Comprehensive Design Review

Team Otto

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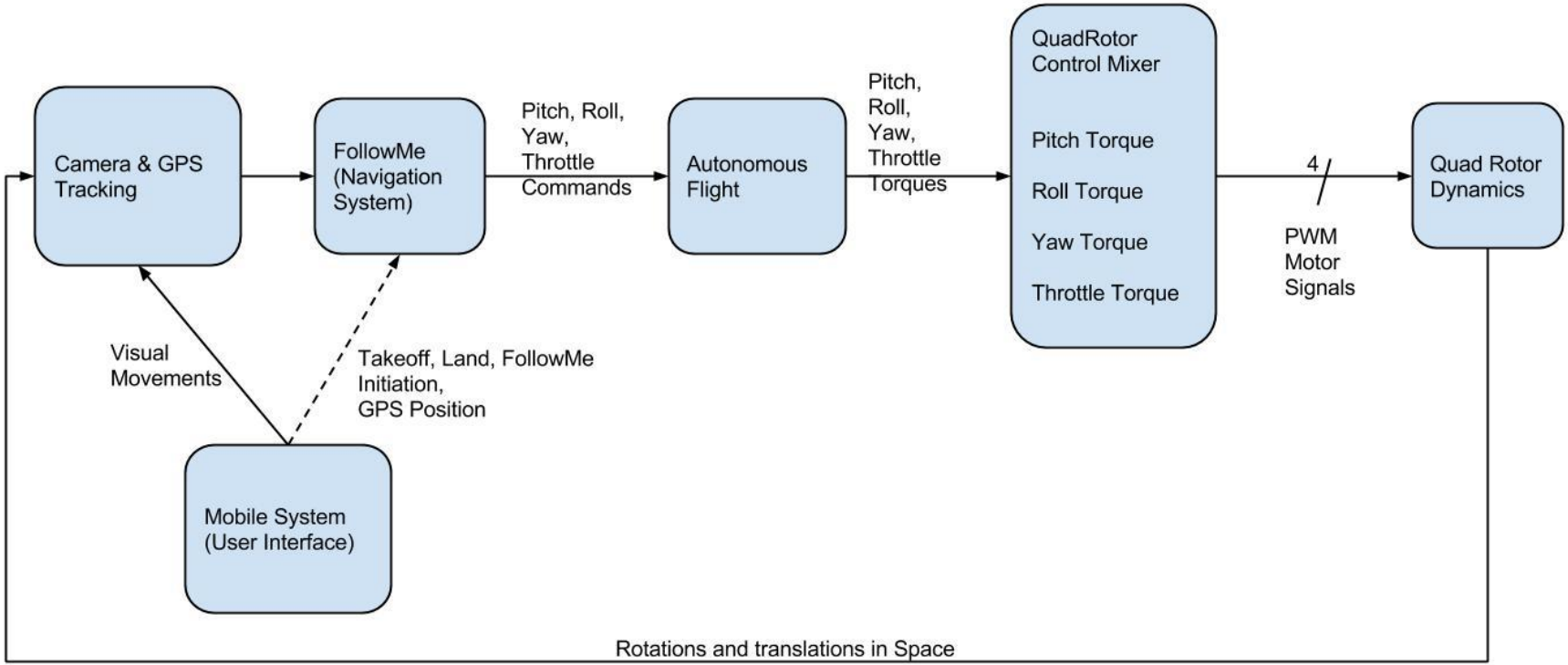
Today

- Otto Description
- System Overview
- Progress
- FPR Goals
- Demo

Otto - The Personal Cameraman

- Drone that will follow and record a user while performing action sports.
- Autonomous flight requiring no manual input from user once airborne.
- Tracks the user via fused GPS and camera tracking data.

