Introduction

- **Pixhawk**: Independent, open-hardware project with Autopilot Hardware and Flight Control Software

Pixhawk drawbacks
- Limited CPU
- Minimal interfaces
- No high quality IMU
- No magnetometer
- No GPS
Pixhawk + Improved Hardware and Software + A Few Gauchos = GauchoHawk
**GauchoHawk**

- **GauchoHawk**: Fully-featured flight controller with superior Autopilot Hardware and Flight Control Software

- **Hardware**: a daughterboard PCB meant to mount the Nucleo F767ZI
  - LPS22HB Barometer
  - MS4515DO Pressure & Temperature Sensor
  - QMC5883L Magnetometer
  - MPU-9250 IMU
  - XBEE 900HP Radio
  - Neo-M8P RTK GPS
  - ADIS16477 IMU

- **Software**: flight control software and driver suite
  - Collects input from on-board sensors to control and fly the drone
  - Started with PX4 and migrated to Betaflight
Microcontroller

**PX4 FMU**
- Arm 32-bit Cortex-M4 CPU
- Up to 168 MHz CPU frequency
- Up to 1 Mbytes of Flash memory
- SRAM: 192 Kbytes
- Only 2 I2C interfaces
- Only 1 SPI interface
- Insufficient for larger more complex applications
Microcontroller

Nucleo F767ZI
- Arm 32-bit Cortex-M7 CPU
- Up to 216 MHz CPU frequency
- Up to 2 Mbytes of Flash memory
- SRAM: 512 Kbytes
- Up to 4 I2C interfaces
- Up to 6 SPI interfaces
- Ideal for prototyping a shield for a variety of applications
Accelerometer

GPS

Gyroscope

Barometer

Magnetometer
Linear Regulator: 5V to 3.3V
XBEE 900HP Transceiver
Linear Regulator: 5V5 to 5V
LPS22HB Barometer
QMC5883L Magnetometer
MPU-9250 IMU
ADIS16477 IMU
NEO-M8P RTK GPS
QMC5883L Magnetometer
MS4515DO Barometer
Logic Level Converters
Servos
LPS22HB Barometer
Accelerometer and Gyroscope

- **Inertial Measurement Unit (IMU):** device that includes an **accelerometer** and a **gyroscope** to measure the drone's linear acceleration and angular velocity.

- Using this information the flight controller can determine the drone's **velocity and position**.

**MPU-9250**
- Uses SPI interface
- Logic for driver exists
- Configured interface

**ADIS16477**
- High-Precision IMU
- BGA part
- Expands potential applications
Magnetometer

- **Magnetometer**: a sensor that measures magnetic fields that a flight controller can use to determine the drone’s position and orientation

**QMC5883L**
- Three-axis magnetic sensor
- Uses I2C interface
- Synchronizes position with IMU
Barometer

- **Barometer**: provides pressure readings which the flight controller can use to determine the drone’s *altitude*

**LPS22HB**
- Preexisting SPI driver written for I2C
- Necessary for plane flight control

**MS4515DO**
- Pressure and temperature transducer
- Configuration required
RTK GPS: a GPS that uses Real-Time Kinematics to improve the precision of position data allowing the flight controller to determine the drone’s position with high precision

NEO-M8P

- High Precision RTK GPS
- UART Configuration required
- Accurate down to the centimeter
Flight Software

- Tested peripherals on breadboard
  - Wrote compatible mbed OS programs
  - Confirmed peripheral functionality and got familiar with interface

- **PX4**: open-source flight control software for Pixhawk
  - Successfully ported and flashed to GauchoHawk's microcontroller
  - Wrote custom drivers
What we Learned

- File structure constantly changing
- Code structure and drivers constantly being modified
- Difficult to configure pins for each peripheral
Flight Software (Round 2)

- **Betaflight**: Another open-source flight control software with similar targets to PX4
  - **Stability, Portability, Flexibility**
  - Wrote a custom target for GauchoHawk
  - Wrote some custom drivers
Betaflight Configuration
Quadcopter Flight
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