STRIDE

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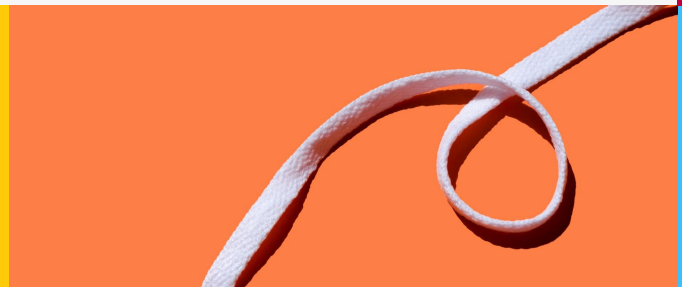
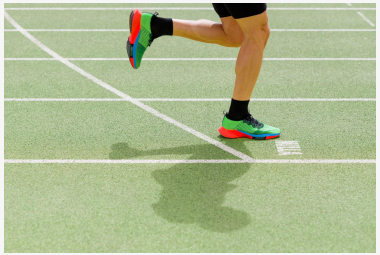


01
Motivations

MOTIVATIONS

Why Stride?



INJURY PREVENTION

A good running form—composed of stride, gait, foot striking, pressure distribution, and cadence—is crucial for minimizing running injuries.

IMPROVED EFFICIENCY

By analyzing stride length, foot strike pattern, and cadence, STRIDE empowers users to make precise adjustments to their training and technique.

LACK OF ACCESSIBILITY

There is a lack of accessible existing products that provide insight into running form outside of a lab, especially on a platform like Garmin.

02
Contributions

CONTRIBUTIONS

Our Impact

- Easily integratable sensor suite
- Data analysis platform built to connect with Garmin
- Allows for the integration of advanced running metrics into their everyday running routines

Final Product

03

MVP Requirements

MINIMUM REQUIREMENTS

Our MVP

SENSORS & DATA

FSRs send information about footstriking and pressure distribution, while IMUs collect path data, triggered by a callback function when a step is detected.

Data is processed by an ESP32 microcontroller and condensed into a smaller data packet to wired transmission or local SD card storage.

CONNECT IQ

ConnectIQ functionality, to be compatible with delayed sensor information, will be a standalone app. This allows us to process and aggregate data after-the-fact once it is uploaded and display key STRIDE features.

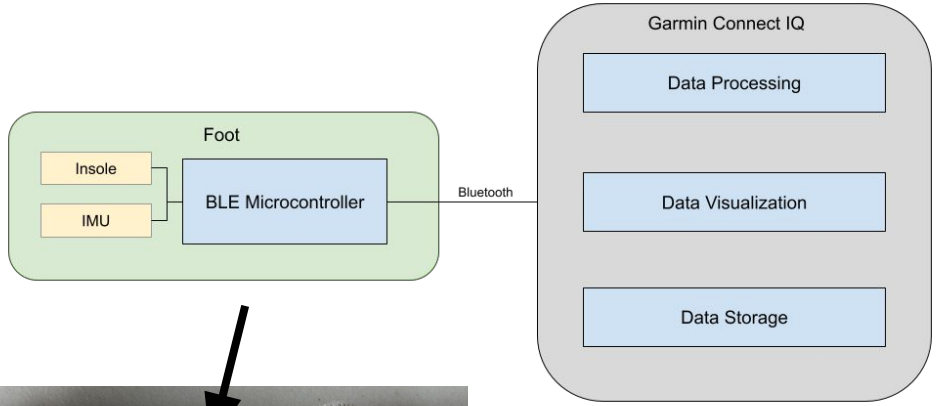
This also offers the flexibility to develop data fields or glances as our data pipeline evolves.