Otto System Overview



WiFi -> UART link

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Overview

Autonomous Flight

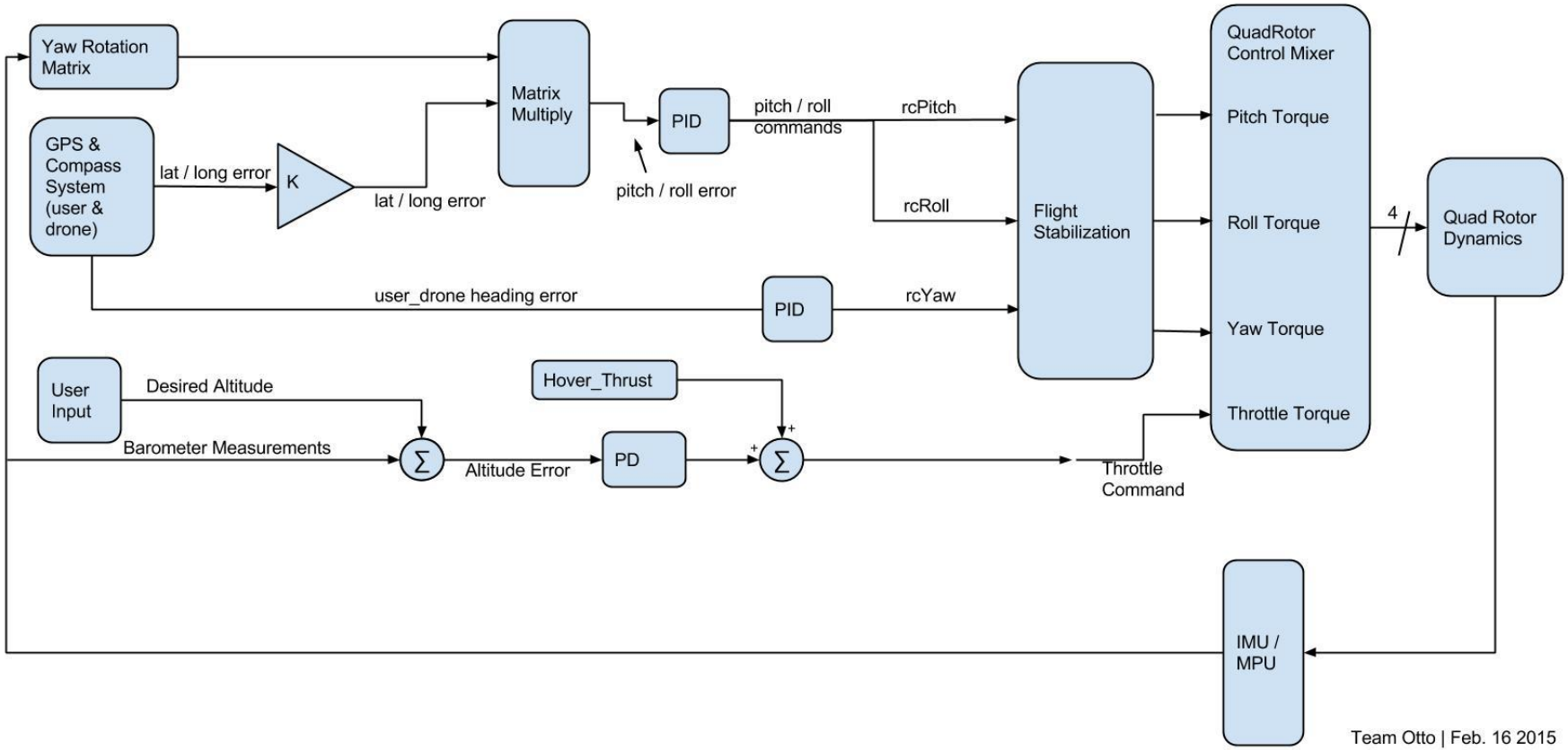
- Takeoff, Land
  - Receives commands from mobile device
- Altitude Control
  - Drone has full throttle control to maintain altitude
- Stable Rotation Control
  - Receives pitch, roll, and yaw commands from FollowMe to move towards target

Overview

FollowMe

- GPS Tracking
  - Commands autonomous flight using GPS locations and compass headings
- Camera Tracking
  - Calculates yaw commands using image processing

FollowMe (Autonomous Guidance)



