HANDS ON
FLIGHT

The Team

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Hardware Development

PCB Design

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Peripheral Integration

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System Design

Outline

- Purpose
- Functionality
- Parts
- Software
- Printed Circuit Board
- Conclusion

Purpose

Problem Statement

Our Solution

Problem

Solution

Design a glove to improve intuitive interactions between humans and machines

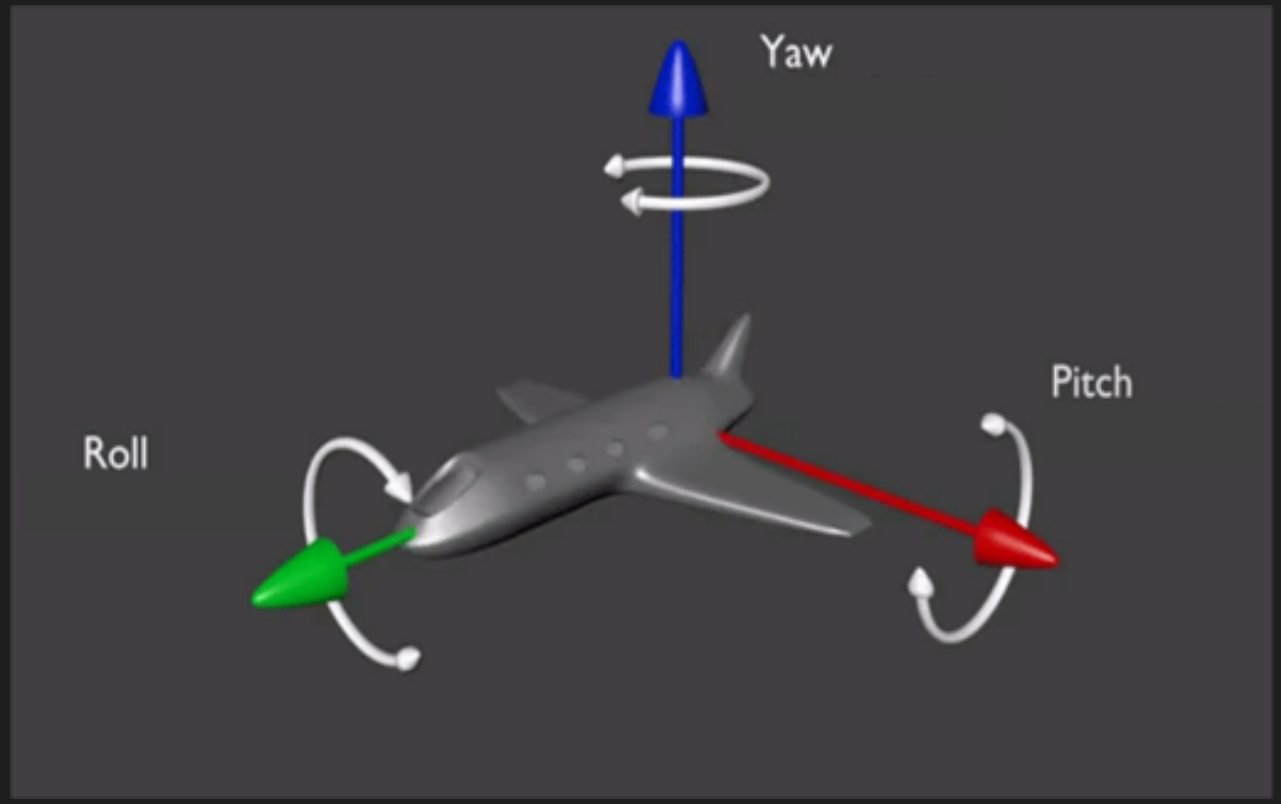
- Haptic feedback
- User friendly sensors
- Form fitting circuit design

