

DESIGN AND DEVELOPMENT OF RECOPTER

An Open source ROS-based
Multi-rotor Platform for Research

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MOTIVATION

Want a UAS to conduct multi-copter research?

Buy a COTS platform

Expensive

Proprietary hardware and software

Lead time for replacements (specially in Australia!!)

Build one from Scratch

Time consuming

Can be expensive as well

Requires a diverse skill set

MOTIVATION

Want a UAS to conduct multi-copter research?

Build one based on a proven open source blueprint

Fully customizable HW and SW

Minimum design iterations

Less expensive than COTS Research UAS

Easily repairable

Quicker and Easier to build

APPROACH

Evaluate the state-of-the-art

Evaluate some of the commonly used multi-copter platforms for research

Identify shortcomings & propose improvements

Propose design specifications for “researcher friendly” multi-copter design

Design, implement and test and improve

Provide a blueprint for the novel design

Build and test multi-copters according to the blueprint

Disseminate

Publish results

Open-source the design

EVALUATE THE S-O-T-A

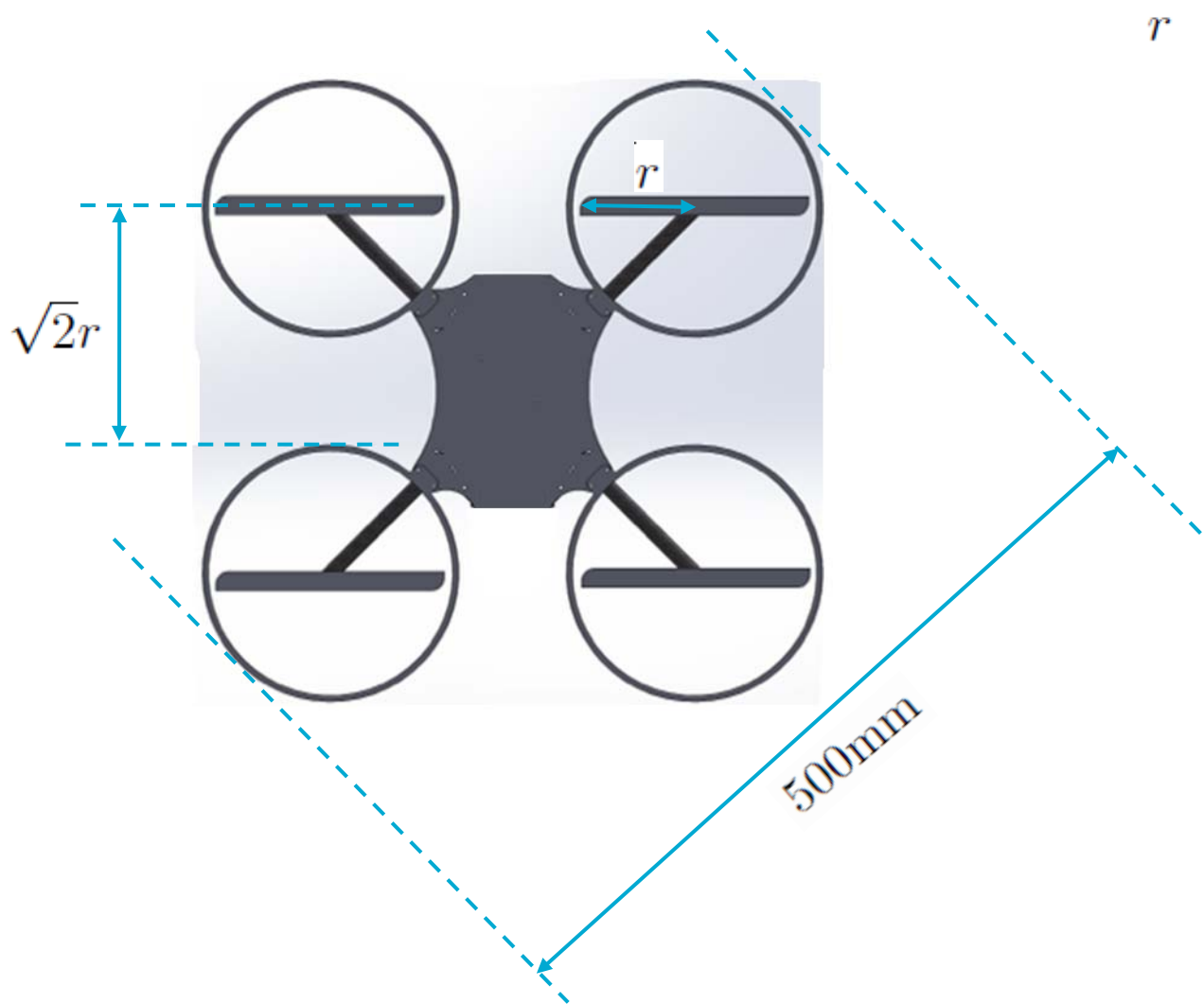
Evaluation Criteria	AR Drone	Hummingbird	Iris+
Total mass (kg)	0.420	0.6	1.4
Tip-to-tip Size (mm)	373	360	526
Flight time @0.1kg (minutes)	9	20	15
Flight time @0.5kg (minutes)	-	-	7
Cost (USD)	500	5000	1000
Hardware/Software openness	1/2	2/3	4/5
Hardware/Software extensibility	1/3	3/2	3/3
On-board camera	720p @ 30Hz	-	-
On-board computer	1GHz	-	-
Indoor stability	Optical flow based	-	-