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Overview

Mobile System

- Mobile App
  - Sends user's GPS location to drone system
  - User input - takeoff, land, FollowMe initiation
  - Displays live diagnostics
- Messaging Protocol
  - WiFi channel between phone and Raspberry Pi
  - UART communication between Raspberry Pi and APM Flight Control Board

Functional

- Autonomous flight
  - Autonomous takeoff
  - Altitude control
  - Stable Rotation control
- FollowMe (not fully completed)
  - Commands autonomous flight using GPS locations and compass headings
- Mobile System
  - Communication between mobile phone, onboard Raspberry Pi, and flight control board

Non-functional

- Mobile System: user selectable separation distance
- Autonomous flight: autonomous land
- FollowMe: camera tracking
  - Not currently integrated
- video recording of user

FPR Goal

User Interaction

- Mobile Phone
  - Takeoff, land, and FollowMe
  - Set altitude and separation distance
- Video
  - Retrieve from drone

FPR Goal

Drone

- FollowMe
  - Accurate flight commands from camera and GPS tracking systems
  - Lock camera on user for video recording
- Flight
  - Autonomous takeoff, flight, and landing
  - Flight commands from FollowMe

FPR Goal

Final Demo

- Stroll around Engineering Quad
  - Start Otto from mobile phone
  - Walk around the quad
  - Otto follows and records the user
  - Initiate landing from phone
  - Retrieve video

Demonstration

Hardware Failure

- Problem
  - Multiple electronic speed controllers (ESCs) malfunctioned yesterday
- Response
  - Performed extensive experiments
  - Resorted to backup plan
  - Relied on four ESCs in our inventory from SDP 2012

Hardware Failure

- Attempted solution
  - Completely disassembled drone, replaced all ESCs
  - Reconstructed drone and tested ESC performance
  - Found difference in throttle response
- Conclusion
  - Unrecoverable in short-term
  - Additional time needed for tuning

