Otto: The Personal Cameraman

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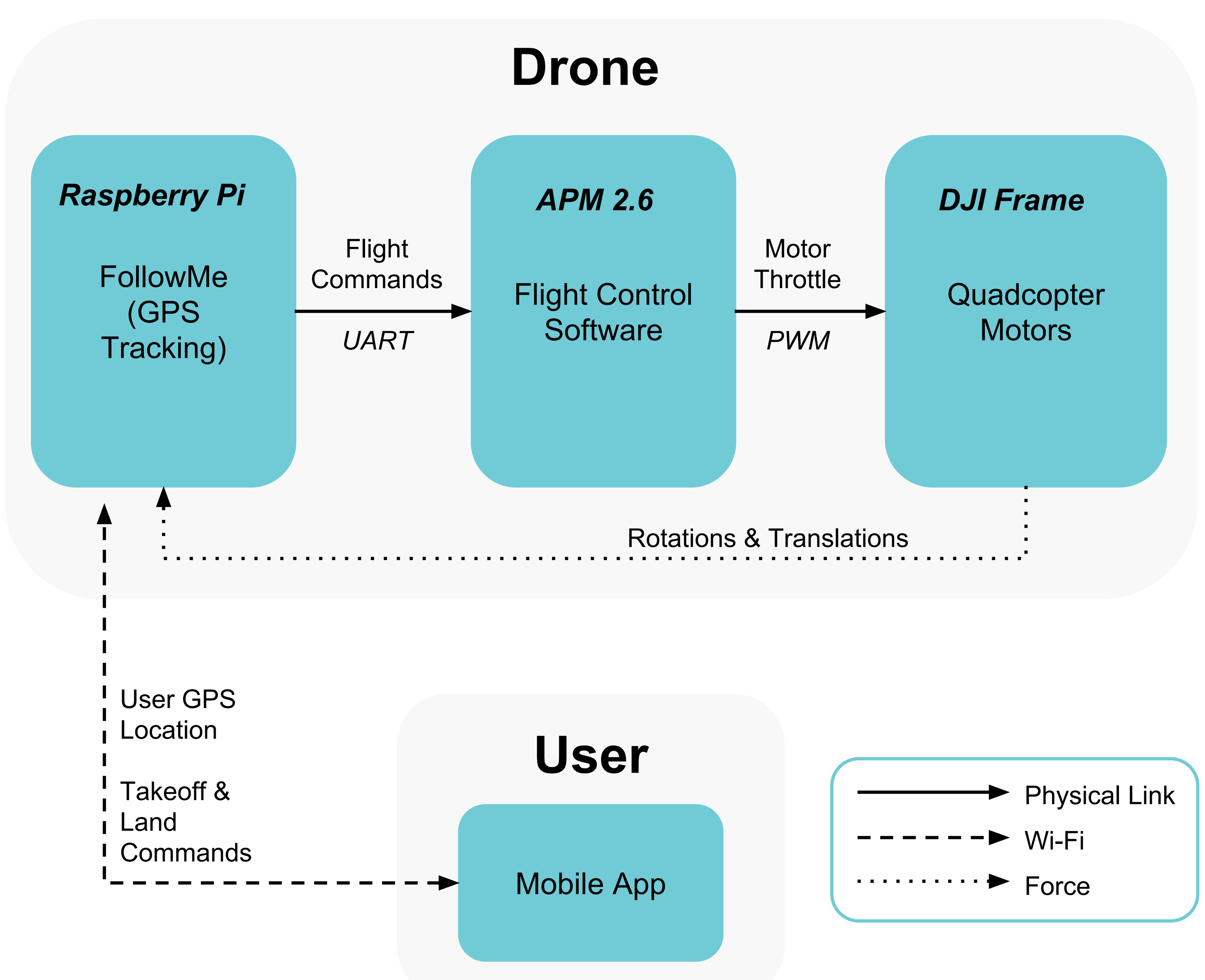
Abstract

Otto is the personal cameraman that introduces a new way to capture your life's most exciting moments. The system is an autonomous quadcopter that is designed to follow and record a user performing an individual action sport. By maintaining a visual lock on the user during his or her performance, Otto is able to capture the entire experience through an on-board high resolution video camera. Once finished, the user can gather video recordings from the drone and share them with loved ones.