Functionality

Sensors and IC Usage System Overview

Sensors and IC Usage

- Capture motion of the hand through Inertial Measurement Units and stretch sensors
- Transmit motion data to drone:
  - Throttle
  - Roll
  - Pitch
  - Yaw
- Haptic feedback for axial movements



System Overview

Hand Control

Sends IMU and Stretch Sensor Data

Arveng Control App

Translates data received into controls for drone

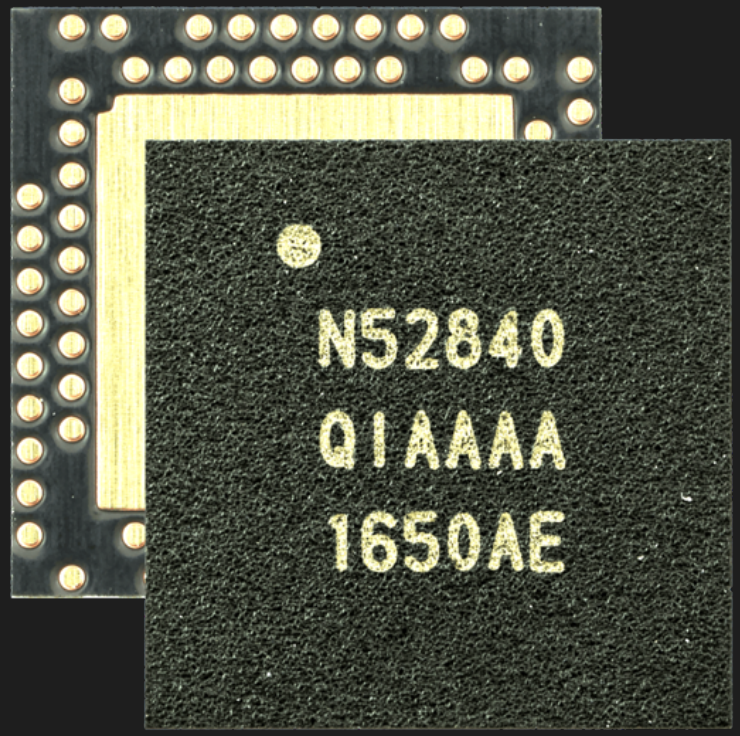
DJI Drone

Parts

- Micro-controller
- IMU
- Haptic driver
- Stretch sensor

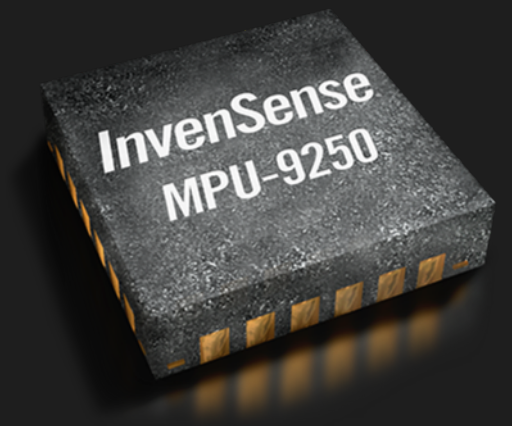
Micro-controller (nRF52840)

- I2C & SPI
- Analog GPIOs
- Integrated Bluetooth 5



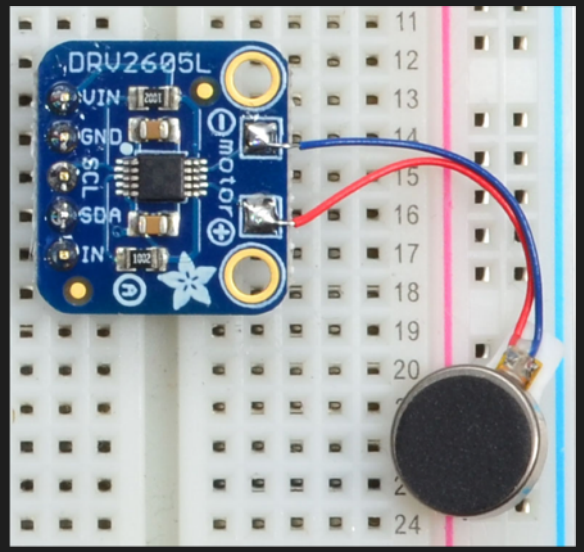
IMU (MPU-9250)

