Hover Hand
Fall Quarter 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

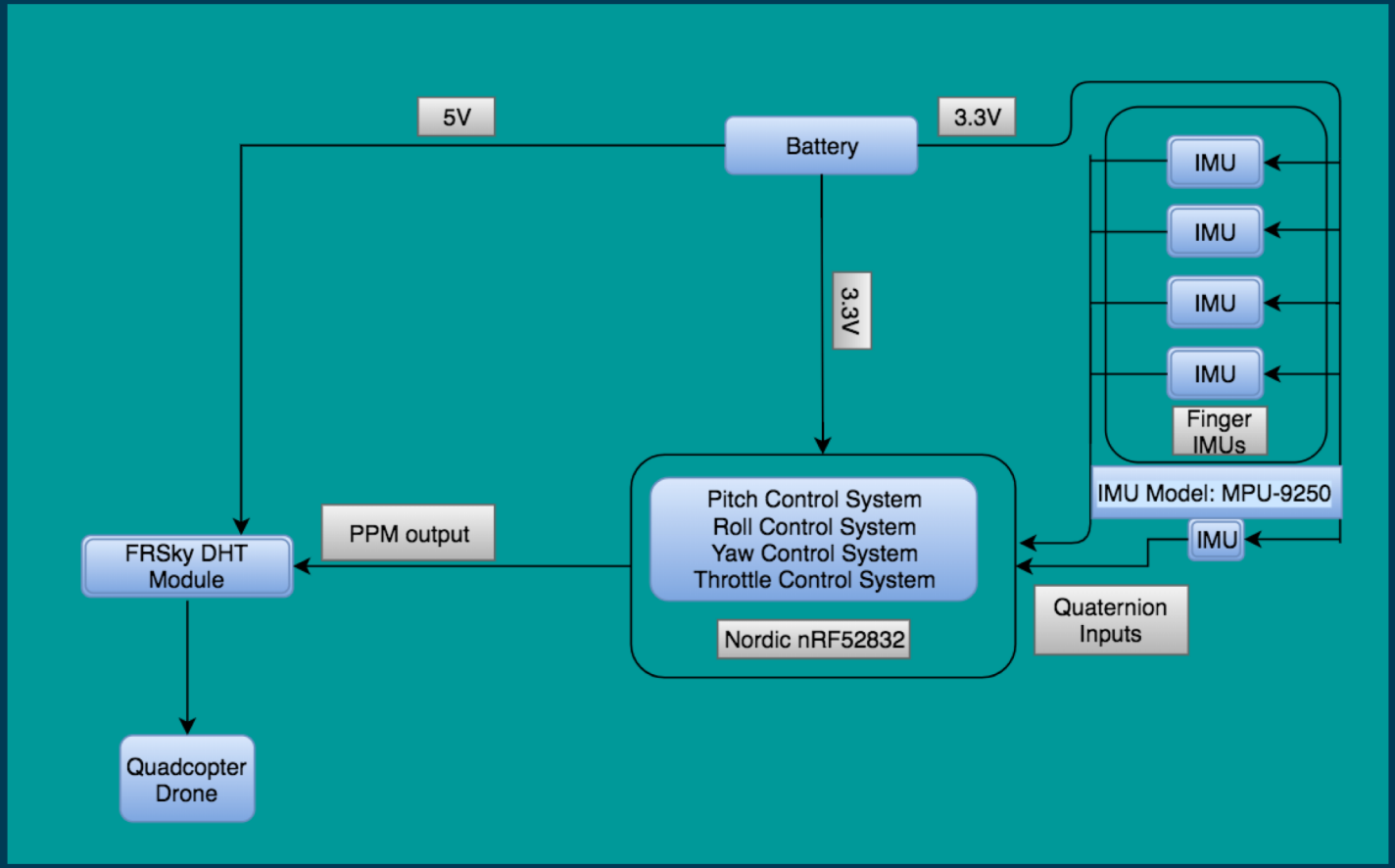
How does it work?

