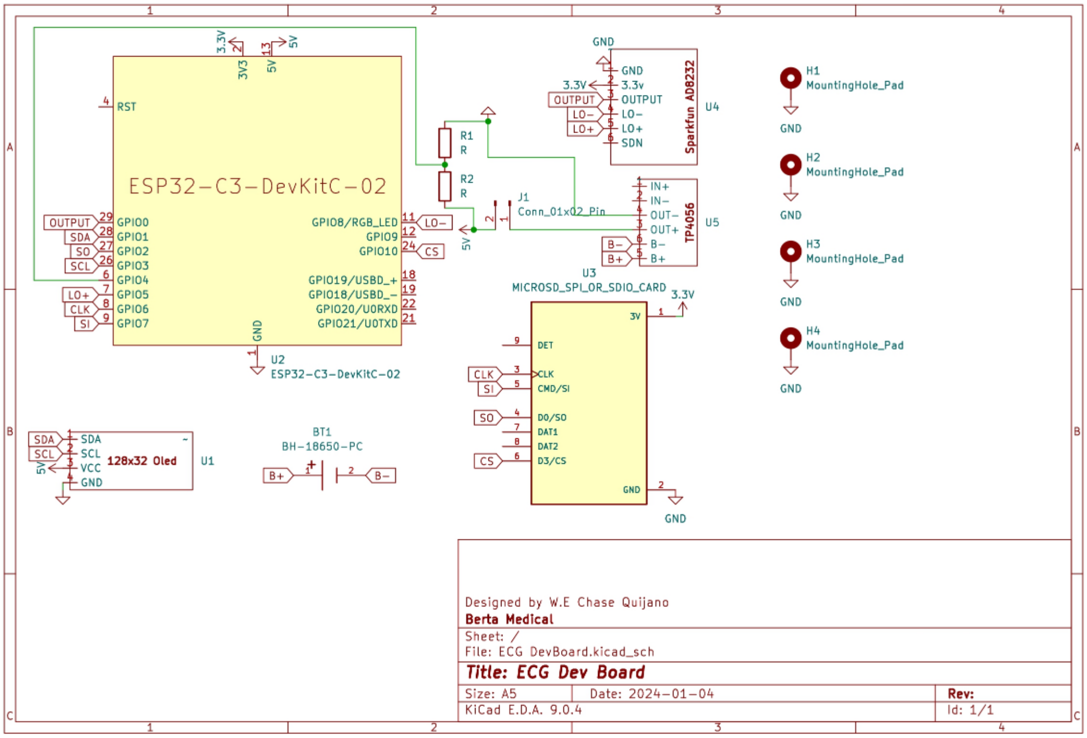
(c) Phase 3: Final Wearable PCB. Integrated sensing and power in a small form factor.

Figure 1: Timeline of device evolution.

