

# Hover Hand

## Critical Design Review

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# Introduction

What is the Hover Hand glove?

- Glove that turns the hand into a quadcopter remote controller

What does a quadcopter remote controller do?

- Sends information to the quadcopter to tell it where to go
  - Throttle
  - Yaw
  - Pitch
  - Roll

# Introduction

How does it work?

- 5 Inertial Measurement Units on the hand for sensing hand movements
  - 4 IMUs on fingers, with exception being the ring finger
  - 1 IMU on the top of the hand
- FRSky DHT 2.4GHz Antenna for establishing connection and communicating with the quadcopter

# Hover Hand Team

Zachary Meyer - Project Lead, Parts Selection,  
Hardware/Software Interfacing

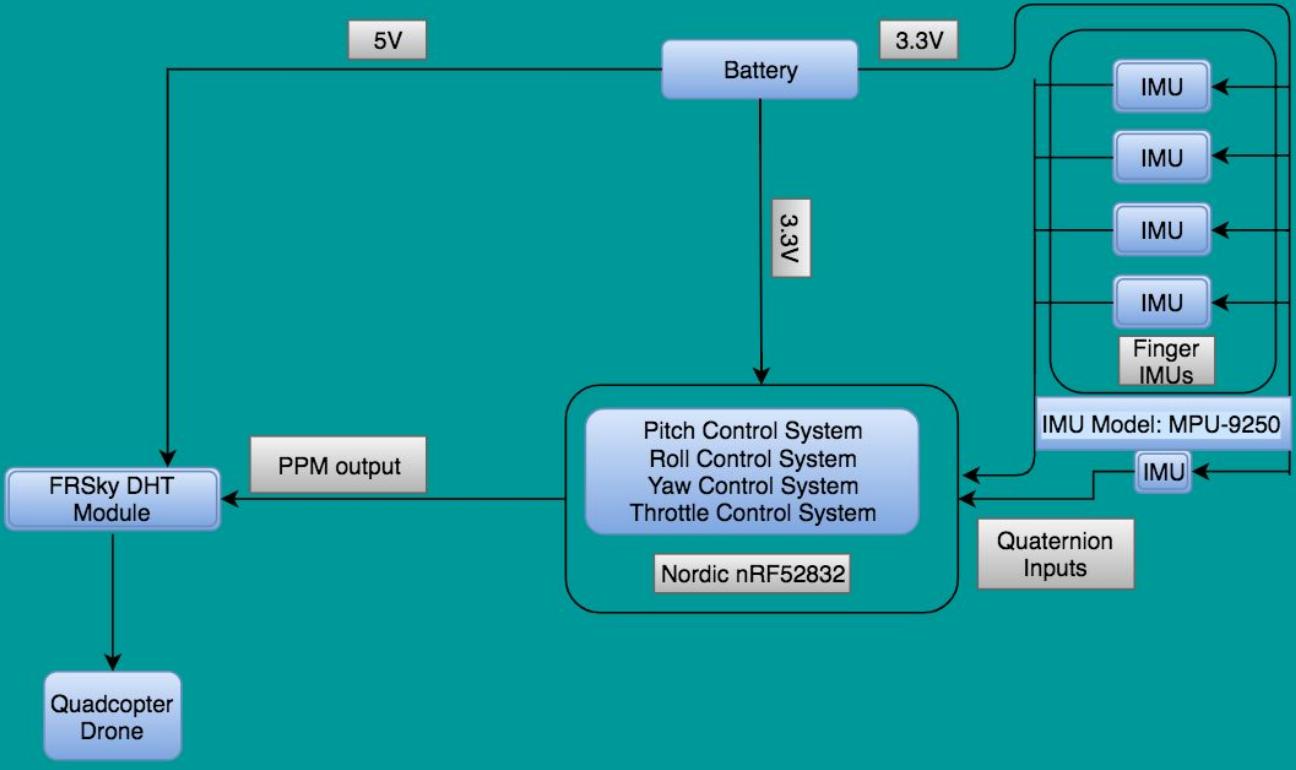
Austin Dorotheo - Software Development

Steven Fields - Hardware Development, PCB/Schematic  
design

Colin Garrett - Hardware Development

Miclos Lobins - Software Development

# High Level Block Diagram



# Bill of Materials

\$116.72 spent on parts

A	B	C	D
Designator	Manufacturer Part Number	Quantity	Description
U5	MPU-9250	1	Inertial Measurement Unit
U2	TCA9548APWR	1	Multiplexer
J1,J2,J3,J4,J5,J7	640456-4	6	4-pin jumpers
J6	S2B-PH-SM4-TB(LF)(SN)	1	JST connector for battery
D1	VLMR51Z1AA-GS08	1	Red LED
R1	ESR03EZPF1502	1	15k
R2,R3,R4	ESR03EZPJ103	3	10k
R5,R6,R7,R8,R9,R10,R11,R12,R13,R14,R15,R16,R33,R34	ESR03EZPJ472	14	4.7k
R17	ESR03EZPJ205	1	2M
R18,R20	ESR03EZPF2203	2	220k
R19	ESR03EZPJ125	1	1.2M
R23	ESR03EZPJ202	1	2k
C1,C2,C3	C0603C104K8RACTU	3	.1uF
C6	CL10A226MQ8NRNC	1	22uF
L1,L2	LQM18FN100M00D	2	4.7uH
B1,B3	LT1300CN8#PBF	2	3.3V voltage booster
B2,B4	MBRS130LT3G	2	schottky diode
C4,C7	GRM21BR60J107ME15L	2	100uF
U1	BL652-SA-01	1	nrF52832

# Parts

## Nordic nRF52832

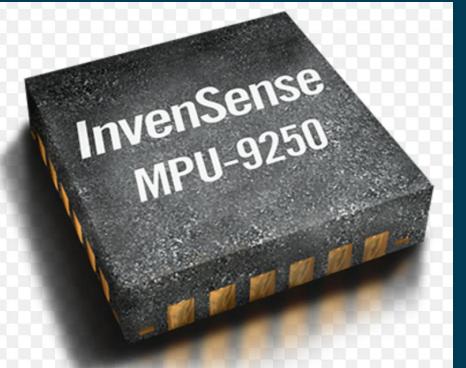
- ARM Cortex M4 Microprocessor
- 64 MHz Clock Speed
- 512KB Flash
- 64KB RAM
- 1.8V-3.6V input supply
- 2.4 GHz transceiver
  - Supports Bluetooth Low Energy
  - RSSI



# Parts

## MPU-9250

- 9-axis IMU
- Contains 2 chips
  - MPU-6500
    - 3-axis gyroscope and accelerometer
    - Onboard Digital Motion Processor (with quaternion outputs)
  - AK 8963
    - 3-axis digital compass
  - Supports I<sup>2</sup>C and SPI



# Parts

## FRSky DHT 2.4GHz Transmitter

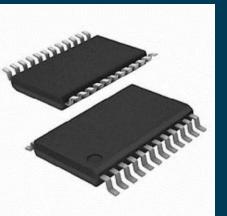
- Takes PPM input
- Bind button to connect to quadcopter
- Switch to change version of FRSky protocol 2-way vs. 1-way
- Handles much of the heavy lifting involved with RF Transmission