- 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

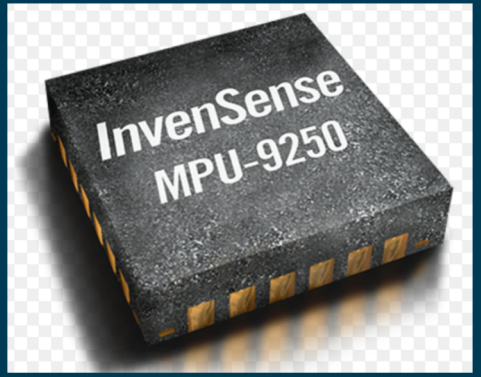
A	B	C	D
Designator	Manufacturer Part Number	Quantity	Description
U5	MPU-9250	1	Inertial Measurement Unit
U2	TCA9548APWR	1	Multiplexer
J1,J2,J3,J4,J5,J7	640456-4	6	4-pin jumpers
J6	S2B-PH-SM4-TB(LF)(SN)	1	JST connector for battery
D1	VLMR51Z1AA-GS08	1	Red LED
R1	ESR03EZPF1502	1	15k
R2,R3,R4	ESR03EZPJ103	3	10k
R5,R6,R7,R8,R9,R10,R11,R12,R13,R14,R15R16,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



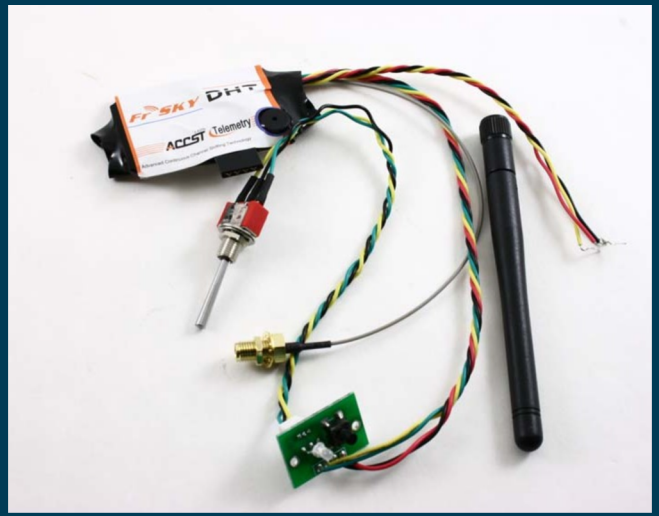
MPU-9250

- 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^2C and SPI

