# SMART CHAIR
# Group 7

Rudy Ramjas - EE

Mackenson Jean - EE

Annavay Kean - CpE

Thien Nguyen - CpE

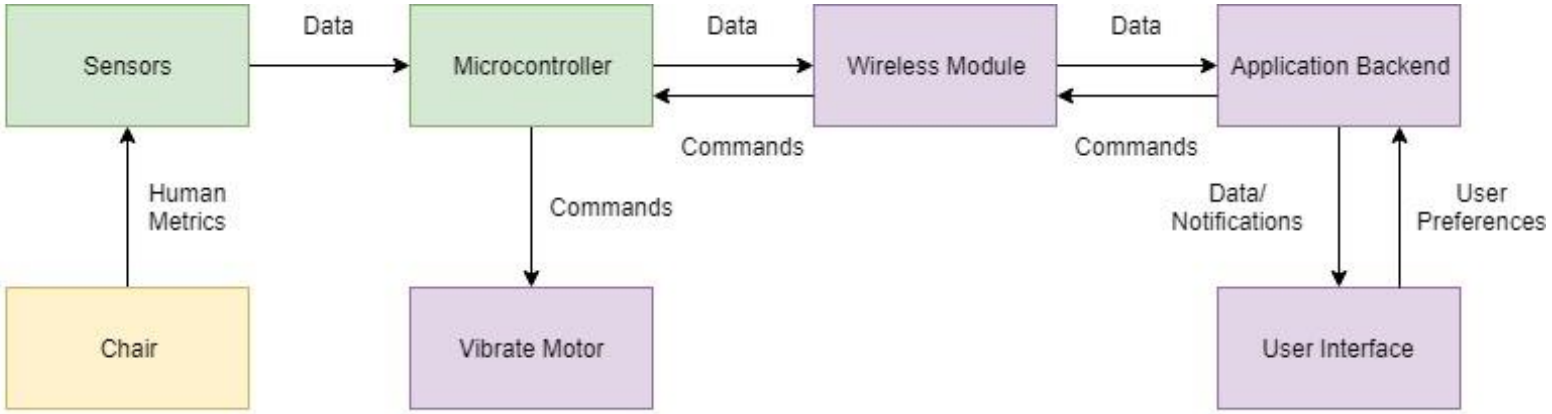
# Goals & Objectives

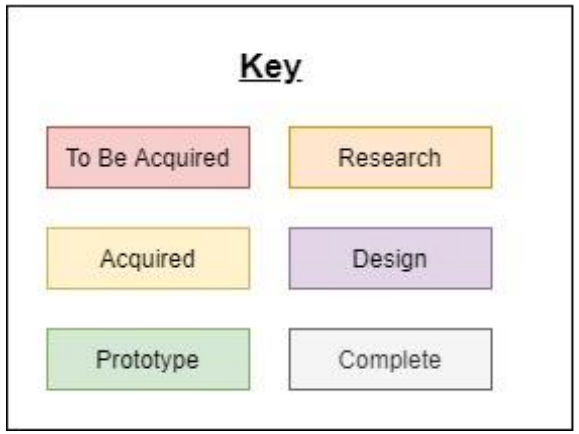
- Help user to become more mindful of posture habits.
- Provide feedback based on measured data.
- Target audience: middle-class office workers.
- Methodology: Center of Gravity

# Specifications

- The device should update the sensor input readings every 30 seconds.
- The device should pair with a phone app.
- The application will display posture data.
- The application will provide feedback on data.
- The software will store user data.
- 5-day standby battery life, minimum.
- PCB not to exceed 230 cm squared.
- Sensor array should be able to load a minimum of 100lbs (45.4kg).
- Vibrate module should operate between 200-400 Hz or rpm equivalent.

# Overview Diagram



# Standards

- Power Standards
  - IEC-60601-1
    - Electrical Shock & Fire Safety
  - UL 1310
    - Devices using multiple power supplies
- Wireless Standards
  - IEEE 802.11
- Application
  - Flutter Development Standards
  - Distribution Standards
  - User Privacy Standards

# Microcontroller Selection

- Communication Protocols

| MCU | F280049PMSR | ATMEGA2560-16AU | PIC24FJ1024GA606-I/PT | MSP430FR2311IPW16R | ATSAMA5D21C-CUR |
|---|---|---|---|---|---|
| Manufacturer | Texas Instruments | Atmel | Microchip Technology | Texas Instruments | Microchip Technology |
| Program Memory (kB) | 256 | 256 | 1024 | 3.75 | 160 |
| Data Memory (kB) | 100 | 8 | 32 | 8 | 128 |
| Clock Frequency (MHz) | 100 | 16 | 32 | 16 | 500 |
| GPIO | 26 | 86 | 53 | 11 | 128 |
| Supply Voltage Range | 1.2 - 1.3V | 1.8V – 5.5V | 2 - 3.6V | 1.8V -3.6V | 1.2V |
| Size L x W (cm) | .072 x .072 | 1.6 x 1.6 | .07 x .07 | .05 x .04 | 1.4 x 1.4 |
| Price (USD) | $10.81 | $12.20** | $4.41 | $1.62 | $6.71 |

# Power Supply

The system will be powered by an AC to DC adapter.

It will be operated by a voltage range from 12V to 3.3V.

The PCB will be using power 24 hours and keep it running under all conditions.