# Parts

## TI TCA9548APWR

- Multiplexer for I<sup>2</sup>C devices
- 8 Devices supported



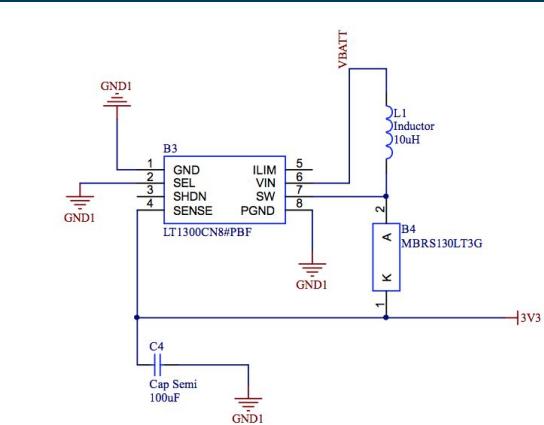
## Adafruit Lithium Ion Battery

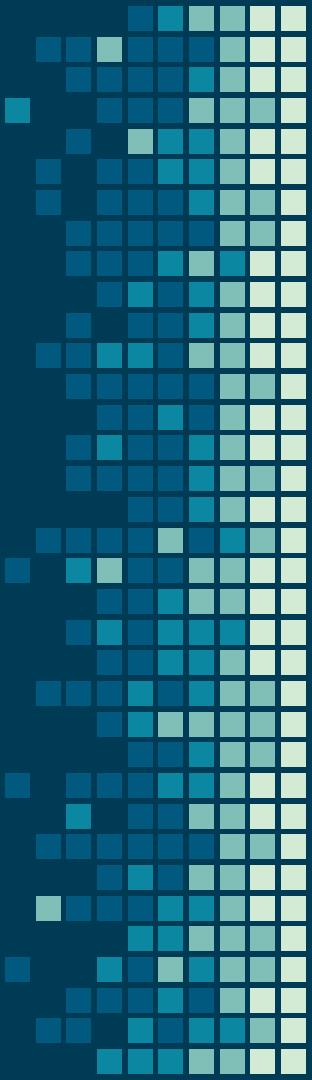
- 500mAh capacity
- 3.7V output



## LM1300 Voltage Converter

- Two used to convert to 3.3V and 5V

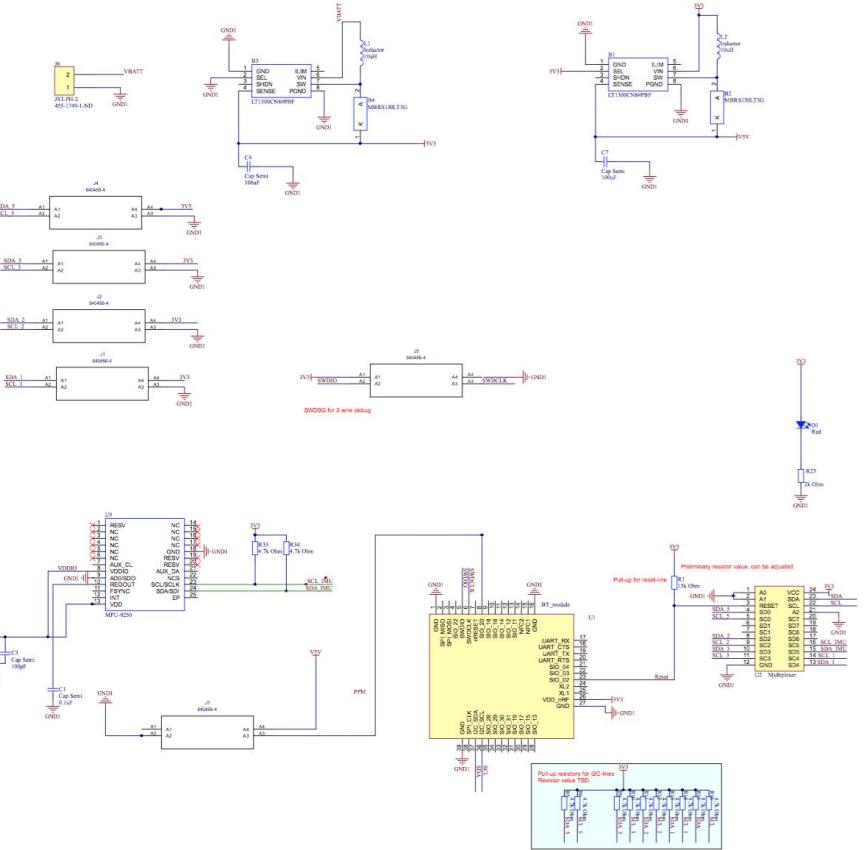