Hardware Failure

- Moving forward
  - Ordering new ESCs

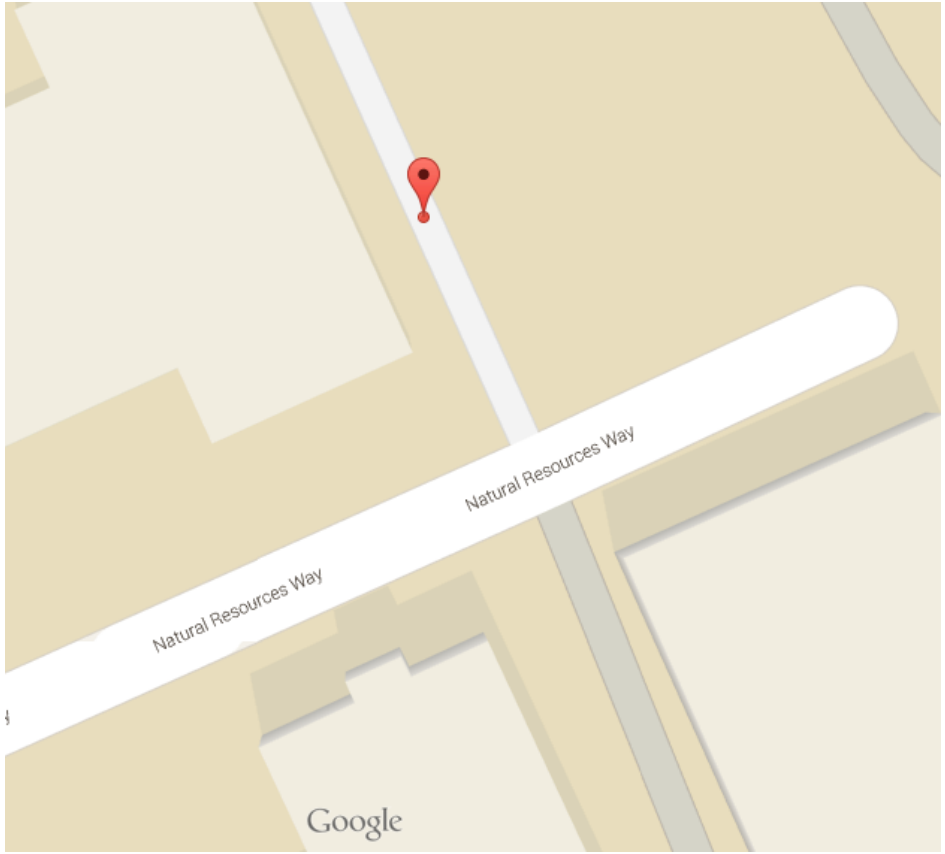
Video Demonstrations

- Autonomous Takeoff
- Altitude hold and Heading hold