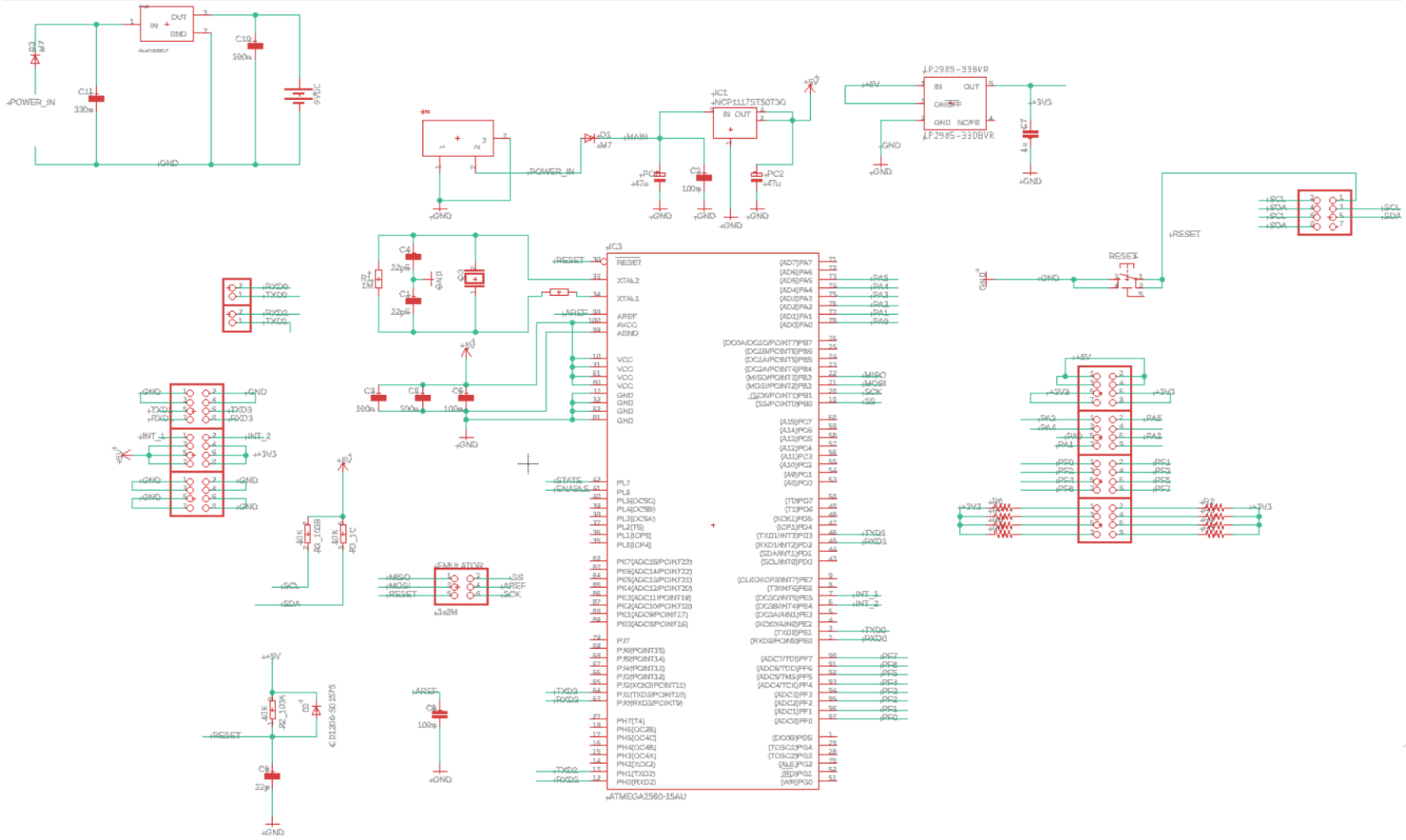
Back up power will provide to the chair by a 9V battery to allows the circuit running after it is disconnected to the wall.

The battery will take over when the main power source is unplugged.