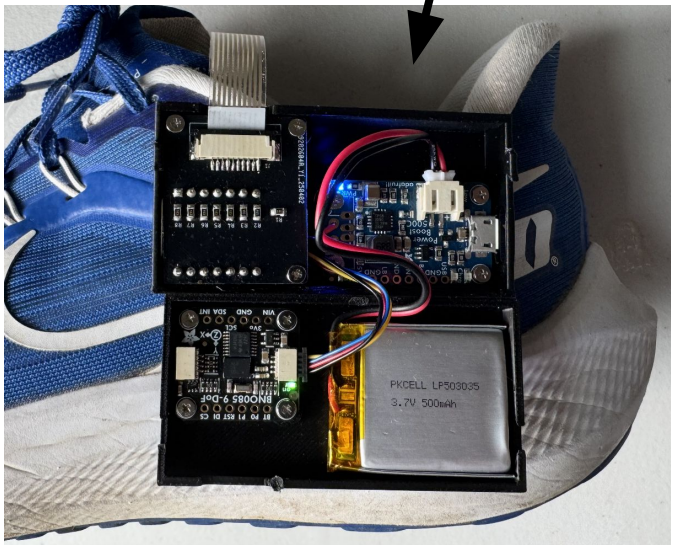
ALLOWANCES

To maximize performance and accuracy in our MVP, we may require a few allowances: wired v. BLE data transmission; a larger, less integrated form factor; wired, continuous power sources instead of battery power; and customization for a specific set of shoes.

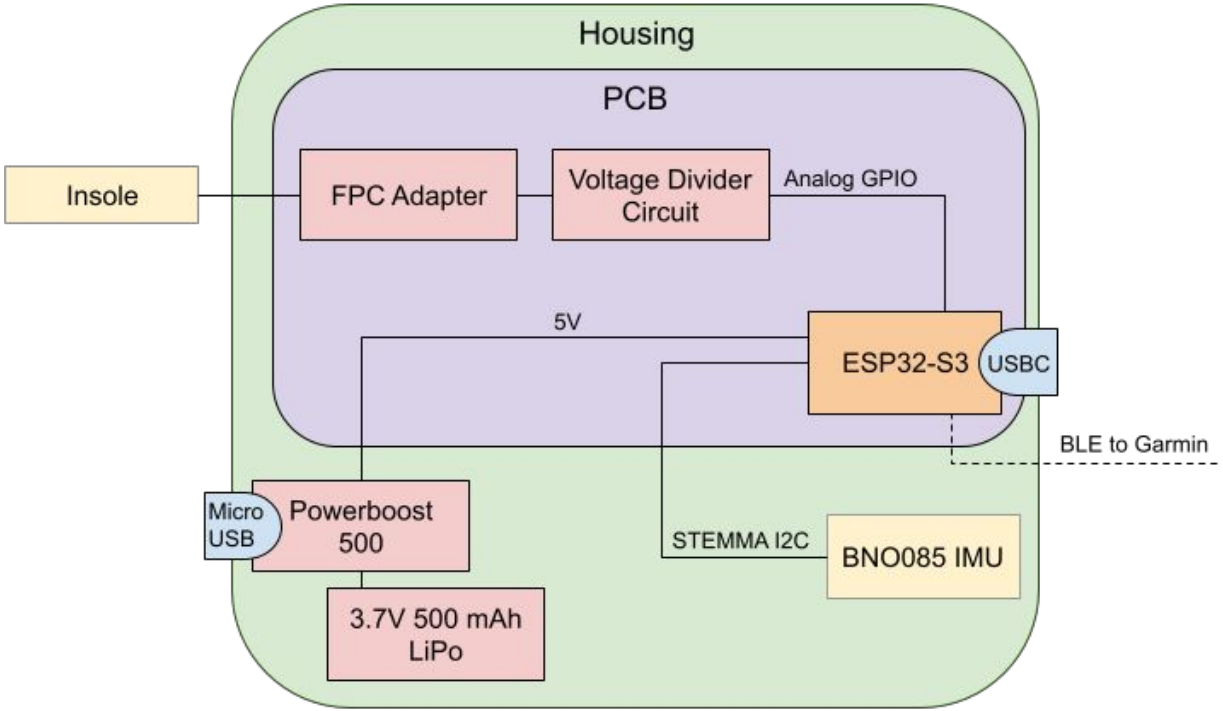
04

Solution Components


Garmin Connect IQ
Data Processing
Data Visualization
Data Storage
Bluetooth
Foot
Insole
IMU
BLE Microcontroller