Takeoff

Altitude / Heading Hold

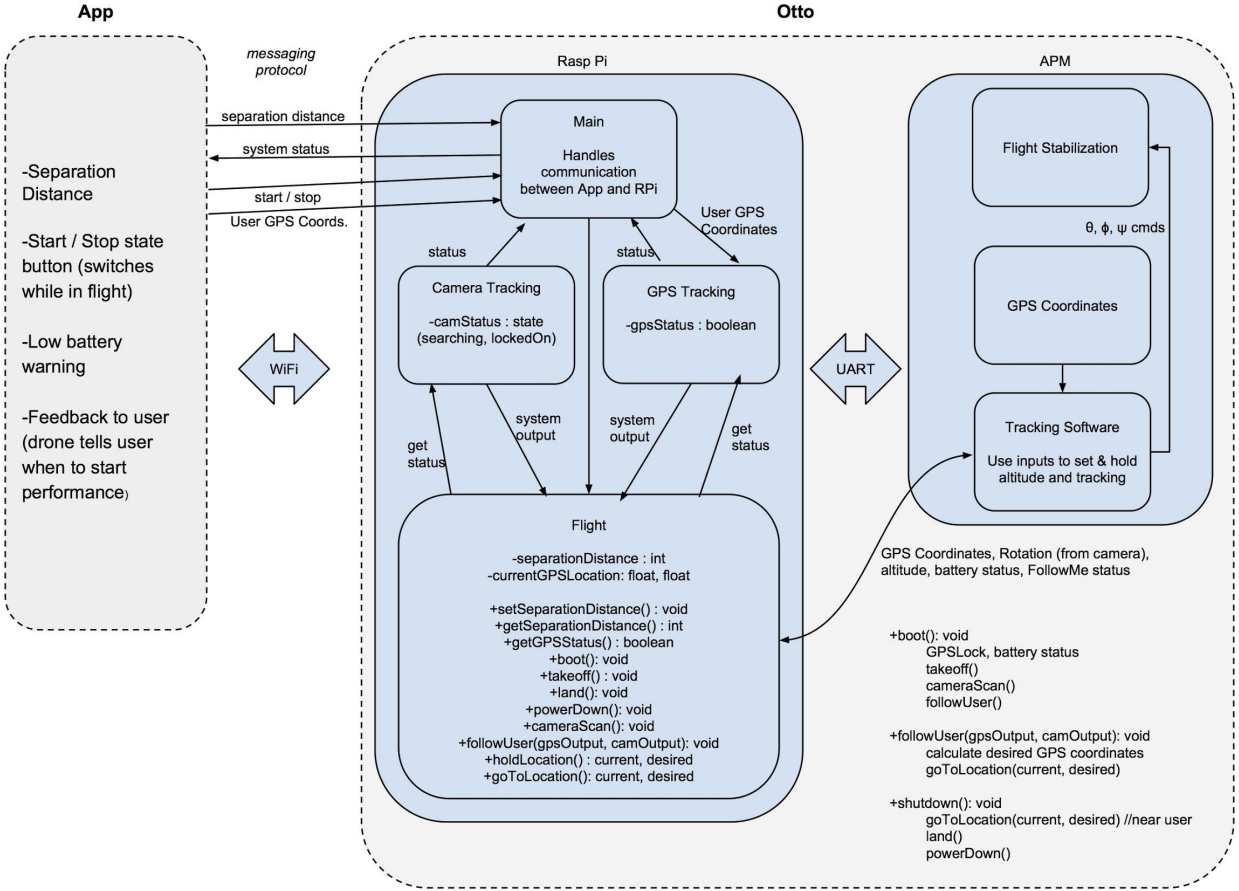
FollowMe: GPS Tracking



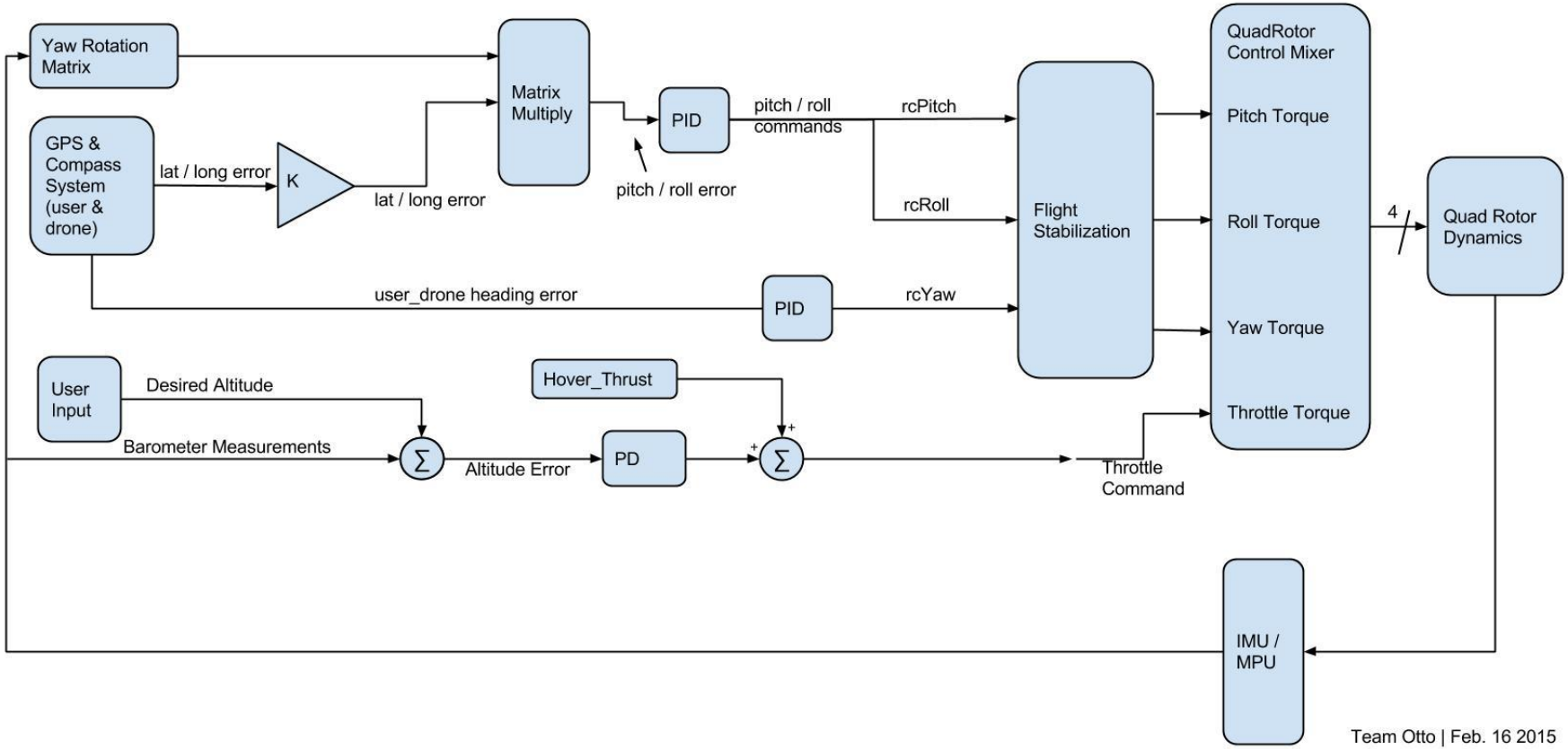
Messaging

Questions?