Parts

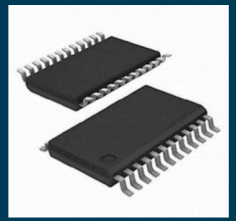
FRSky DHT 2.4GHz Transmitter

- 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

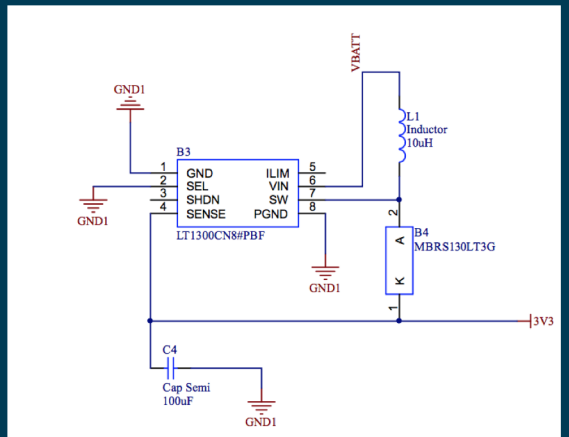


- Multiplexer for I^2C devices
- 8 Devices supported

Adafruit Lithium Ion Battery

- 500mAh capacity
- 3.7V output

LM1300 Voltage Converter

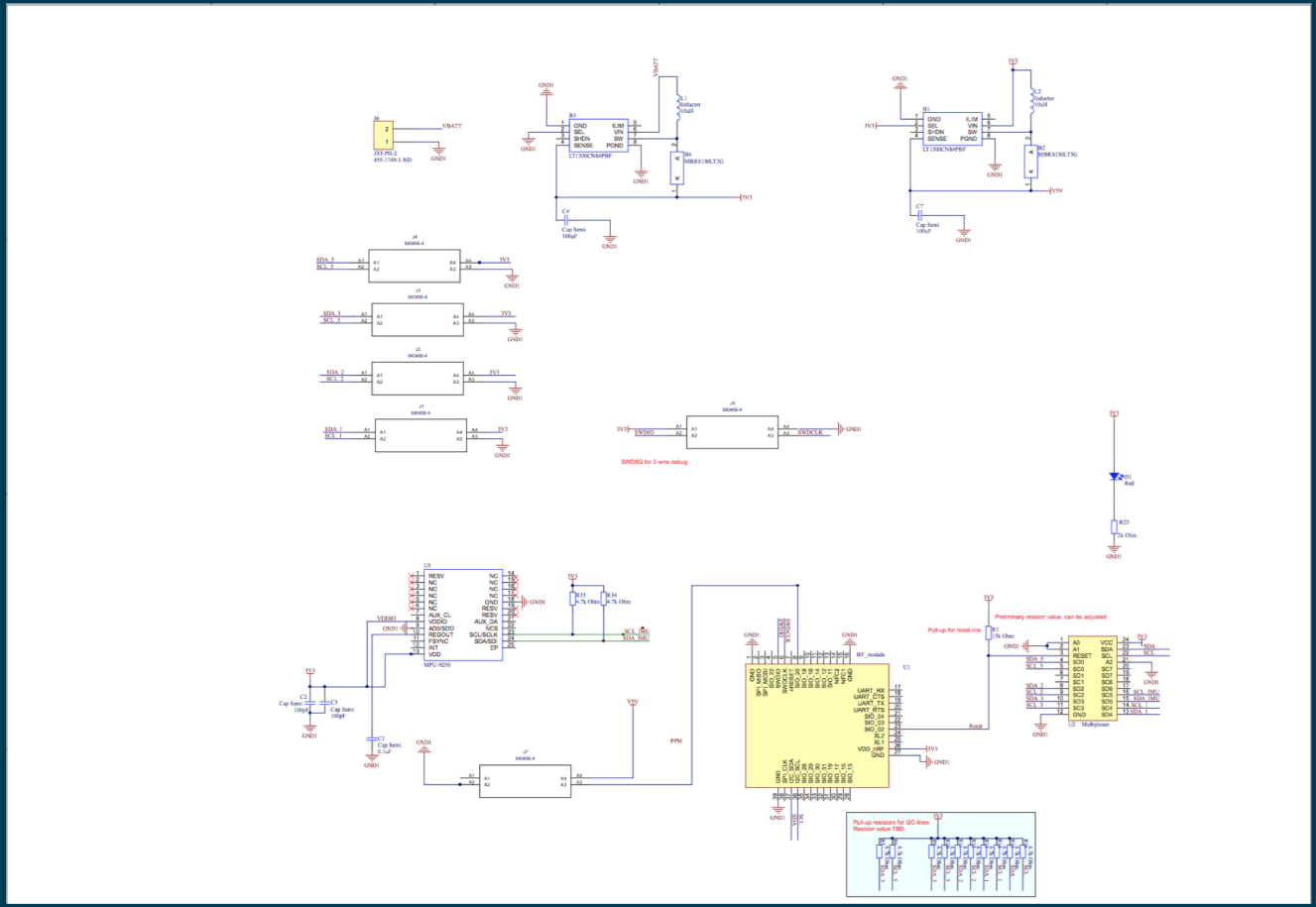


- Two used to convert to 3.3V and 5V

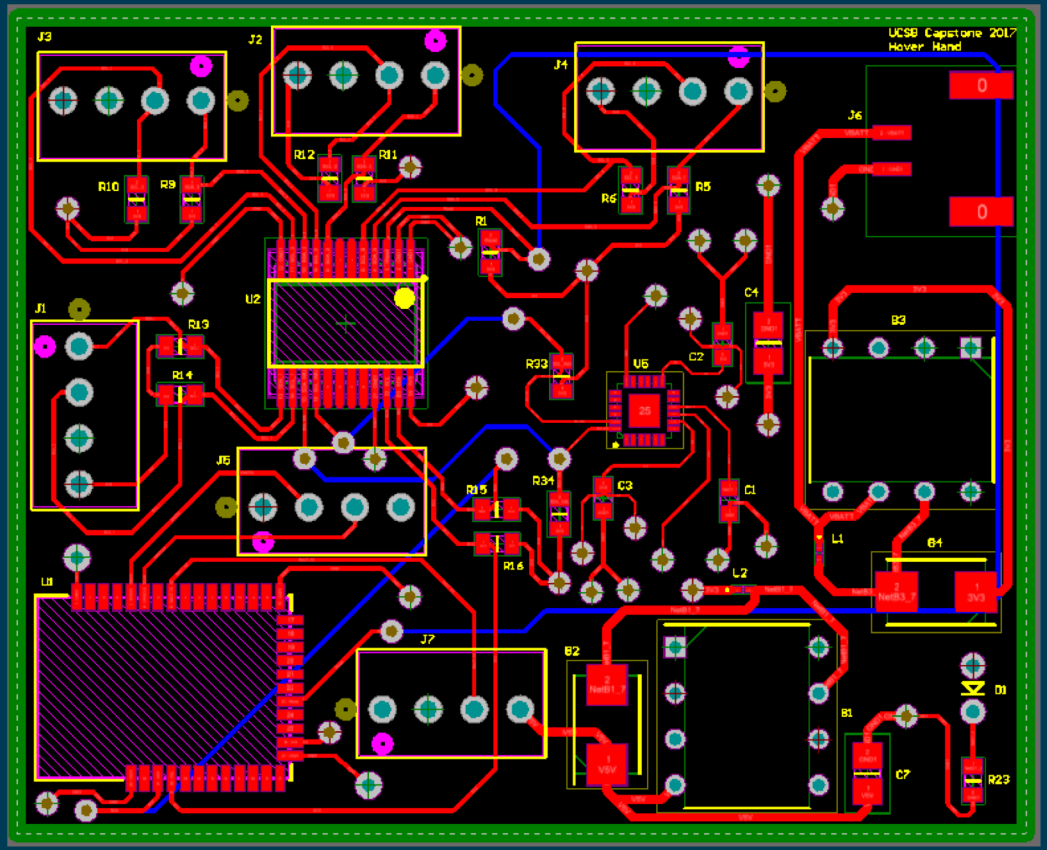
Power Distribution

- 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


VBATT
GND1
3V3
LT1300CN8#PBF
MBRS130LT3G
SWDIO
SWDCLK
SWDBG for 2-wire debug