Block Diagram



Specifications

Specification	Goal	Actual
Maximum drone/user separation distance	30 m	30 m
Minimum drone/user separation distance	5 m	10 m
Average flight time (with fully charged battery)	10 min	10 min
Maximum speed of drone	30 mph	20 mph
Maximum angular velocity of drone in yaw	1.8 rad/s	1.8 rad/s
Total drone mass	< 1500g	1400g
Throttle level required to lift the drone	50% throttle	64% throttle

System Overview

Otto follows and records a user by executing our FollowMe software. The FollowMe software is a combination of altitude hold, GPS tracking, and bearing tracking functions.

Results

Otto is capable of performing the following tasks autonomously:

- Altitude hold
- Takeoff and Land
- Track user (via GPS)
- Maintain visual lock on the user

In addition, we have a fully-featured Android application that provides user control of Otto.

Acknowledgements

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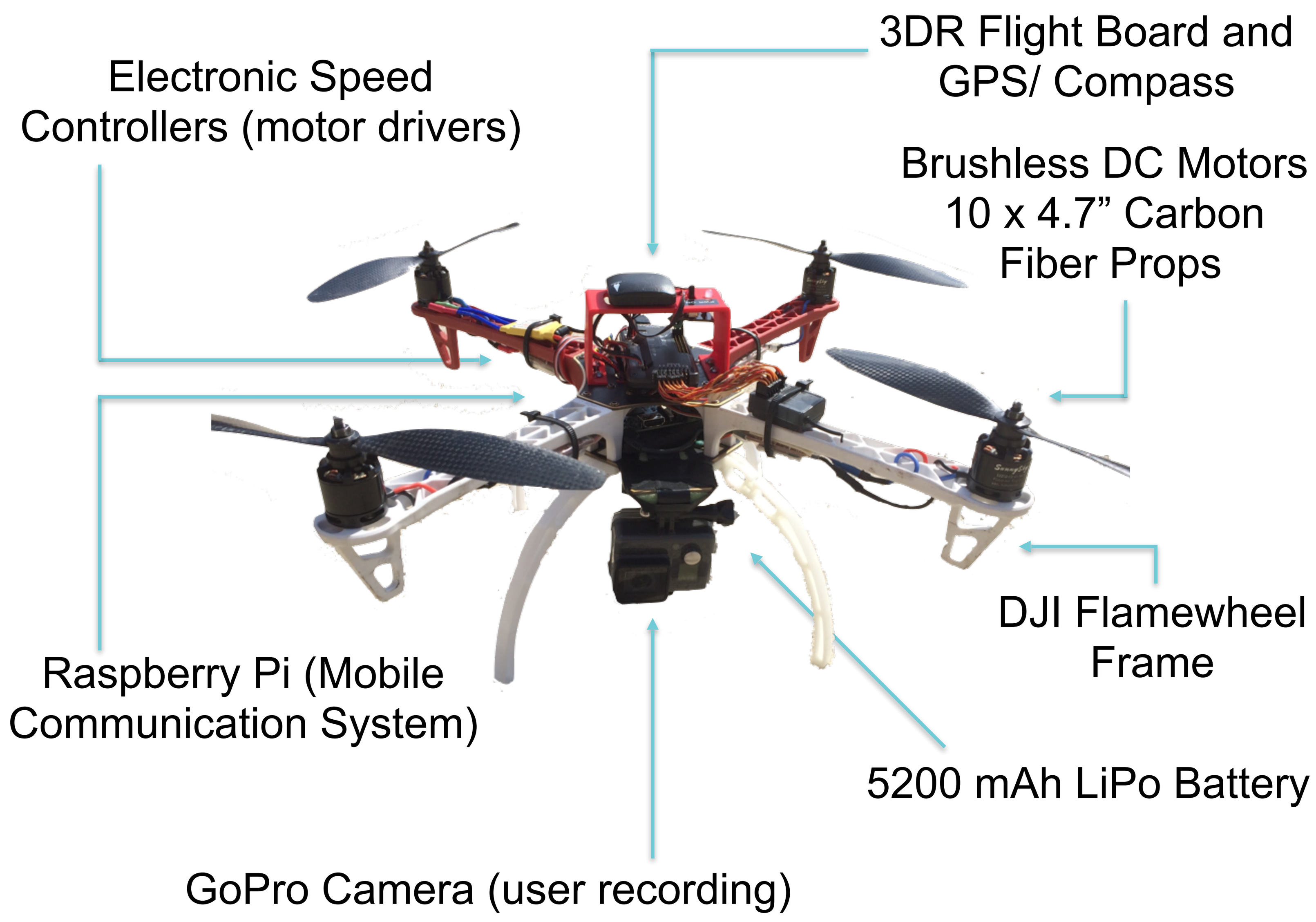
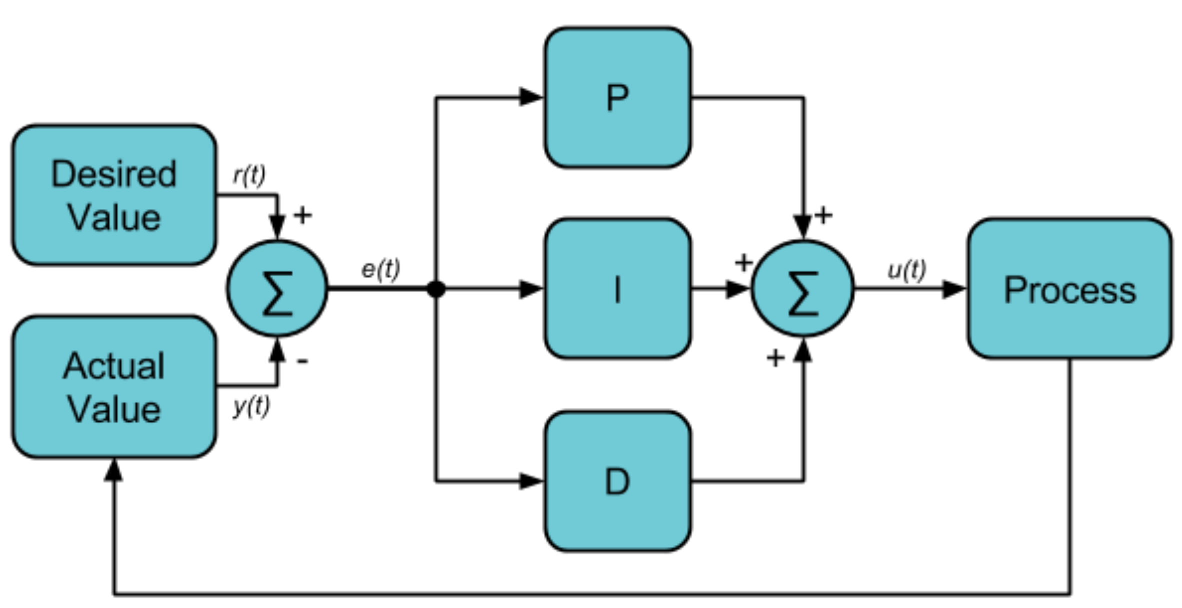
Quadcopter Hardware