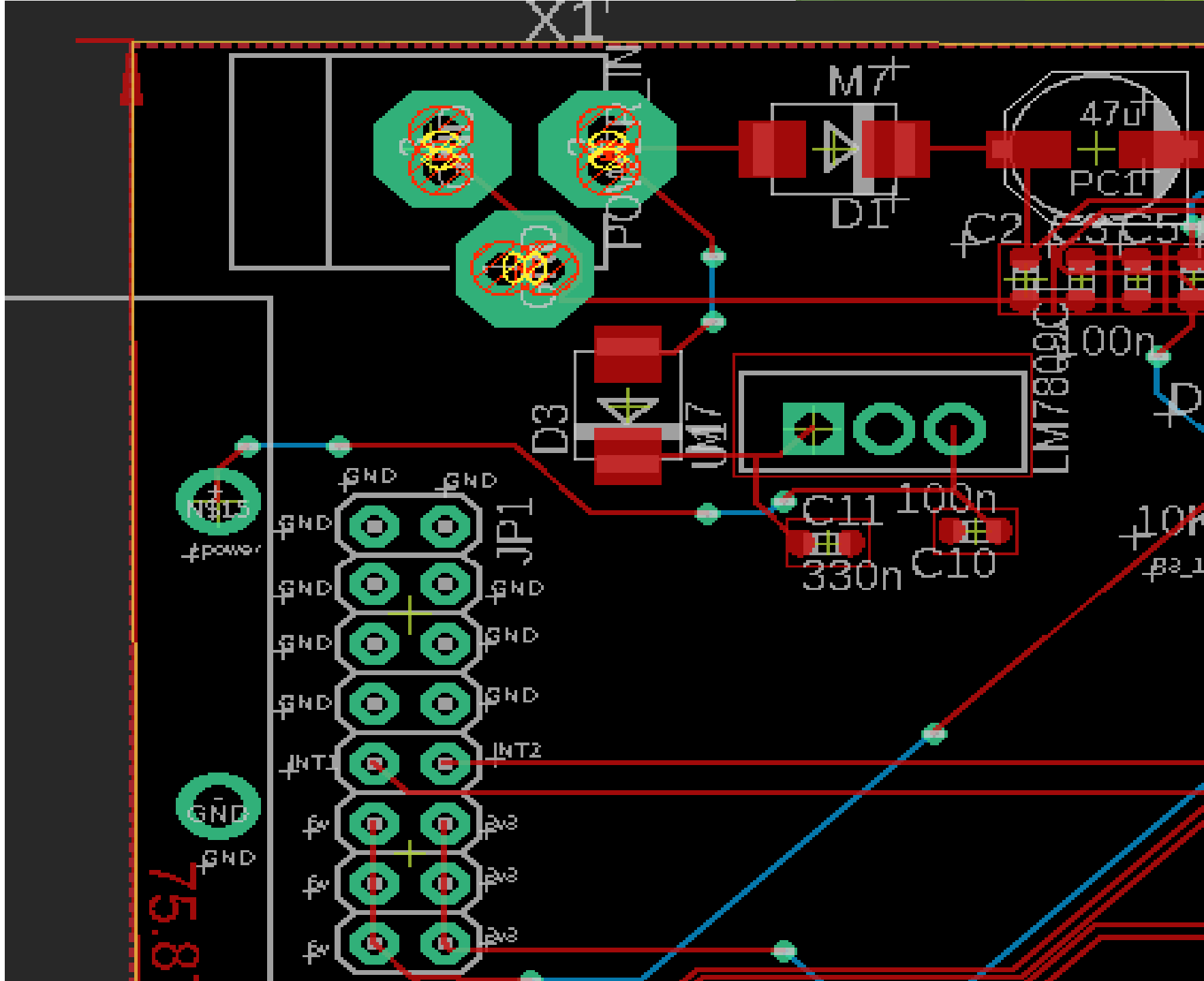
# Battery Supply

- 9V Rating
- Lithium ion composition
- Rechargeable
- Less Expensive
- Easily substitutable