PKCELL LP503035
3.7V 500mAh


Land
Load
Launch
GARMIN



APPROACH

FSR Insole:
- 8 pads change in resistance based on the pressure of the step

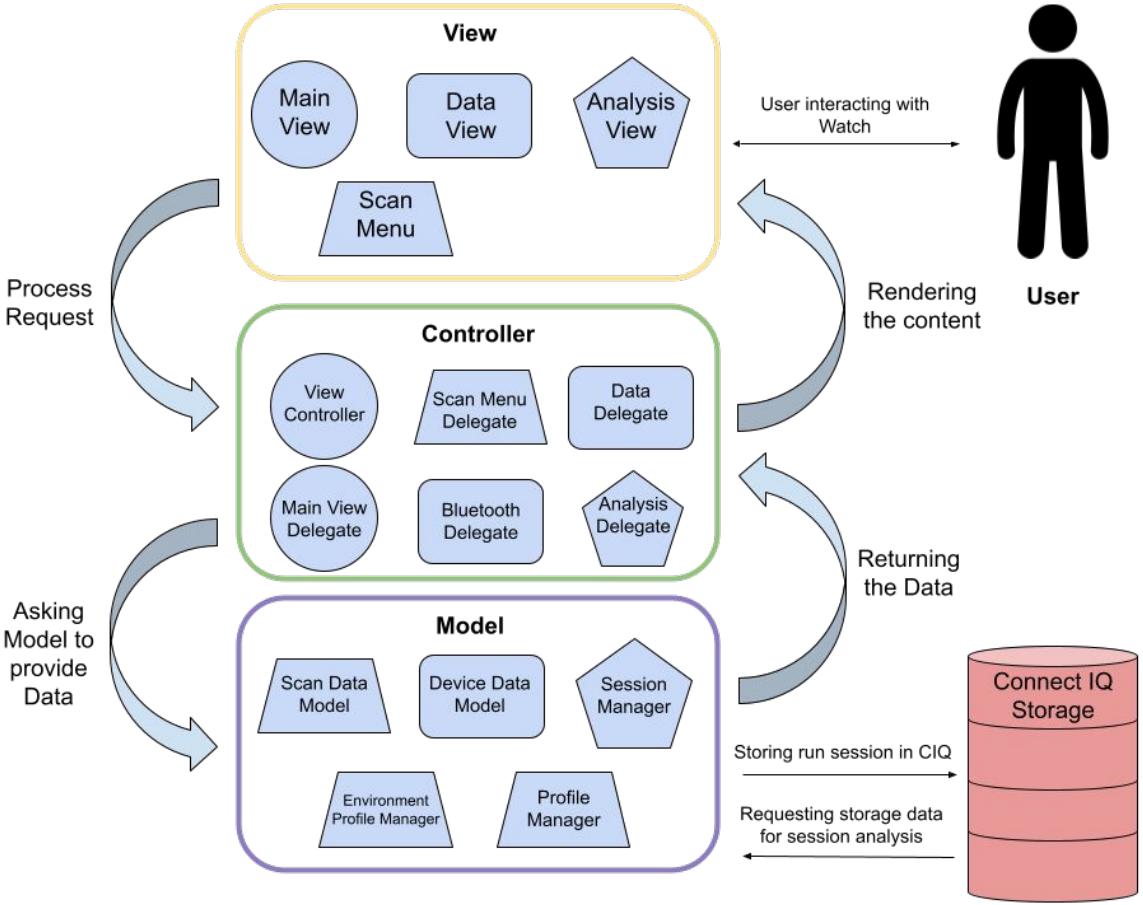
PCB:
- FPC Adapter:
  - Connects to FSR Insole
- Voltage Divider Circuit:
  - Converts change in resistance to change in voltage
- ESP32-S3:
  - Small BLE enabled MCU with 10 analog GPIO ports, reading IMU and changes in voltage to transmit to watch

BNO085 IMU:
- Reads the movement of the foot during the stride through I2C

LiPo:
- Provides 500 mAh of 3.7V to the system

Powerboost 500
- Steps 3.7 up to 5V for MCU, allows for easy charging

Hardware Block Chart



High Level CIQ Block Chart

05

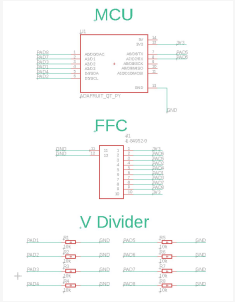
Module: FSR Reading

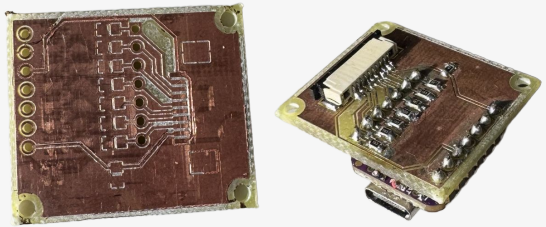
FSR Reading

Hardware

WEARABLE & WIRED

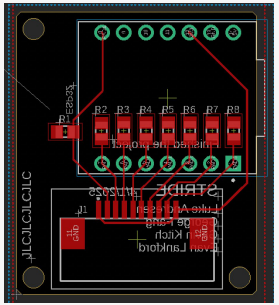
- FPC adapter connects FSR insole to a voltage divider with 10kΩ resistors on a breadboard
- ESP32 ADCs read changes in voltage
- Proved responsiveness but the construction severely limited functionality