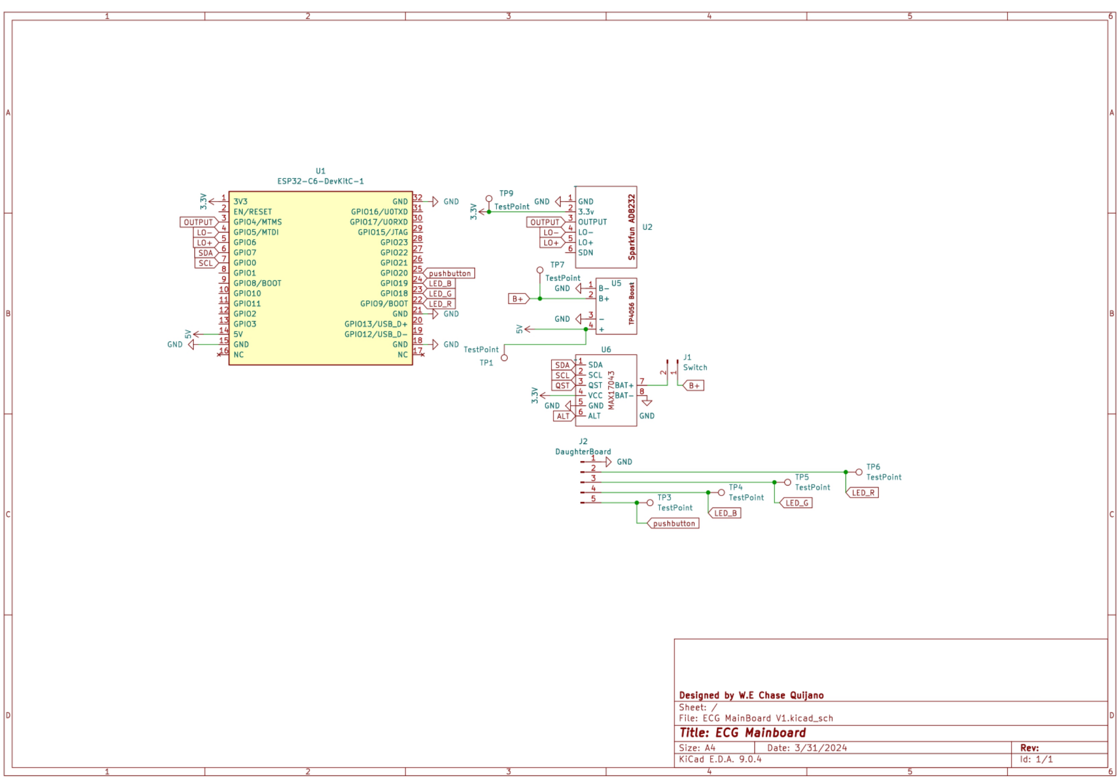
4 System Design Approach

4.1 Hardware

- **Dev Kit PCB**: modular headers; OLED for debug; microSD logging.
- **Final Wearable PCB**: ECG front-end, ESP32, MAX1704x fuel gauge, TP4056 charger.
- Designed in KiCad; assembled in house; footprints and test points for manufacturability.

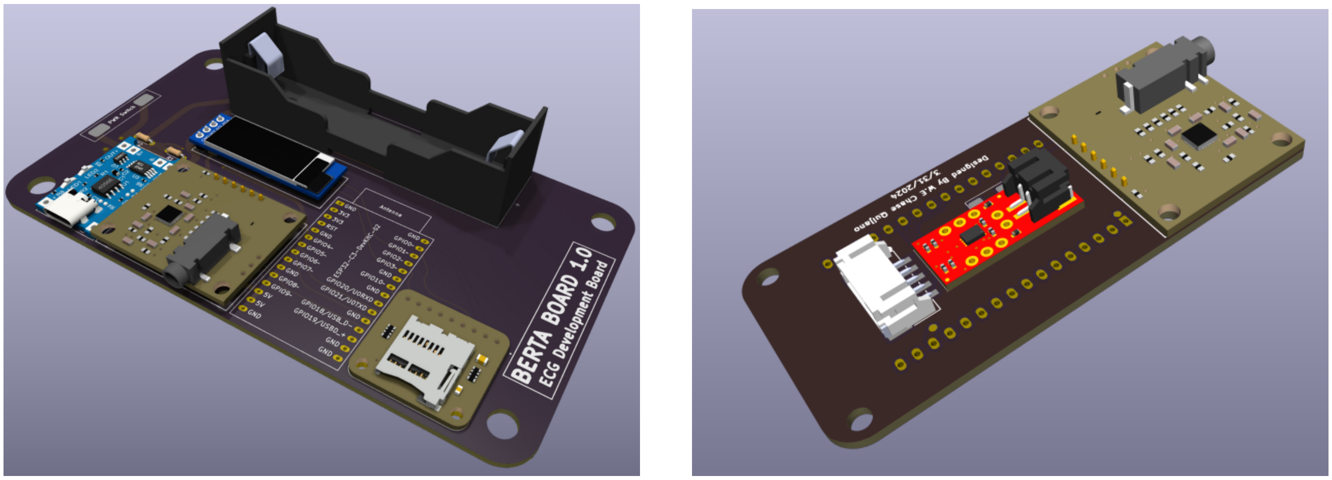


(a) Dev Kit schematic.