# Schematic Overview

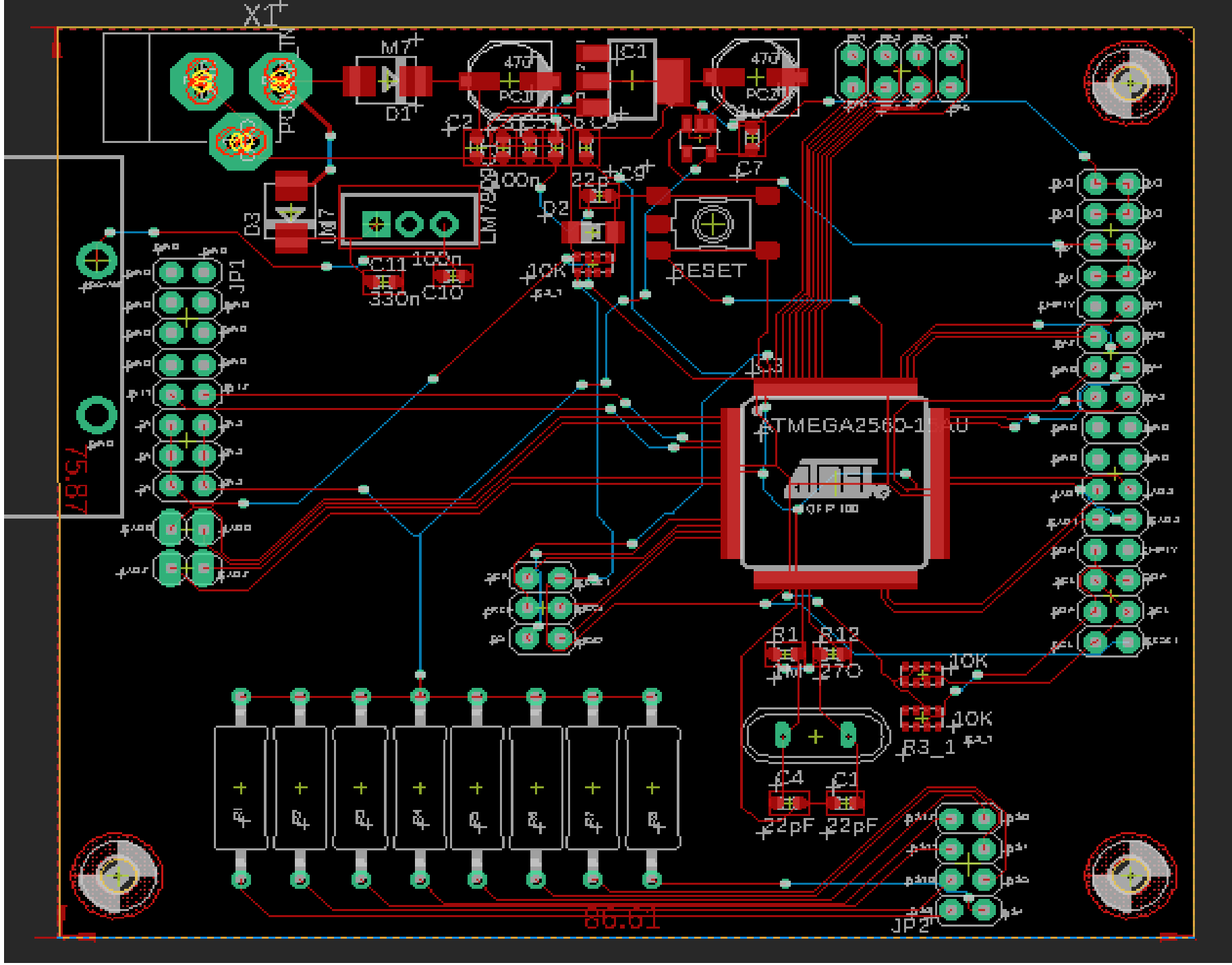


# PCB Power Supply

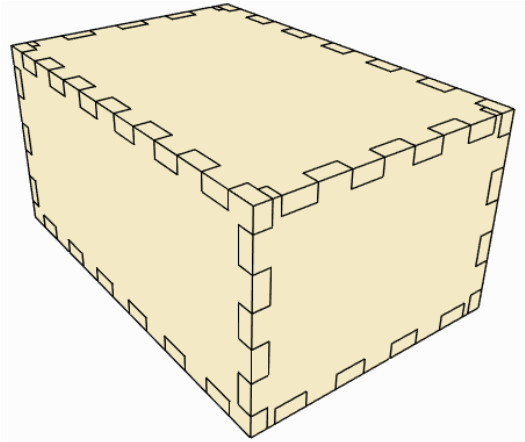


# Overall PCB

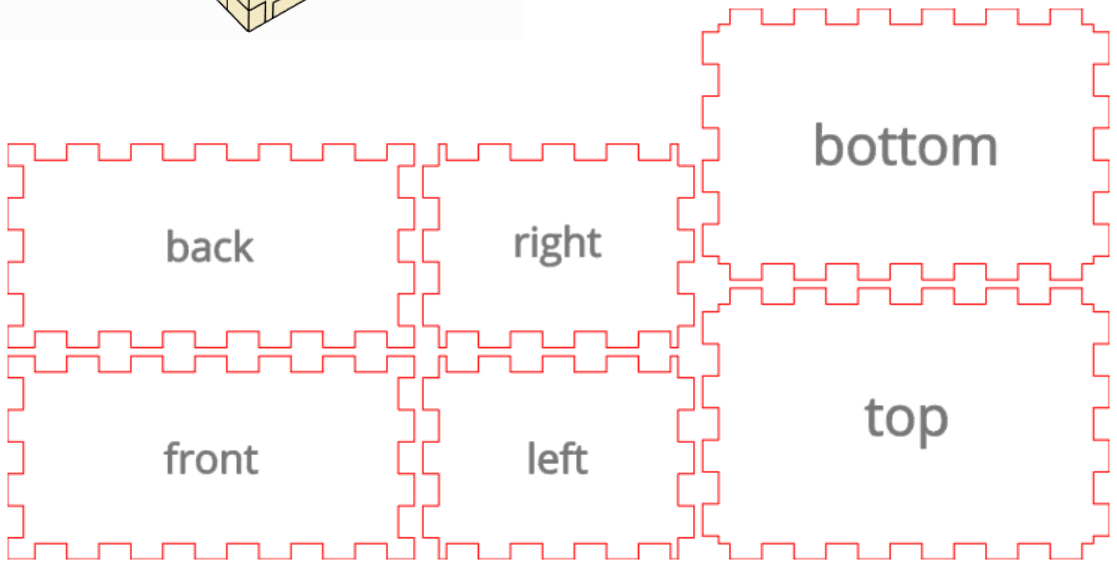
- 76 x 87mm (LW)
- Designed in Eagle
- 3 screw-holes



# PCB Enclosure



- Wood
- Laser cut in TI lab
- 6” x 4” x 4” (LWH)

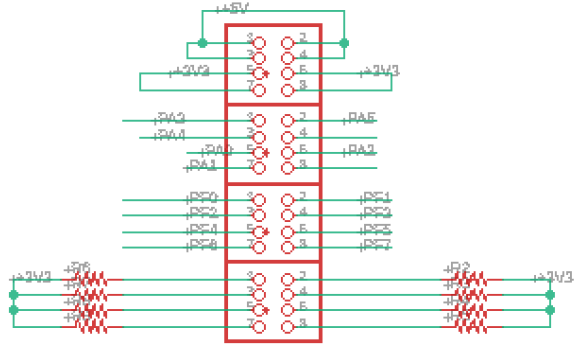


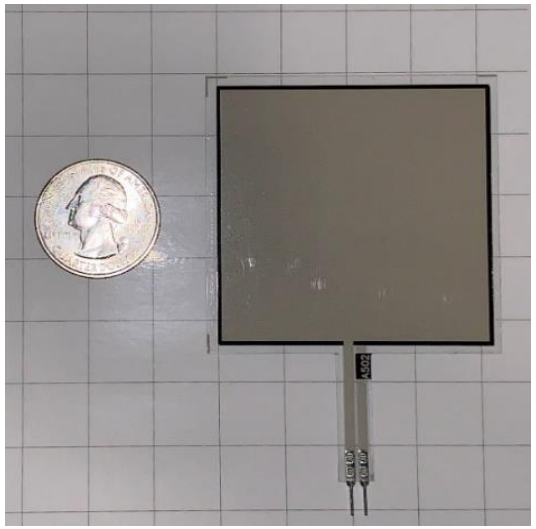
# FSR Selection

| | Tekscan A502 | Tekscan A301 | SEN-09376 | FSR-406 |
|---|---|---|---|---|
| Price per unit | $23.24 | $12.18 | $11.25 | $12.99 |
| Surface Area($in^2$) | 4 | 0.375(diam) | 3.0625 | 2.25 |
| Response time(μs) | ≤ 3 | ≤ 3 | ≤ 5 | ≤ 5 |
| Load range(N) | 44kN max | 444N max | * | 100N max |
| Drive voltage(V) | Variable | Variable | * | * |
| Amplifier circuit | Multiple | Multiple | Volt. Div. | Multiple |

# FSR Selection

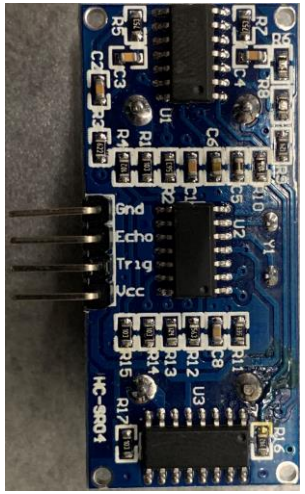
- Tighter tolerance: < 3%
- Multiple integration methods
  - Voltage Divider
- Engineering support (Manufacturer)
- Utilize MCU ADC channels to process signal