- SPI
- Orientation calculations
- Gyro + Accelerometer + Compass



Haptic driver (DRV2605L)

- I2C
- Vibrating motor disc
- User feedback



Stretch sensors

- Analog output
- Stretching changes capacitance
- Functional control of drone

```
thumb:456
index:393
middle:430
ring:411
pinky:427
```

Software

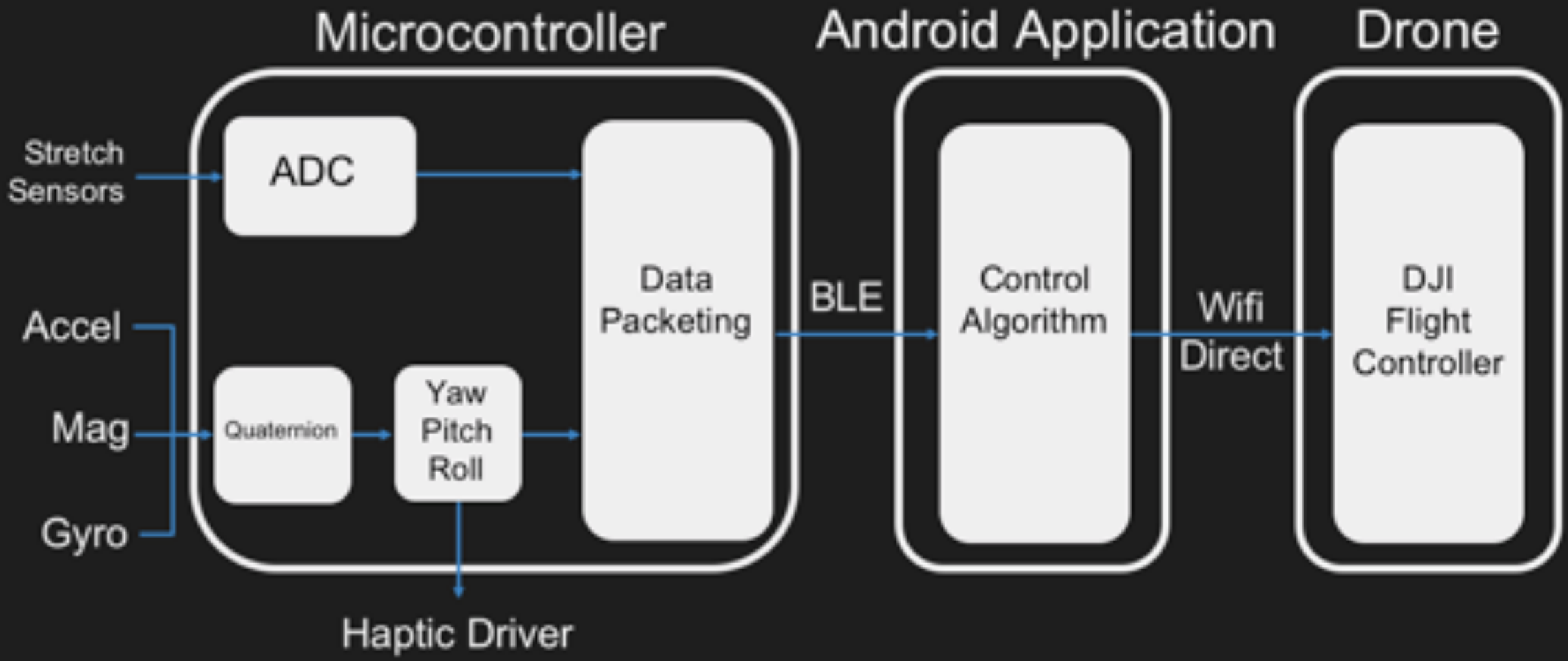
Signal Block Diagram

IMU

Stretch sensor

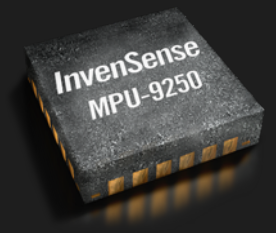
Haptic driver

Signal Block Diagram



IMUs

- Read quaternion values



$$q_0 = q_w = cos(\alpha/2)$$
$$q_1 = q_x = sin(\alpha/2)cos(\beta_x)$$
$$q_2 = q_y = sin(\alpha/2)cos(\beta_y)$$
$$q_2 = q_z = sin(\alpha/2)cos(\beta_z)$$

- Convert quaternions to yaw, pitch, and roll

$$q_1,\ q_2,\ q_3,\ q_4$$

$$yaw = atan2(2(q_0q_1 + q_2q_3),\ 1 - 2({q_1}^2 + {q_2}^2))$$
$$pitch = asin(2(q_0q_2 - q_3q_1))$$
$$roll = atan2(2(q_0q_3 + q_1q_2),\ 1 - 2({q_2}^2 + {q_3}^2))$$

Stretch sensors

- Measuring capacitance via RC charge timing
- One charge pin in series with resistor and stretch sensor
- Controls drone throttle