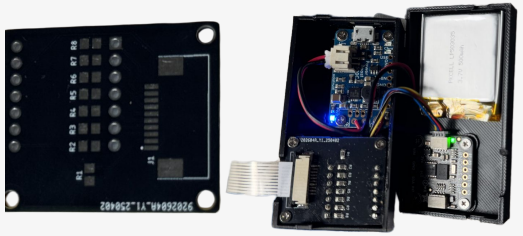




IN-HOUSE WIRELESS PCB

- Made PCB to collapse the FPC adapter and breadboard circuit
- Limited inhouse manufacturing meant some pads could not be read and made assembly tough



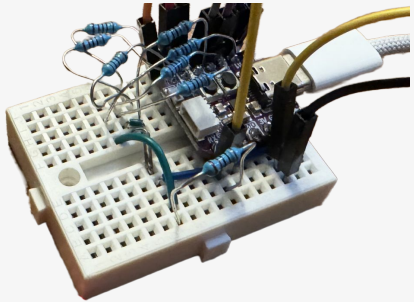


FINAL DESIGN

- Ordered from a large manufacturer
- Allowed for a completely wireless, fully functional pressure reading system

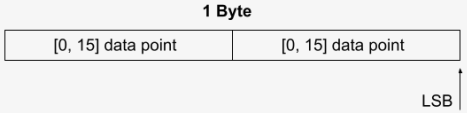
FSR Reading

Data Processing



INITIAL TRANSMISSION

- Attempted to send 10 evenly spaced data points
  - 8 pads x 10 points x 16 bit INTs = **160 bytes**
- Sent in 20 byte chunks
- Latency too high to be useful



COMPRESSION

- Chose 3 distinct relative indices that best illustrated the stride
- Mapped values to [0,15] based on maximum pressure
- Two 4-bit values per byte
- Final packet is **13 bytes**

VISUALIZATION

- Unpack received bluetooth packets in ConnectIQ
- Map values to yellow-red color scale
- Display spatially in Data View

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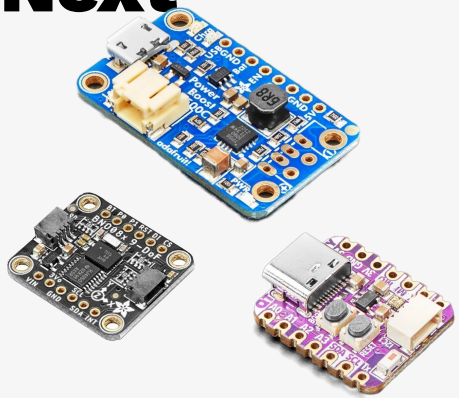
Demo


3:15 AM

07
Conclusion

Future Work

What's Next

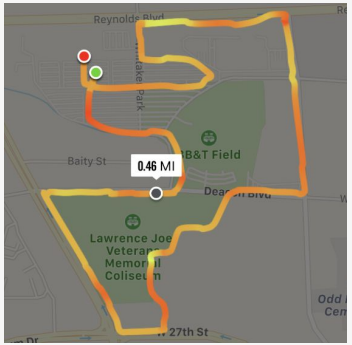


MINIMIZATION

Shrink circuitry, integrating BNO085, ESP32-s3, and Powerboost 500 into one PCB. This allows for further minimization of our clip-on, increasing comfort and reducing form factor of our design.

CUSTOM COMPONENTS

Customize our pressure pad order: a shoe insole with embedded sensors that doesn't end in an FPC. This improves comfort, ease-of-use, and simplifies the connection with the peripheral.



DATA INSIGHTS

Expand offerings with personalized analysis and running tips after a user's run. Develop a mobile application for larger, more detailed data visualizations and the opportunity to socialize.

Thank you