Hover Hand
Winter Quarter
Review
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Hover Hand Team

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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
How does it work?

- 5 Inertial Measurement Units (IMUs) measure hand movements
  - 4 IMUs on all fingers except ring finger
  - 1 IMU on the back of the hand
- SoC processes measurements to interpret meaning of movements
- FRSky 2.4GHz Antenna establishes connection and communicates with the quadcopter
Parts: Microcontroller

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: Sensor

**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: Transmitter

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
Other Important 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
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
Software Development

Quaternion Inputs:
- Stored in a 2-D float 5x4 matrix
  - 5 rows for 5 sensors
  - x,y,z acceleration vector
  - Rotation angle

Yaw, Pitch, Roll (YPR) Values
- Stored in a 5x4 float array
  - 5 rows for 5 sensors
  - Each index stands for yaw, pitch, roll, throttle

Pulse-Position Modulation (PPM) Array
- Stored in a 6-index uint array
  - 1 index for each ppm channel
Plan for Spring Quarter

- Receive two populated PCBs and attach them to two new gloves
- Tune software algorithms using current prototype as well as new gloves
- Create extended functionality to keep drone hovering in place or disable it with emergency shutdown.
Stretch Goals for Spring Quarter

- Use Bluetooth to send signals in addition to FRSky, enabling use of Bluetooth drones
- Create updated hardware design with the following changes:
  - Replace outdated parts with newly released parts
    - SoC: nRF52832->nRF82840
    - MPU: MPU-9250->ICM-20948
  - Change out parts from the first prototype that were limiting board size such as the voltage converters and jumpers
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