MPU-9250
Preliminary resistor value, can be adjusted
Pull-up for reset-line
Reset
Multiplexer
Pull-up resistors for I2C-lines
Resistor value TBD.
PPM

PCB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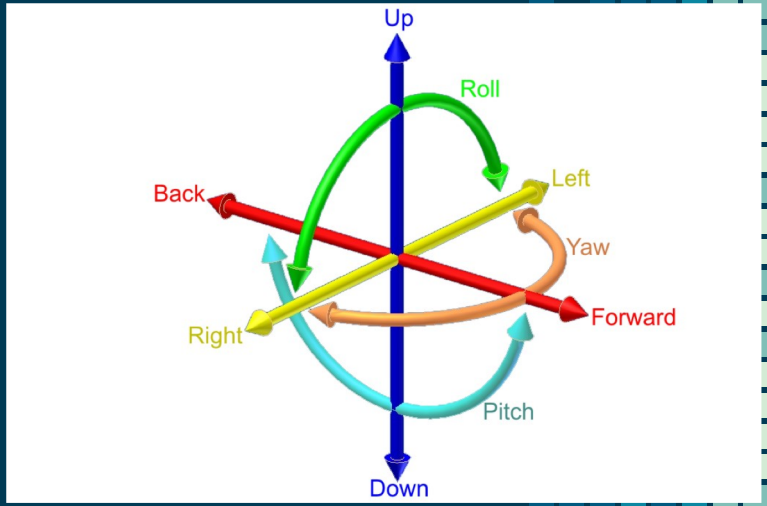
Hover Hand
J3
J2
J4
J6
R12
R11
R10
R9
R6
R5
R1
U2
J1
R13
R14
R33
U5
C4
C2
B3
J5
R15
R34
C3
C1
L1
B4
R16
L2
U1
J7
B2
D1
B1
C7
R23

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

Thanks to:

Yogananda Isukapalli, Capstone Instructor

Celeste Bean, TA

Caio Motta, TA

Arveng Technologies, Sponsor

Thank you for your contributions as well as making this possible!