(b) Final wearable schematic.

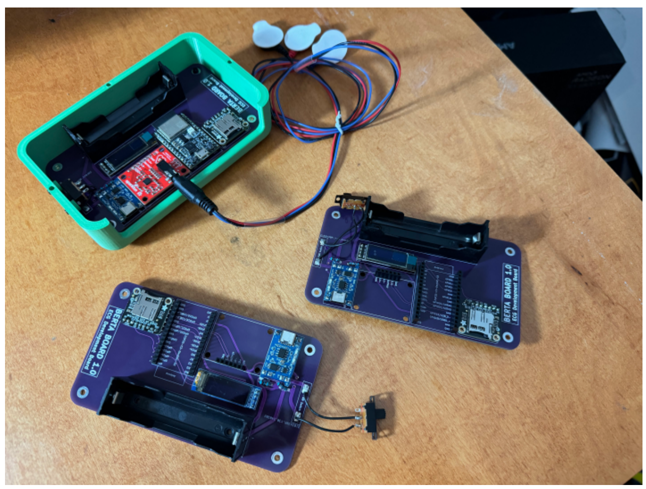
Figure 2: Key schematic blocks for custom PCBs.



(a) Dev Kit PCB.

(b) Final Wearable PCB.

Figure 3: PCB renders.



(a) Dev Kit During Assembly.

4.2 Firmware

ESP32 (C++) for ECG sampling, basic filtering, and packaging encrypted MQTT messages. The Dev Kit was utilized as a rapid iteration platform before final wearable integration.

4.3 Cloud & UI

- **AWS IoT Core** for device messaging; secure storage.
- **Doctor/Patient portals**: web front-ends for live and historical ECG review. Potential integration of AI analytics to detect multiple health trends in patients.