# Proximity Sensor

- Operates within 3cm range
- Located on mid-back of chair



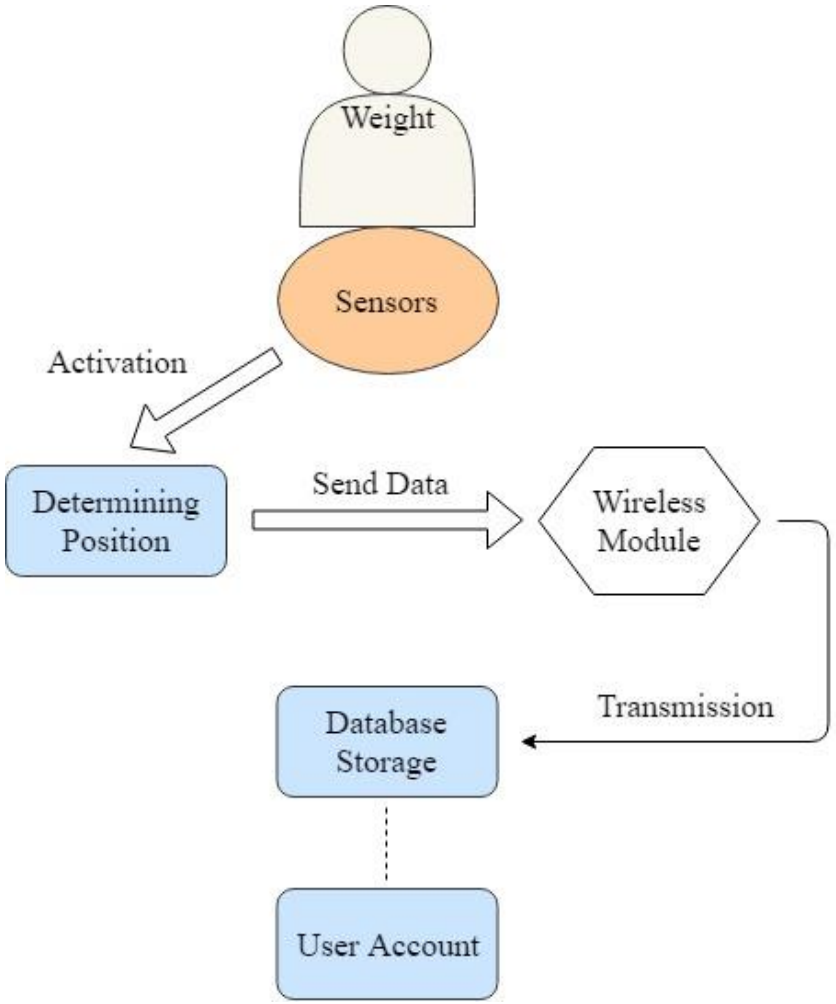
# Vibrate Module

- Low cost: <$1.00 per unit
- Simple integration
- DAC to supply pulse signal
- 2.8v - 5v

# Software Design

- Wireless Communication
- NoSQL Database
- Application Framework

# Flowchart Diagram



# Wireless Modules

| Bluetooth | Wi-Fi |
| --- | --- |
| Shorter Range | Longer Range |
| Close proximity | Remote Location |
| Direct Connections | Online Connection |
| Lower Power | Higher Power |

# Bluetooth Specification

| Hardware Features | Software Features |
|---|---|
| -80 dBm sensitivity | PIO: low-disconnect & high-connect |
| +4 dBm RF transmit power | Rising Pulse will disconnect |
| Low Power 1.8 V Operation | Auto-connect on last device |
| PIO Control | Pair Last Device as Default |
| UART Interface | PINCODE: 0000 / 1234 |

# Wi-Fi Specification

| Hardware Features | Software Features |
| --- | --- |
| CPU: Tensilla L 106 32-bit | Security: WPA / WPA2 |
| Integrated Memory (SRAM) | Encryption: WEP/TKIP/AES |
| SPI External Flash | Firmware: OTA Network |
| RF 2.4 GHz Receive/Transmit | SDK: Supports Cloud Server |
| Adjustable Power Mode | Network Protocol: TCP/UDP/HTTP |

# Wireless Module

Wi-Fi vs Bluetooth

- Wi-fi can store value into database
- Bluetooth has no storage
- Bluetooth lack of Full Duplex support

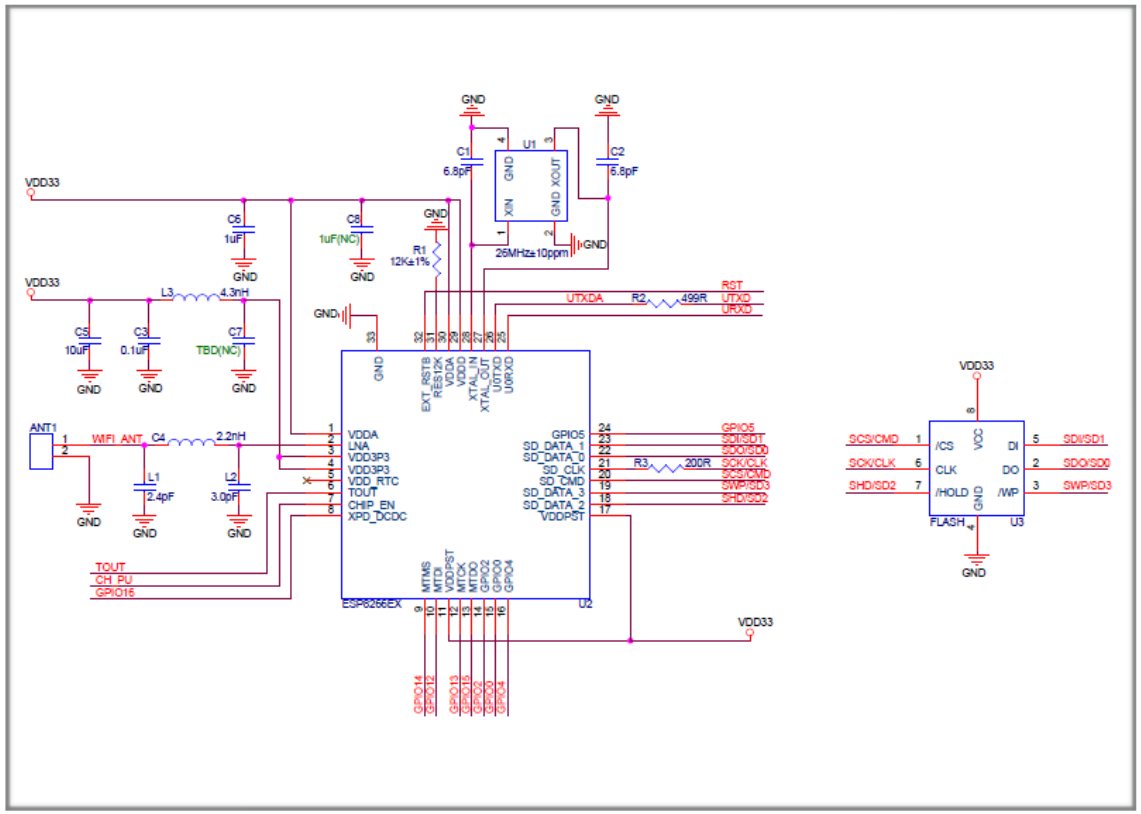
ESP8266

- Breadboard testing
- Surface mount
- Antenna RF optimization

# ESP8266 Schematic

Main Aspects

- Power Supply
- Power-on sequence and reset
- Flash
- Crystal oscillator
- RF
- External resistor
- UART