DESIGN SPECIFICATIONS

Criteria	Condition
MTWO	< 2kg
Tip-to-tip size	< 500mm
Max Payload	> 0.5kg
Flight time (0.1kg payload)	> 30 minutes
Flight time (0.5kg payload)	> 20 minutes
Cost	< 1500USD
Openness	Fully open source HW & SW
Extensibility	Modular HW, Standard SW + interfaces
Indoor Stability	Either through optical flow or Tags

DESIGN PROCESS – FRAME



$r < \sim 8$ inches

COTS propeller
options

$8 \times 2.7''$

$7 \times 2.4''$

$6 \times 2''$

DESIGN PROCESS – THRUSTERS AND BATTERY SELECTION

Propellers – T-Motor Carbon Fiber (6, 7, 8 inches)



Motors – Matching T-Motor motors capable of providing at least 5N thrust with any one of the selected propellers

(MN 2206 and MT2208)

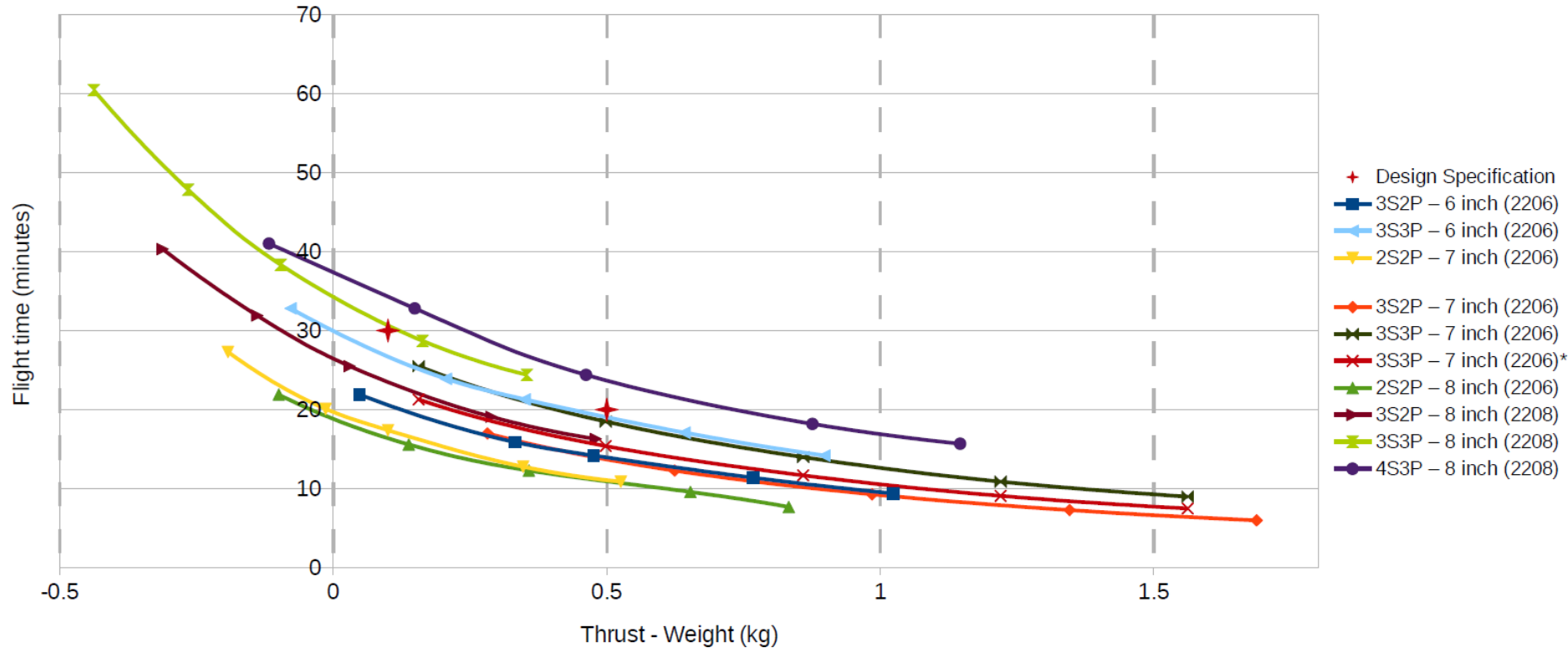


Batteries – **high discharge Li-Ion**

(compatible configurations with selected Motor/Propeller combinations include 2S2P, 3S2P, 3S3P, 4S3P)