Haptic driver

- Selecting waveform
- Soft and stronger buzzes

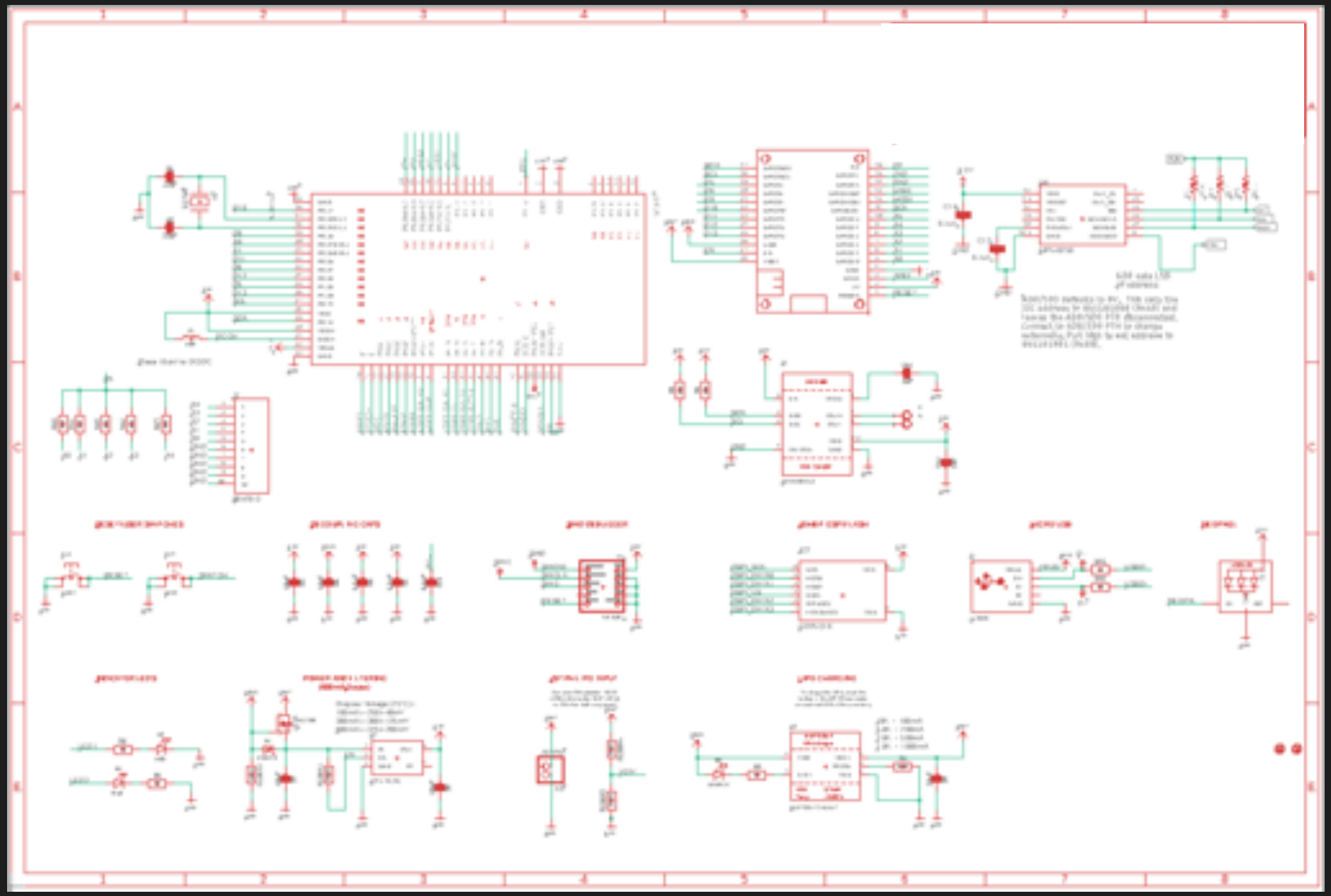
PCB

- Power Requirements
- Schematics
- Board Layout
- Our PCB

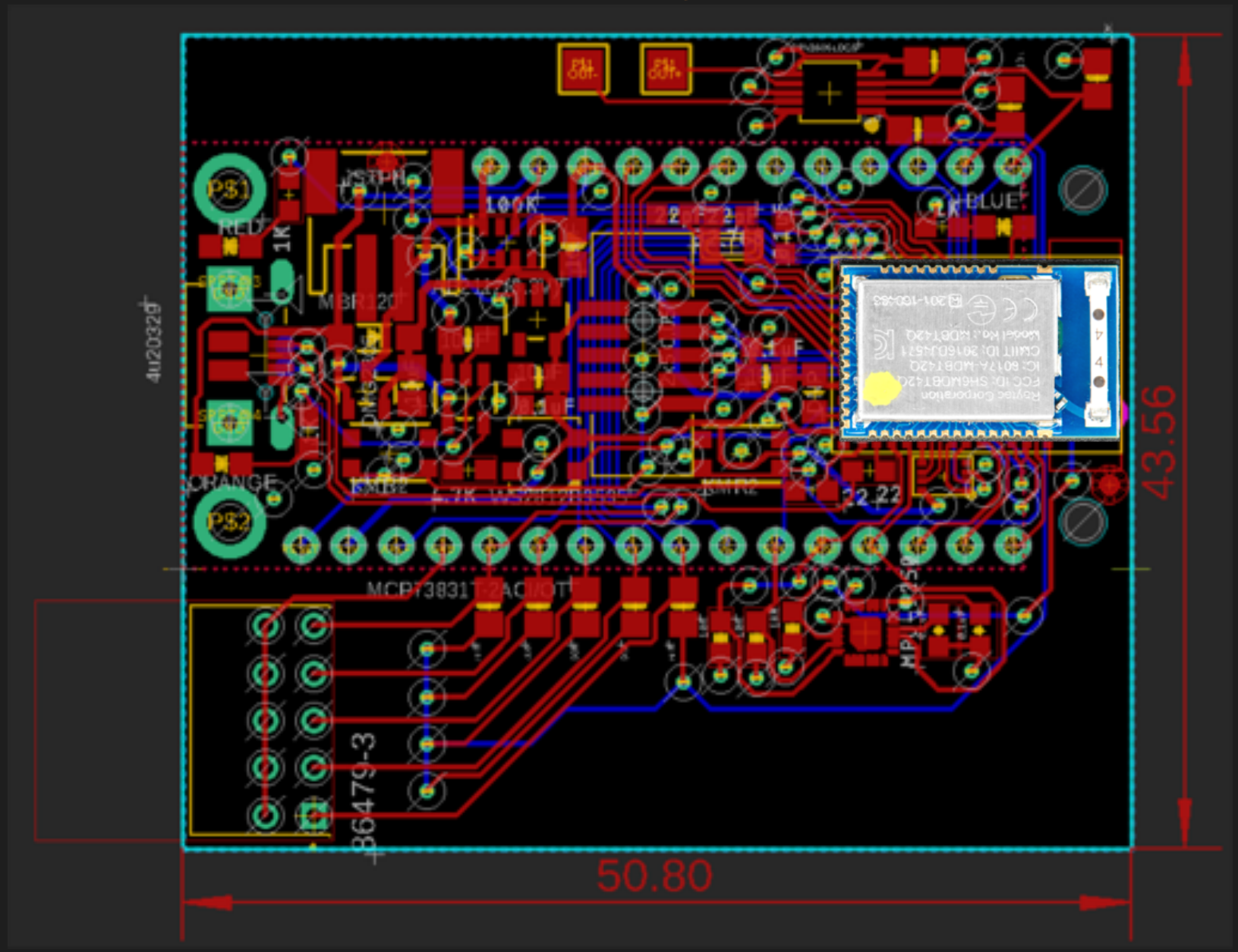
Power Requirements

- Voltage Requirements: 1.7 v to 3.3 v operation
- IMU: 2.4 v - 3.6 v, Operating current 3.5 mA
- Haptic driver: 2 v - 5.2 v, Operating current ~2.4 mA
- Stretch sensors: 3 v - 5 v, Operating current ~1 uA
- 3.7 v 2000 mAh Lithium polymer battery