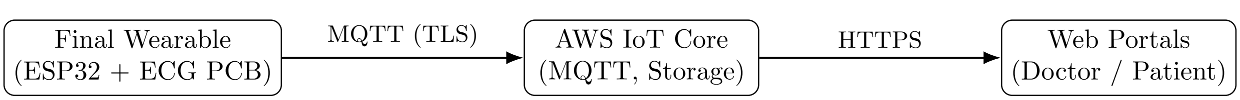
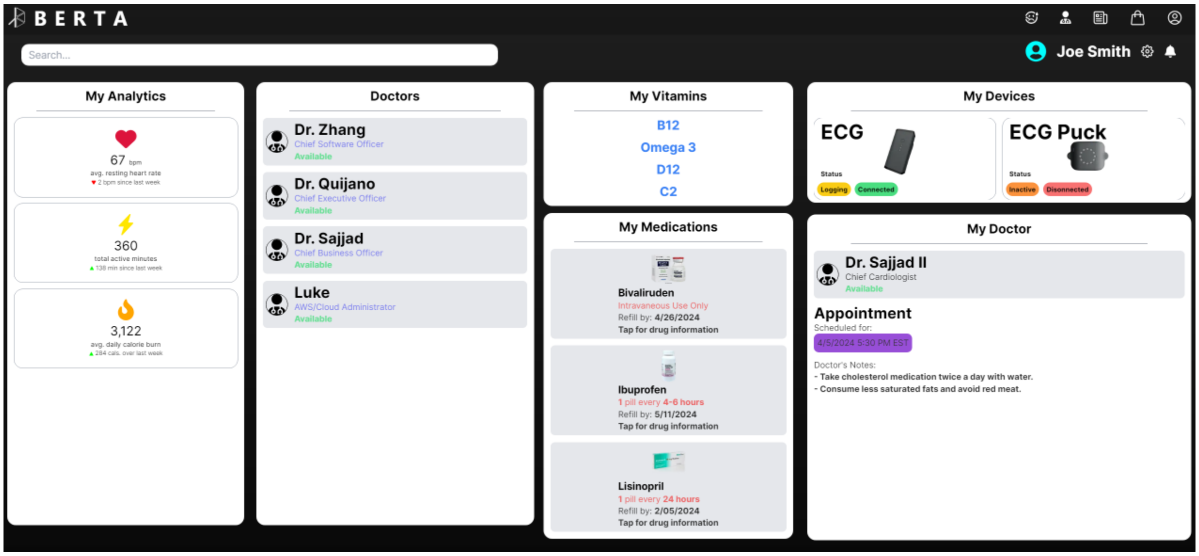
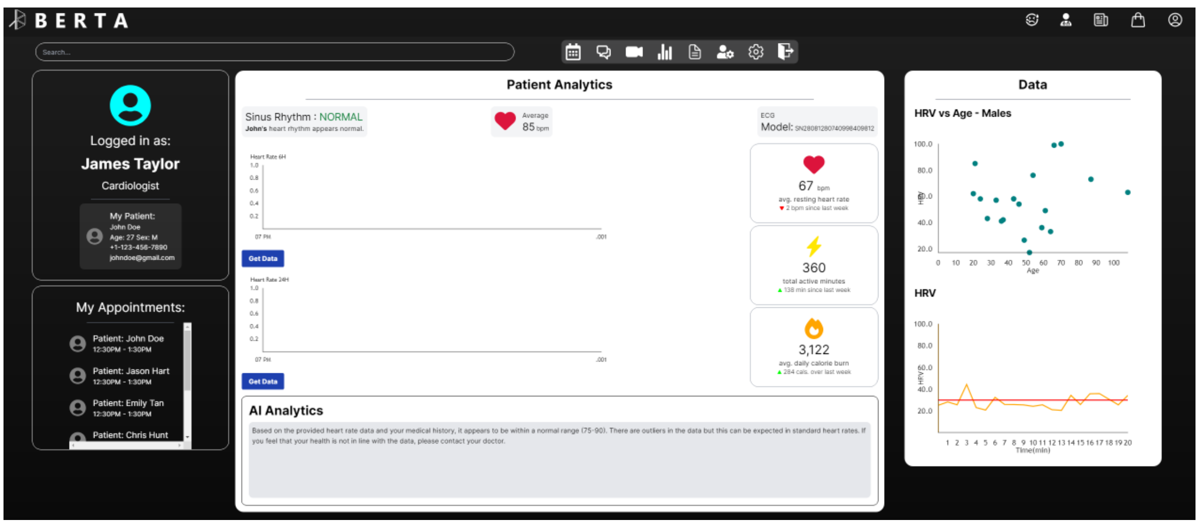


Figure 5: System-level data flow.



(a) Patient portal — vitals & history.

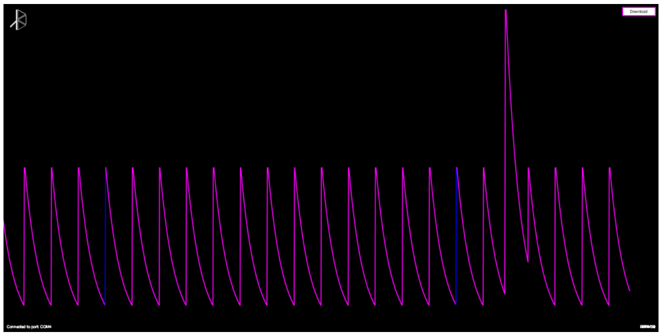


(b) Doctor portal — monitoring dashboard.