Back Up Slides


App
-Separation Distance
-Start / Stop state button (switches while in flight)
-Low battery warning
-Feedback to user (drone tells user when to start performance)
messaging protocol
separation distance
system status
start / stop
User GPS Coords.
WiFi
Otto
Rasp Pi
Main
Handles communication between App and RPi
User GPS Coordinates
status
status
Camera Tracking
-camStatus : state (searching, lockedOn)
GPS Tracking
-gpsStatus : boolean
get status
system output
system output
get status
Flight
-separationDistance : int
-currentGPSLocation: float, float
+setSeparationDistance() : void
+getSeparationDistance() : int
+getGPSStatus() : boolean
+boot(): void
+takeoff() : void
+land(): void
+powerDown(): void
+cameraScan(): void
+followUser(gpsOutput, camOutput): void
+holdLocation() : current, desired
+goToLocation(): current, desired
UART
APM
Flight Stabilization
θ, ϕ, ψ cmds
GPS Coordinates
Tracking Software
Use inputs to set & hold altitude and tracking
GPS Coordinates, Rotation (from camera), altitude, battery status, FollowMe status
+boot(): void
GPSLock, battery status
takeoff()
cameraScan()
followUser()
+followUser(gpsOutput, camOutput): void
calculate desired GPS coordinates
goToLocation(current, desired)
+shutdown(): void
goToLocation(current, desired) //near user
land()
powerDown()

FollowMe (Autonomous Guidance)



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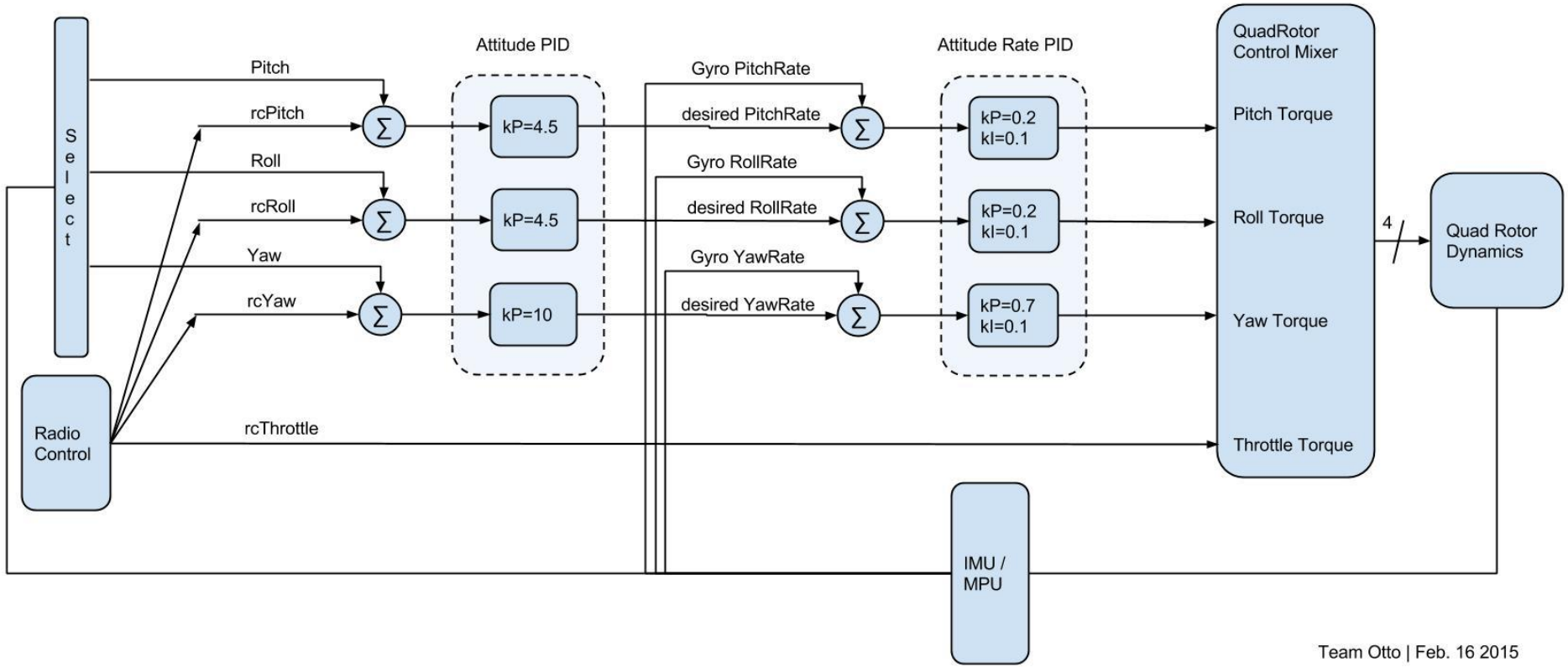
Flight Stabilization