# ESP8266 Pros and Cons

Pros

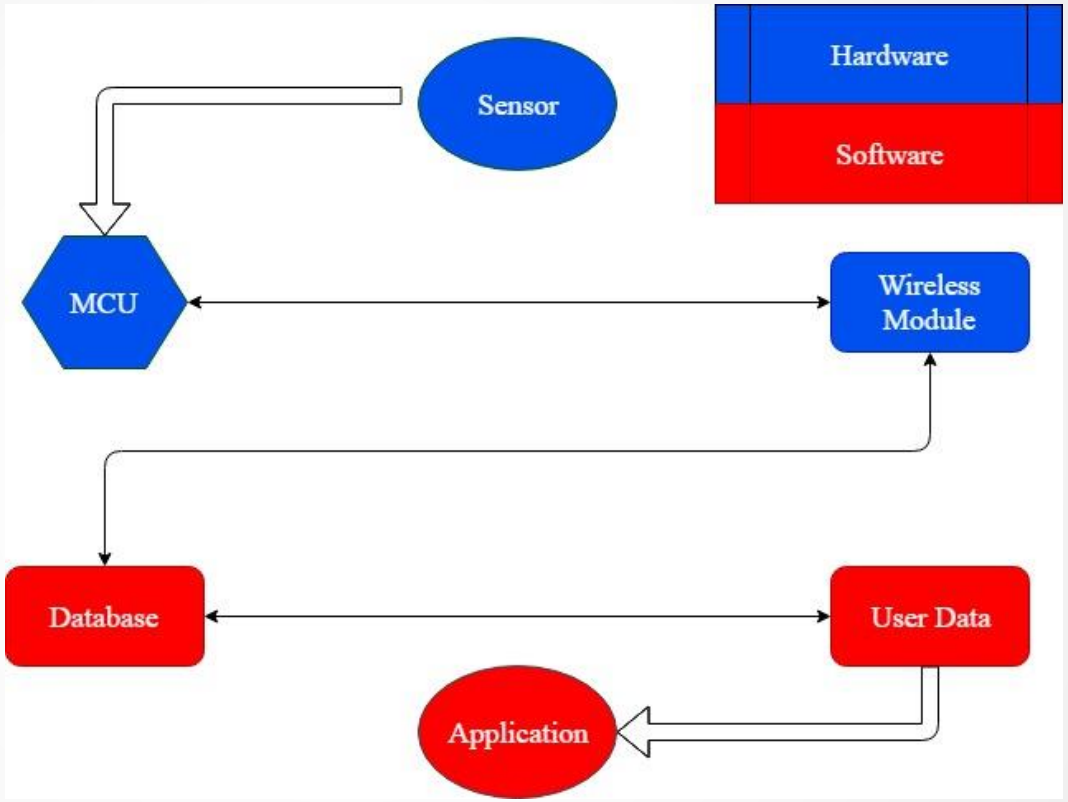
- Compatibility with IDE
- Multiple GPIO pins
- Powerful capabilities

Cons

- Difficult to start working
- Requires multiple libraries

# Wireless Communication

- Sensor data
- Wi-Fi Transmission
- Send data through cloud
- Database Receive data
- Firebase



# Purpose of Application

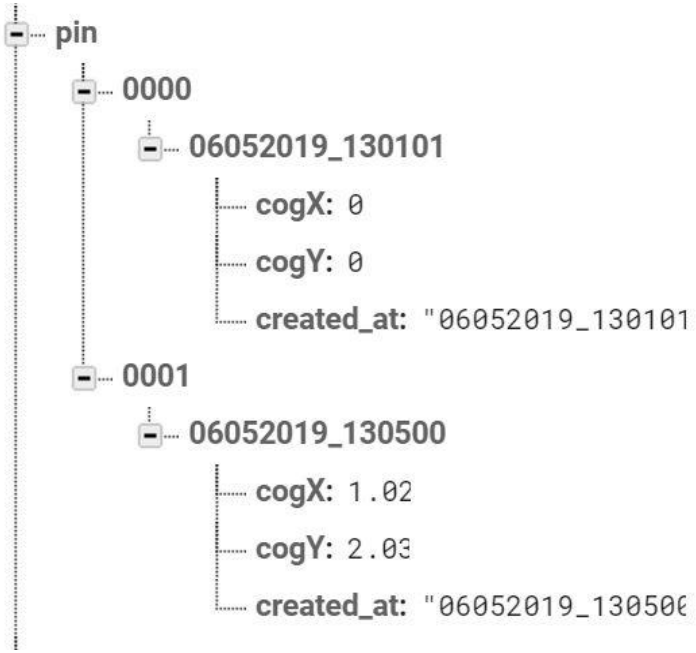
- To allow the user to view posture data.
- To provide feedback on posture data to the user.
- To allow the user to alter settings.