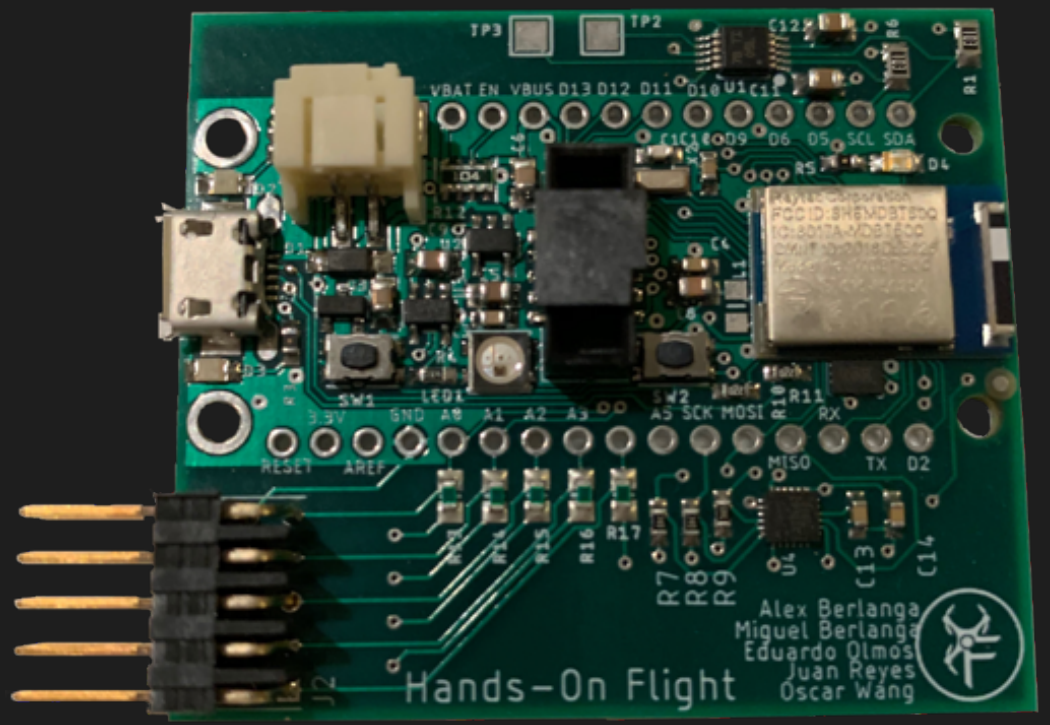
Schematic : Full Block Diagram



PCB Layout


43.56
50.80
PS1
PS2
RED
ORANGE
BLUE
100K
1K
2K
MCP73831T-2ACI/OT
B6479-3

Our PCB


TP3
TP2
VBAT EN VBUS D13 D12 D11 D10
D9 D6 D5 SCL SDA
SW1
LED1
3.3V GND A0 A1 A2 A3
A5 SCK MOSI MISO RX TX D2
RESET AREF
R7 R8 R9
R16 R17
Alex Berlanga
Miguel Berlanga
Eduardo Olmos
Juan Reyes
Oscar Wang
Hands-On Flight