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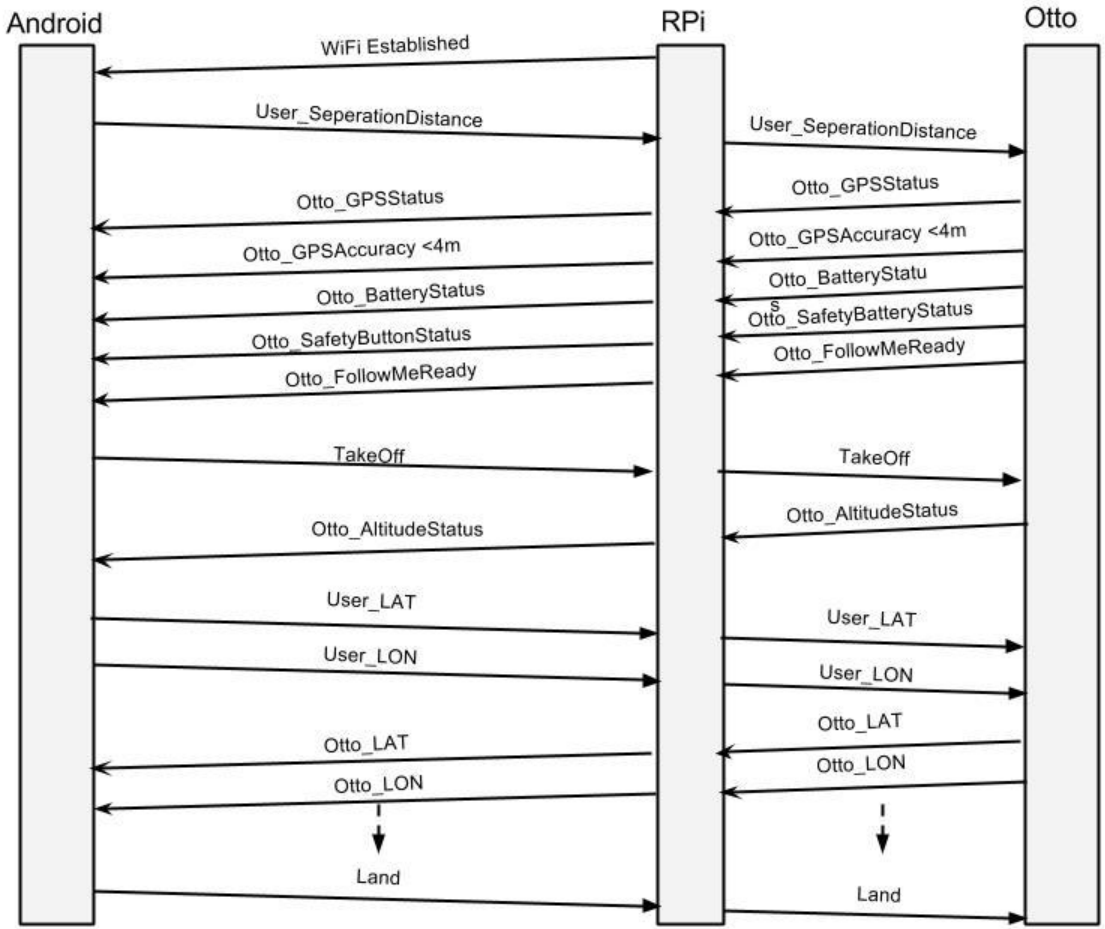
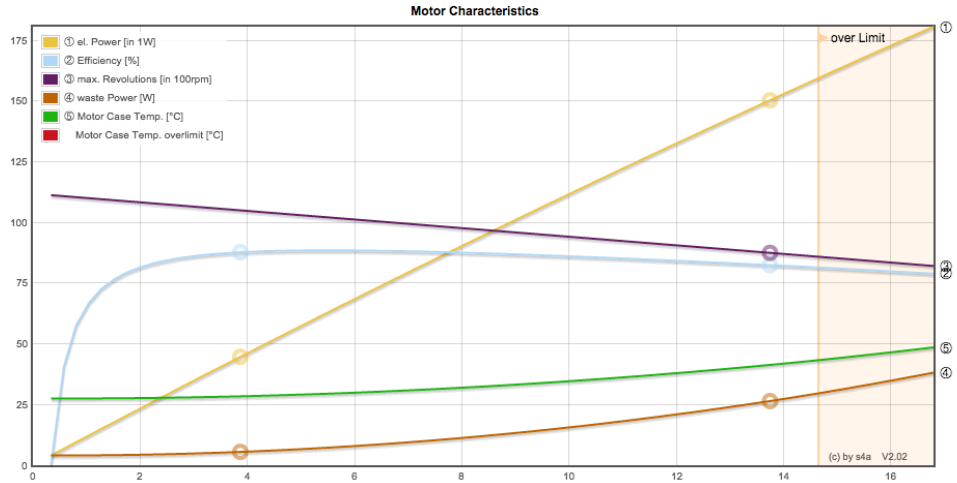
TakeOff