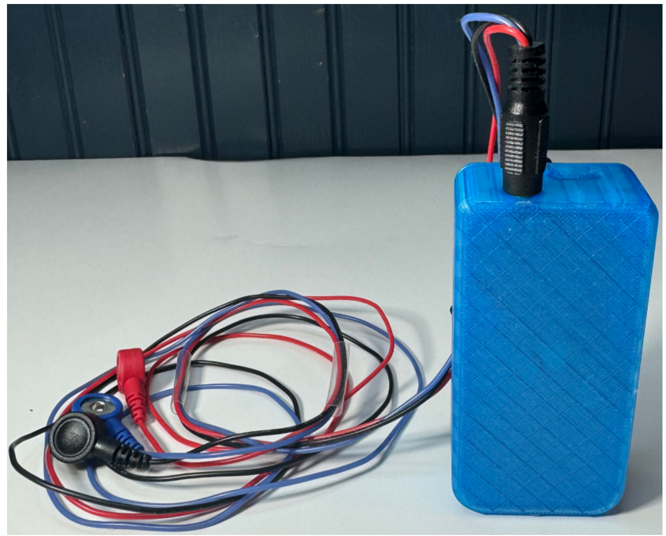
Figure 6: User-face web portals.

5 Testing & Validation

- Electrode contact quality and signal stability verified on prototype and final PCB.
- Dev Kit validated MQTT communication to AWS.
- Visual demonstration at Rowan Startup Competition.



(a) Captured ECG waveform (sample output).



(b) Final ECG wearable fully assembled.

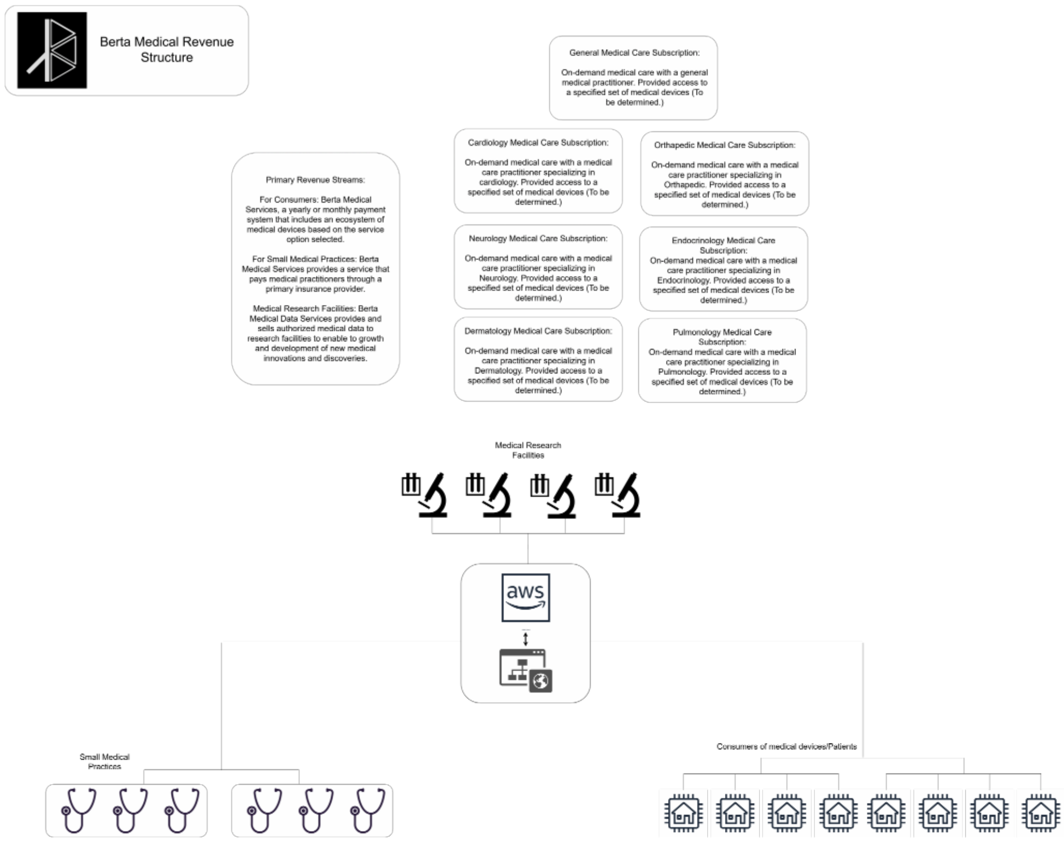
Figure 7: Validation artifacts (signal & hardware).