Conclusion

The Hands-On Flight Glove

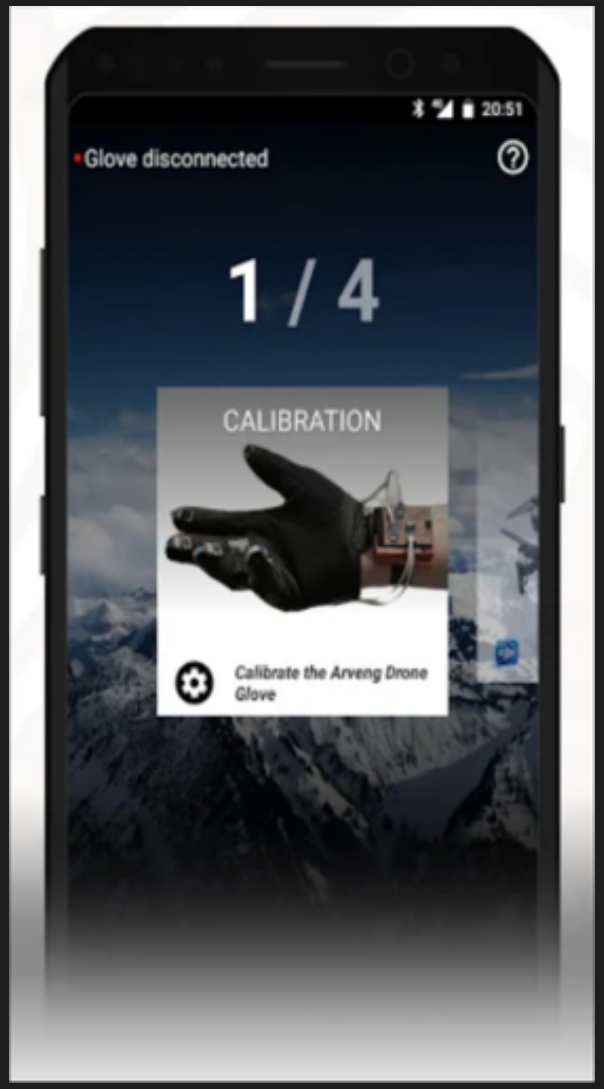
Arveng App

From Hands-Off to Hands-On Flight

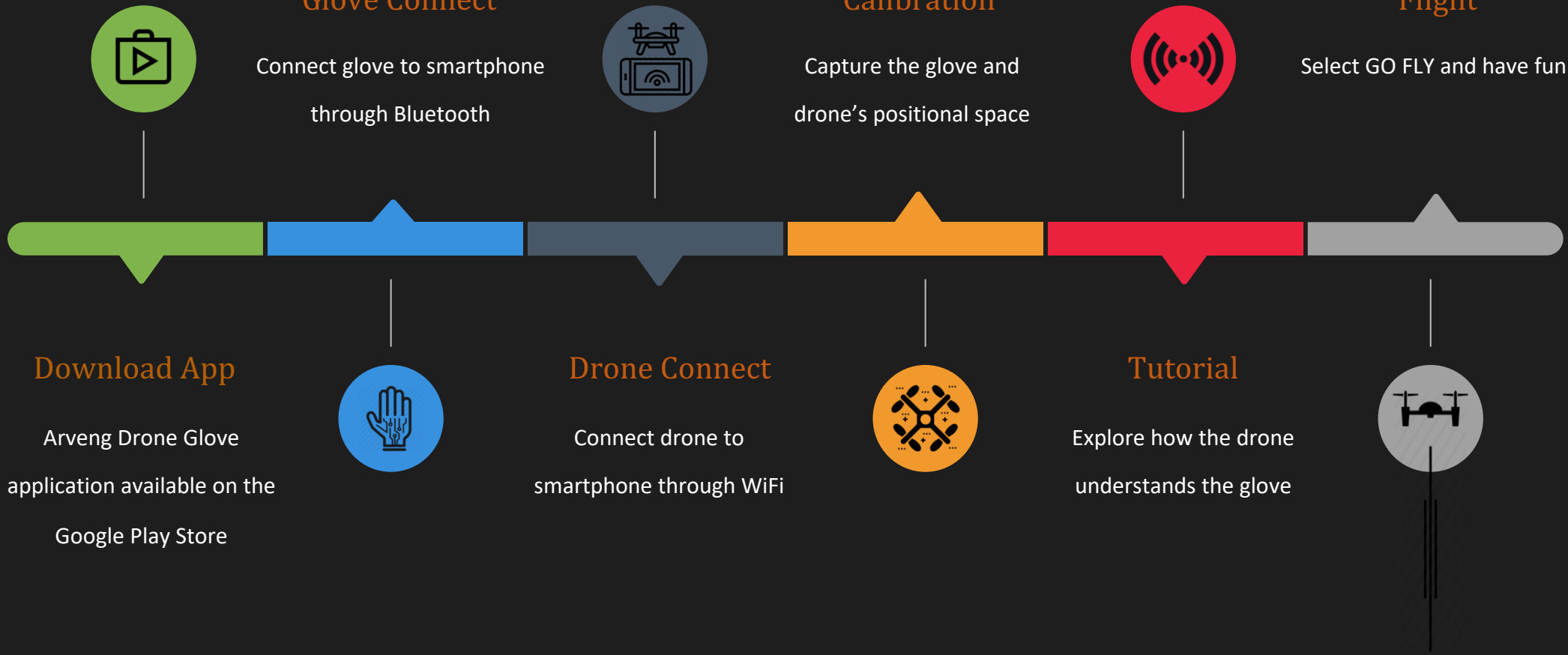
Demo

The Hands-On Flight Glove

Arveng App


20:51
Glove disconnected
1 / 4
CALIBRATION
Calibrate the Arveng Drone Glove

From Hands-Off to Hands-On Flight



Download App

Arveng Drone Glove application available on the Google Play Store

Glove Connect

Connect glove to smartphone through Bluetooth

Drone Connect

Connect drone to smartphone through WiFi

Calibration

Capture the glove and drone's positional space

Tutorial

Explore how the drone understands the glove

Flight

Select GO FLY and have fun!

Demonstration

A Special Thanks To:

- Yogananda Isukapalli, Capstone Instructor
- Brandon Pon, TA
- Carrie Segal, TA
- Magnus Arveng, Sponsor
- Laritech, PCB Manufacturer and Assembler

Qualcomm

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ODM SOLUTIONS

UC SANTA BARBARA
engineering and the sciences

Questions?