# Application Design

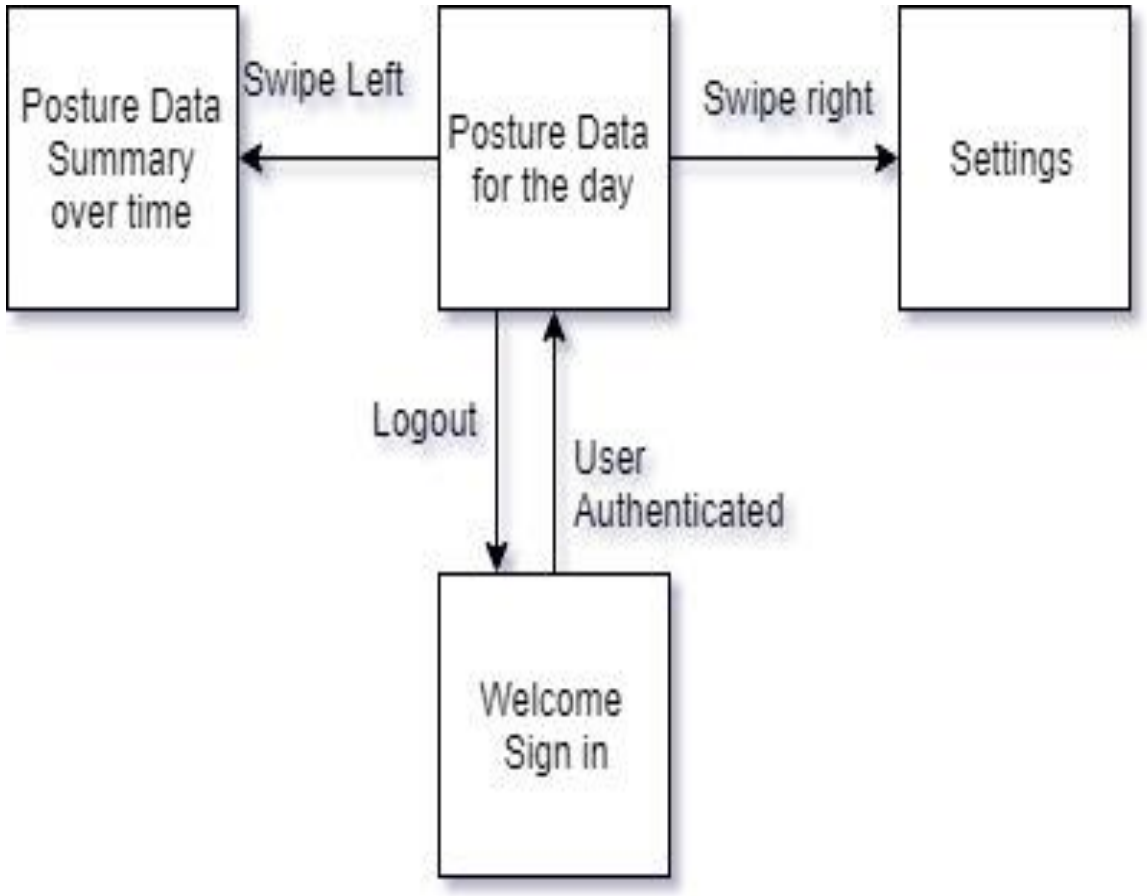
- Technologies Used:
  - Firebase serves as the back-end.
    - User Accounts
    - NoSQL Database
  - Flutter serves as the front-end framework.
    - Developed by Google
    - Dart Language
    - Hot reload

# NoSQL Database Design

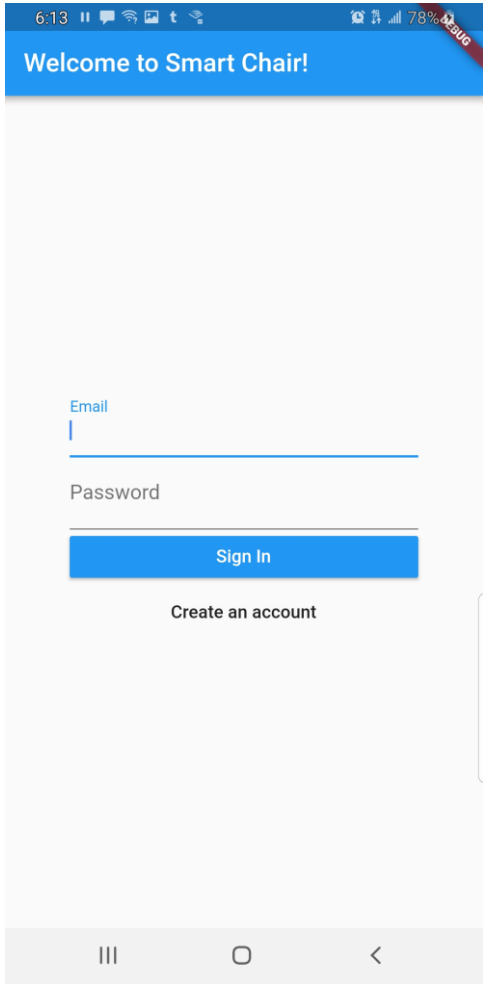
- Provides support for offline data persistence.
- Each data entry contains the center of gravity on the left-to-right axis and the front-to-back axis and the timestamp.
- This is subject to change during the process of integrating the legitimate sensor data into the software.