Flight Stabilization



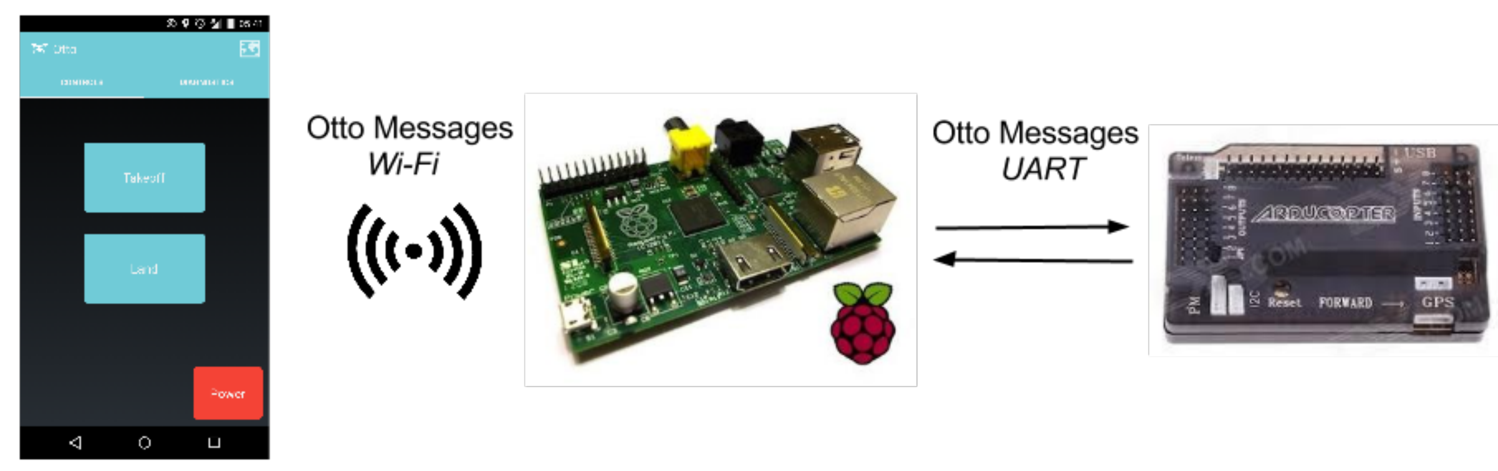
To perform flight stabilization, we utilized a majority of the sensors onboard the APM2.6 Flight Control Board, including its accelerometer, gyroscope, and barometer. Measurements from each of these sensors is fed into a PID (proportional, integral, derivative) feedback controller along with the desired values. The PID controller determines the error between desired and actual values, and returns the change in throttle to the main flight software.