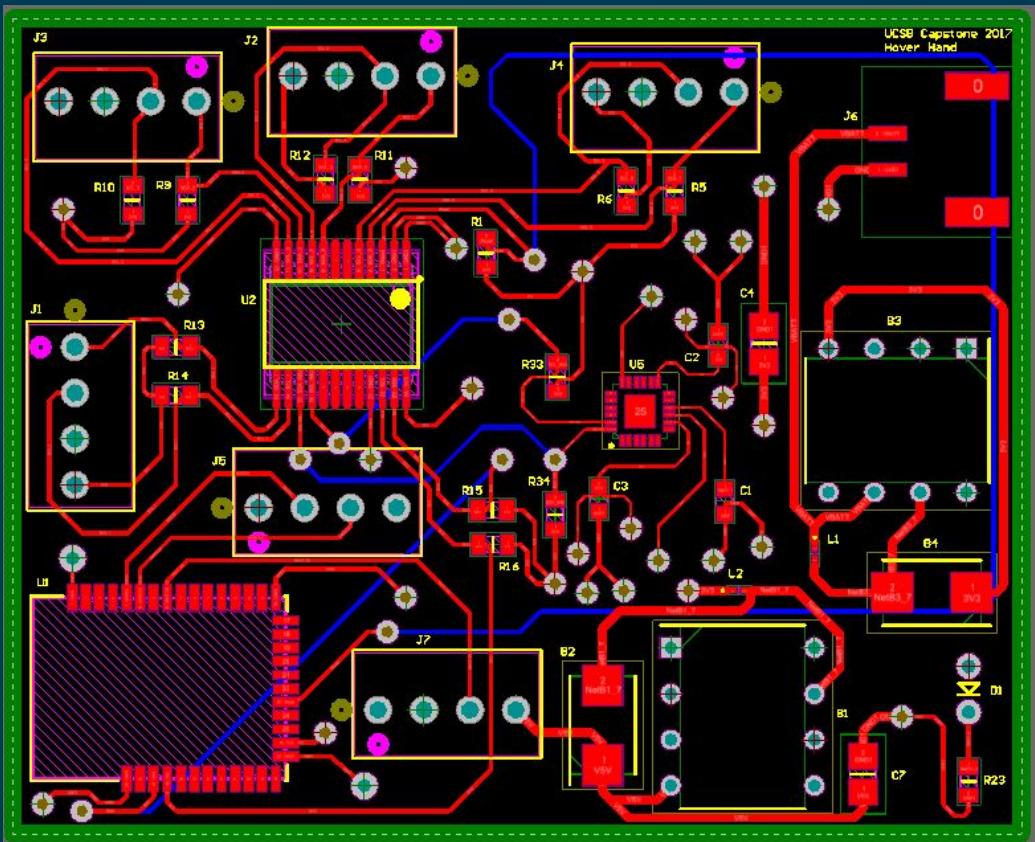
# Power Distribution

- 3.7V Battery will be regulated to 3.3V and 5V
- No analog devices, so not necessary for different power planes of the same voltage
- Nearly all components Powered by 3.3V
  - Processor
  - IMU
  - Multiplexer
- FRSky RF module is the only component powered by 5V