Android
RPi
Otto
WiFi Established
User_SeperationDistance
User_SeperationDistance
Otto_GPSStatus
Otto_GPSStatus
Otto_GPSAccuracy <4m
Otto_GPSAccuracy <4m
Otto_BatteryStatus
Otto_BatteryStatus
Otto_SafetyButtonStatus
Otto_SafetyBatteryStatus
Otto_FollowMeReady
Otto_FollowMeReady
TakeOff
TakeOff
Otto_AltitudeStatus
Otto_AltitudeStatus
User_LAT
User_LAT
User_LON
User_LON
Otto_LAT
Otto_LAT
Otto_LON
Otto_LON
Land
Land

Drone HW

Battery		Motor @ Optimum Efficiency		Motor @ Maximum		Motor @ Hover		Total Drive		Multicopter	
Load:	10.77 C	Current:	5.38 A	Current:	14.00 A	Current:	4.24 A	Drive Weight:	785 g	All-up Weight:	1500 g
Voltage:	11.06 V	Voltage:	11.44 V	Voltage:	10.92 V	Voltage:	11.51 V		27.7 oz		52.9 oz
Rated Voltage:	11.10 V	Revolutions*:	10231 rpm	Revolutions*:	8704 rpm	Throttle (linear):	47 %	Current @ Hover:	16.94 A	add. Payload:	844 g
Flight Time:	5.6 min	electric Power:	61.6 W	electric Power:	152.9 W	electric Power:	48.8 W	P(in) @ Hover:	199.3 W		29.8 oz
Mixed Flight Time:	11.4 min	mech. Power:	54.5 W	mech. Power:	125.6 W	mech. Power:	42.9 W	P(out) @ Hover:	171.7 W	max Tilt:	50 °
Hover Flight Time:	15.7 min	Efficiency:	88.5 %	Efficiency:	82.1 %	Efficiency:	88.1 %	Efficiency @ Hover:	86.2 %	max. Speed:	48 km/h
Weight:	390 g			est. Temperature:	42 °C	est. Temperature:	29 °C	Current @ max:	56.01 A		29.8 mph
	13.8 oz				108 °F		84 °F	P(in) @ max:	659.0 W		
						specific Thrust:	7.69 g/W	P(out) @ max:	502.5 W		
							0.27 oz/W	Efficiency @ max:	76.2 %		



Current Solution - AirDog

Current Solution - HEXO+

Current Solution - Iris+

Camera - GoPro Hero (2014)