Cost

Part	Development Cost	Production Cost (1000)
APM 2.6 Flight Board and GPS Module	$239.98	$139.99
Raspberry Pi Model B+	$38.39	$32.00
DJI FlameWheel Multi-Rotor Air Frame	$32.00	$25.00
SunnySky 2212 980kv Brushless Motors (4)	$77.56	$74.76
F-20A Electronic Speed Controllers (4)	$32.00	$12.00
10" x 4.7" Carbon Fiber Propellers (4)	$23.98	$17.98
DJI FlameWheel Landing Gear	$17.99	$5.99
Luminer 5200mAh Battery	$49.99	$44.99
Printed Circuit Board	$9.55	$3.82
MicroSD Card	$17.88	$7.93
TOTAL	**$539.32**	**$364.46**

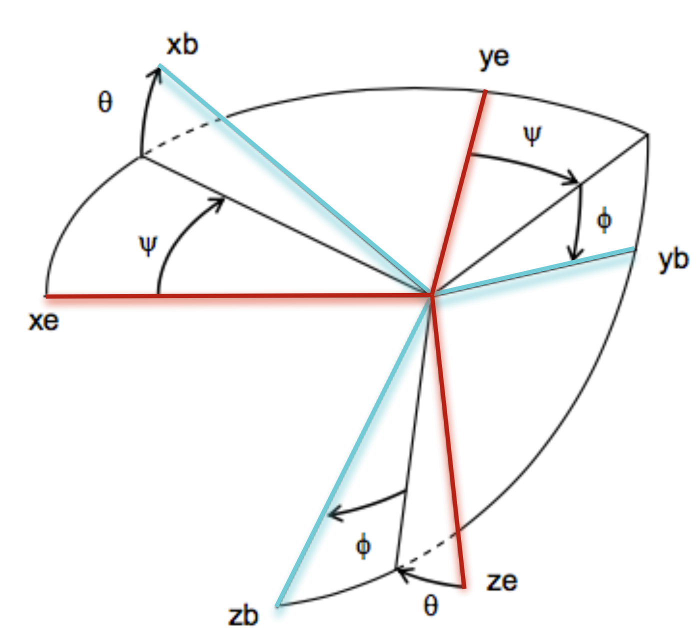
Mobile System

The mobile system contains two subcomponents: an android app, which is responsible for the user interface of Otto, and a messaging protocol, which is responsible for exchanging messages between the user’s phone and Otto.



The messaging protocol is built on top of a UDP connection over Wi-Fi @2.4Ghz and a UART communication link which has a baud rate of 115200. Messages are ASCII encoded and they include a start of message character, message identifier, payload and an end of message character. This messaging protocol enables the user to initiate takeoff, land and view live diagnostics.

FollowMe (GPS Tracking)



This is Otto’s navigation system; the inputs are the drone’s and user’s GPS coordinates and the output is pitch, roll, and yaw commands to be used to fly the drone to the target. First, the orientation of the drone must be translated from its local body axis system to the global earth axis coordinates (seen above), it is done using the direction cosine matrix (dcm). The commands are calculated through a PID feedback controller. The heading is obtained from the onboard magnetometer (compass).

FollowMe (GPS Tracking)