6 Reflection & Future Work

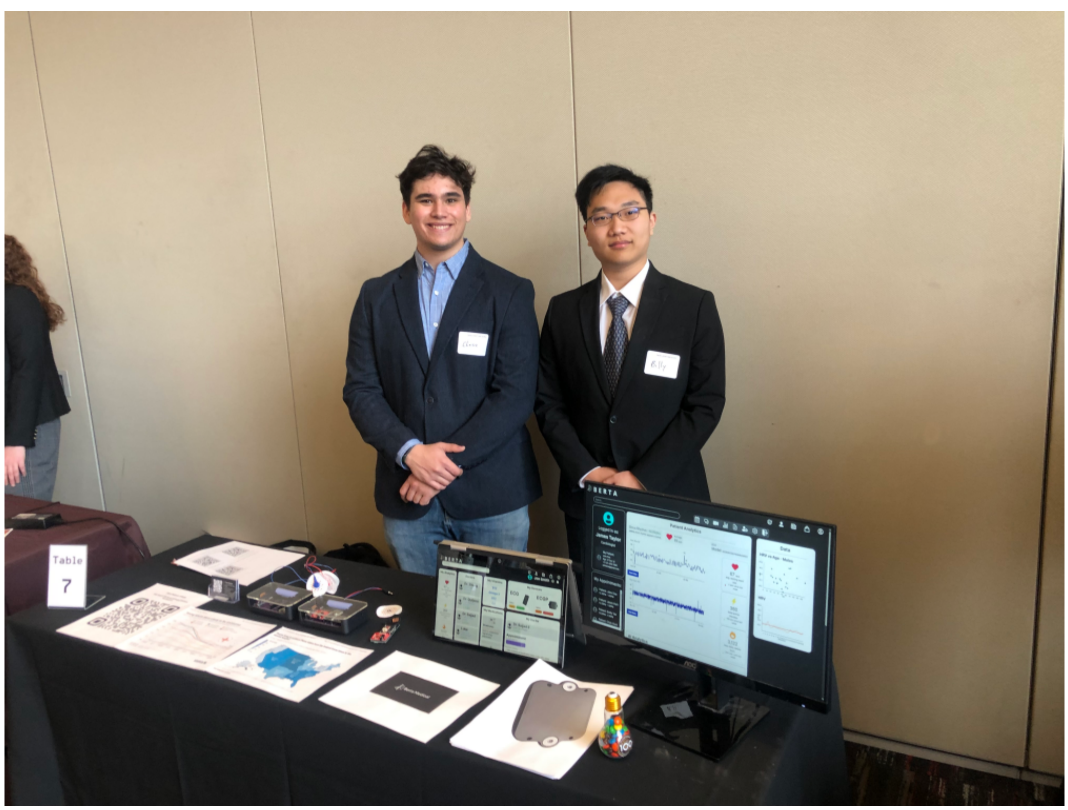
- Dev Kit phase accelerated firmware reliability.
- Next steps: UI and hardware design improvements. Potentially user testing and feedback.

7 Entrepreneurship Context

Co-founded **Berta Medical** with **Billy Zhang**. Built hardware, AWS backend, and web portals; developed revenue model; and pitched to physicists, engineers, and business leaders at the Rowan New Venture Competition.



(a) Revenue structure diagram (startup model).



(b) Pitch at Rowan New Venture Competition.

Figure 8: Startup artifacts.