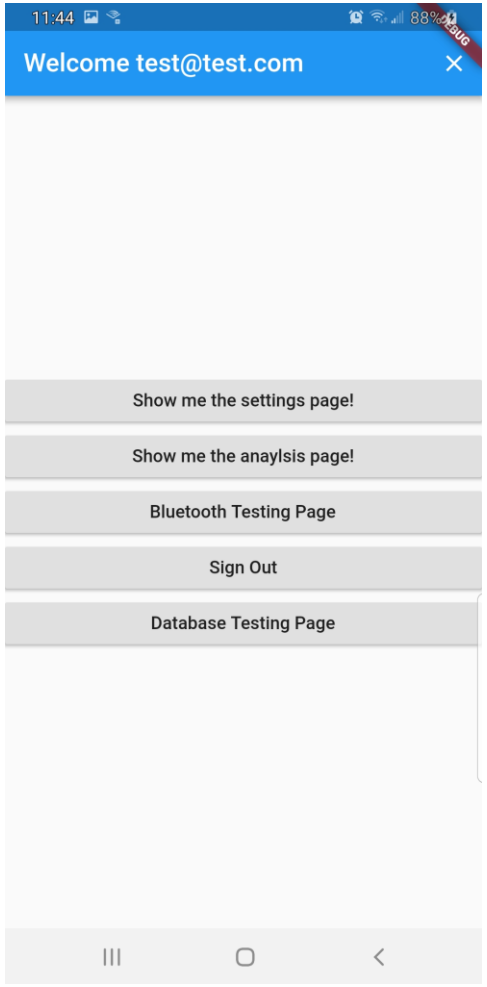


# User Interface Design



# User Interface Design

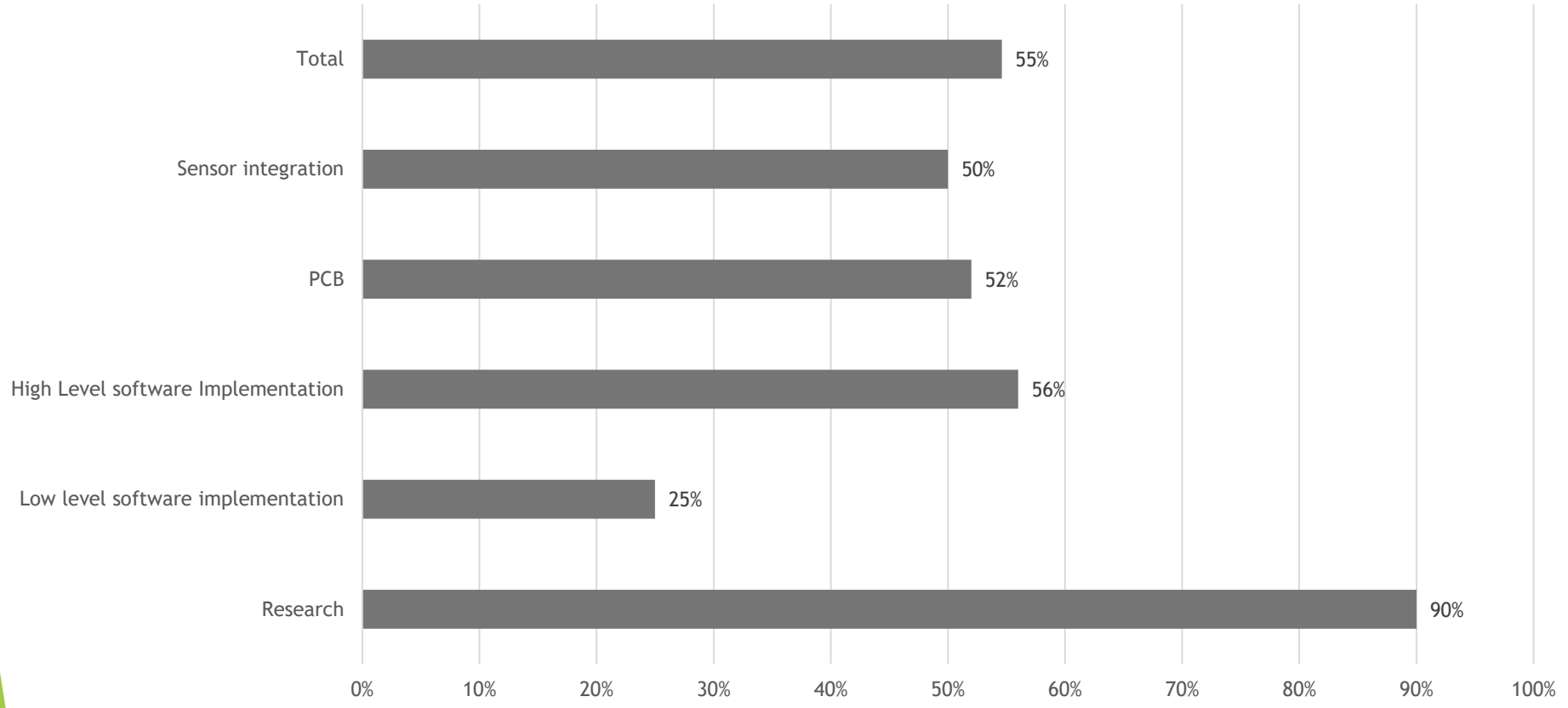


# Application Completion Status

- Complete:
  - Firebase authentication
  - Firebase database (including read/write)
  - Basic Layout
  - Basic navigation
- Pending:
  - Settings / User Preferences
  - Posture data represented in graphical format
  - Recommend Stretches/Yoga poses
  - Swipe navigation
  - Color Theming

# PROGRESS GRAPH



# Roles

| Task | Primary | Secondary | Status |
|---|---|---|---|
| Wireless Communication | Thien | Annavay | proto |
| Database Development | Annavay | Thien | proto |
| Mobile Application | Annavay | Thien | Proto |
| Microcontroller | Rudy | Mackenson | Ordered |
| Power Supply | Mackenson | Rudy | proto |
| Rechargeable Battery | Mackenson | Rudy | Received |
| Force Sensor Integration | Rudy | Thien | proto |
| Vibration Module | Rudy | Thien | Received |
| User Interface | Annavay | Thien | In development |
| PCB Design | Mackenson | Rudy | 2nd iteration |

# BUDGET SHEET

| Item | Description | Quantity | Cost | Total | Estimated Cost |
|---|---|---|---|---|---|
| Tekscan A301 | round force sensors - 4 pk | 1 | $53.60 | $53.60 | $150.00 |
| Tekscan A502 | Larg square force sensors - 4 pk | 1 | $108.25 | $108.25 | |
| 556-ATMEGA2560-16AU | Microcontroller | 3 | $12.20 | $36.60 | $40.00 |
| Chair | Office chair, cloth, rolling | 2 | 0 | 0 | $75.00 |
| Eleego Mega 2560 R3 | ATmega Dev board | 1 | $13.99 | $13.99 | $16.00 |
| HC-SR04 | ultrasonic proximity sensor | 1 | 0 | 0 | $10.00 |
| Mircrochip ATMega2560 | microcontroller samples from OEM | 5 | 0 | 0 | - |
| Final Paper | printing and binding | 1 | $27.98 | $27.98 | $30.00 |
| System Enclosure | Housing for PCB | | | | |
| PCB surface components | PCB resistors, caps, etc. | Multiple | | 34.17 | $50.00 |
| Firebase | Backend manager | 1 | - | - | - |
| ESP8266 | Wi-Fi Module | 4 | $19.99 | $19.99 | $40.00 |
| Total | | | | **$291.33** | **$840.00** |

# Implementation Challenges

- Software-Hardware Integration
  - Proper data transmission
  - Formatting data
- Foam of chair (Sensors)
  - Reduce thickness of foam
    - Partition foam
  - Add barrier between sensors and foam

# Q&A