# Schematic



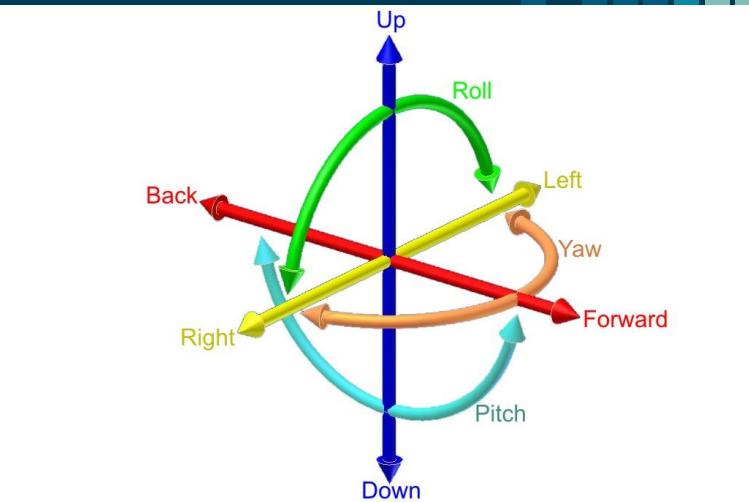
# PCB



# Software Development

## Control Algorithms

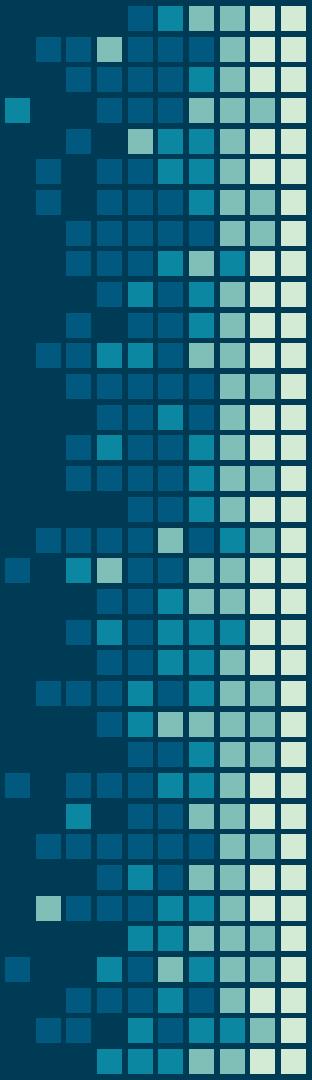
- Four main inputs to quadcopter:
  - Roll
    - left/right angular hand movement
  - Pitch
    - forward/back angular hand movement
  - Yaw
    - left/right hand movement across the wrist
  - Throttle
    - upward/downward movement of the middle finger alone



# Software Development

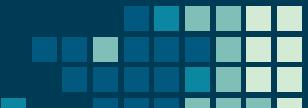
## Signal Flow

- Quaternion inputs received from IMUs
  - Converts quaternions to Euler angles using algorithms
    - Used to calculate yaw, pitch and roll
- Yaw, pitch, roll, throttle converted to PPM signal
  - Values converted to quadcopter range
    - Range for quadcopter: 1000-2000
  - PPM output to GPIO pin
  - DHT transmitter converts PPM signal to FRSky RF protocol
  - FRSky flight controller receives signal



# Conclusion

- Prototype PCB is out for production & assembly
  - Should be completed and sent to us in the next week
- Plans for Winter and Spring
  - Ensure valid operation of the prototype glove
  - We plan to do a respin with an updated design
    - Replace outdated parts with newly released parts
      - nRF52832->nRF82840
      - MPU-9250->ICM-20948
    - Change parts from the first prototype that were limiting board size such as the voltage converters and jumpers
    - Remove FRSky RF module and use bluetooth connection, which is built into the nRF52840
      - We will need to add a bluetooth receiver to the quadcopter and most likely change signal output from PPM to accommodate the new method of communication
  - Tune Software algorithms using first prototype glove
  - Test bluetooth Tx/Rx design using first prototype glove
  - Implement special gestures for actions such as hovering in place, or emergency shutdown



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