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
# Bill of Materials

$116.72 spent on parts

<table>
<thead>
<tr>
<th>Designator</th>
<th>Manufacturer Part Number</th>
<th>Quantity</th>
<th>Description</th>
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<tbody>
<tr>
<td>U5</td>
<td>MPU-9250</td>
<td>1</td>
<td>Inertial Measurement Unit</td>
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<tr>
<td>U2</td>
<td>TCA9548APWR</td>
<td>1</td>
<td>Multiplexer</td>
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<tr>
<td>J1,J2,J3,J4,J5,J7</td>
<td>640456-4</td>
<td>6</td>
<td>4-pin jumpers</td>
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<td>J6</td>
<td>S2B-PH-SM4-TB(LF)(SN)</td>
<td>1</td>
<td>JST connector for battery</td>
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<tr>
<td>D1</td>
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<td>Red LED</td>
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<td>R1</td>
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<td>2M</td>
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<td>4.7uH</td>
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<td>B1,B3</td>
<td>LT1300CN8#PBF</td>
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<td>3.3V voltage booster</td>
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<td>schottky diode</td>
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<td>C4,C7</td>
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<td>BL652-SA-01</td>
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<td>nRF52832</td>
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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 I²C 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 I²C 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
Thanks to:
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