DESIGN PROCESS – THRUSTERS AND BATTERY COMPARISON



Data from experimental results obtained from <http://www.rctigermotor.com>

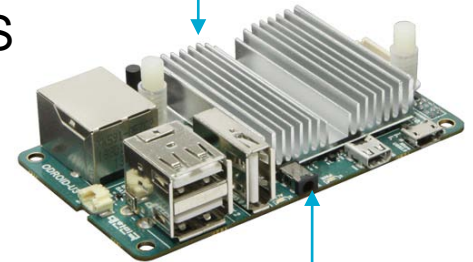
AVIONICS + SOFTWARE

Auto-pilot – Pixhawk with native Pixhawk flight stack



mavlink over RS-232

On-board Computer – Odroid U3* with ROS + MAVROS



USB 2

On-board Camera – Point grey Firefly



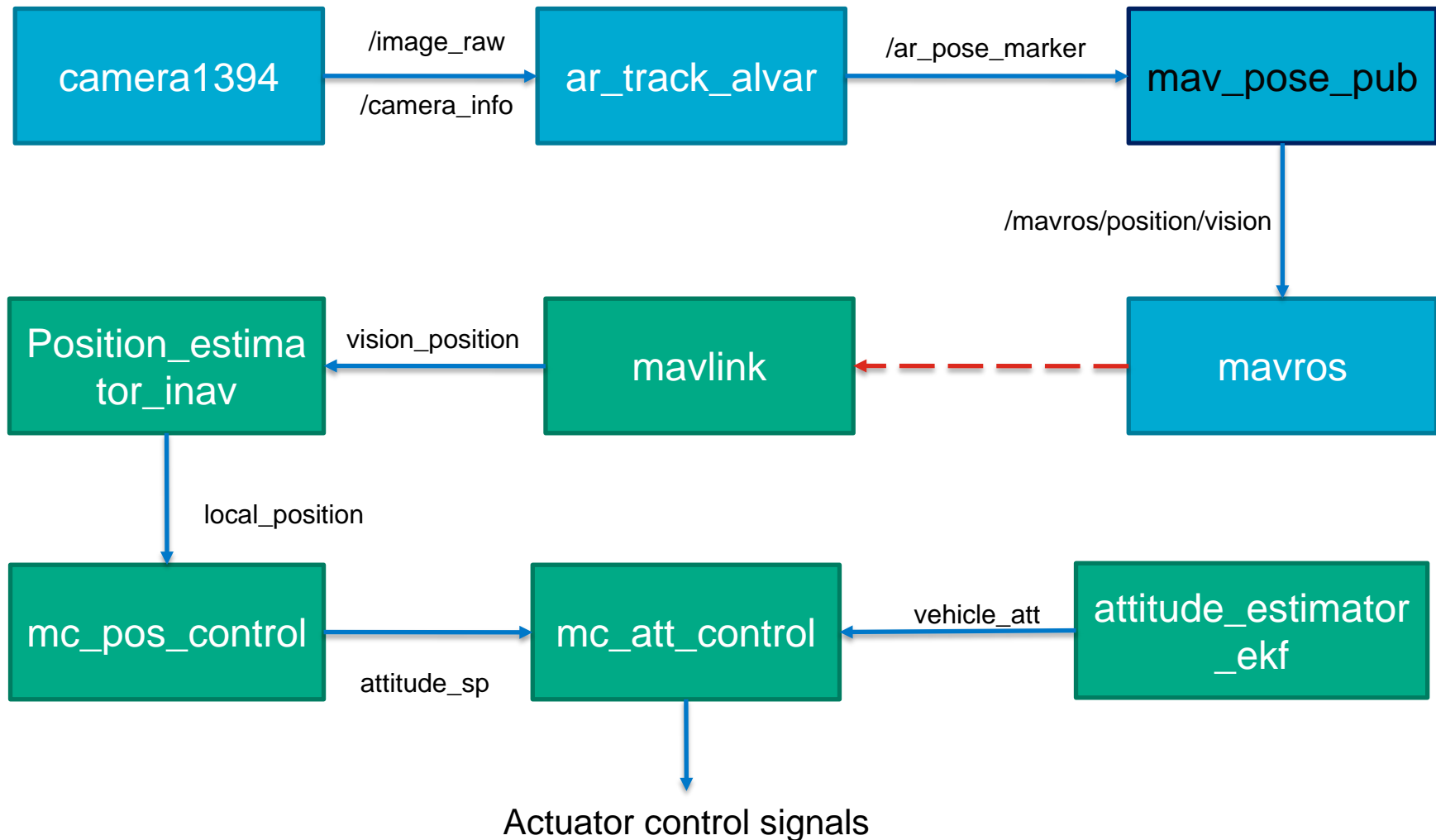
PUT IT ALL TOGETHER – RECOPTER V 1



FINAL SPECIFICATIONS

Criteria	Proposed	Achieved
Dead Weight	< 1kg	1.03kg (3s3p)
MTWO	< 2kg	2.5kg
Tip-to-tip size	< 500mm	500mm (7 inch prop)
Max Payload	0.5kg	1.0kg
Flight time (0.1kg payload)	> 30 minutes	24 (with 2.5Ah batteries)
Flight time (0.5kg payload)	> 20 minutes	13.5 (with 2.5Ah batteries)
Cost	< 1500USD	~1200USD (including on-board computer and Camera)
Openness	Fully open source HW & SW	Pixhawk, Odroid, ROS
Extensibility	Modular HW, Standard SW + interfaces	Modular frame, ROS+mavros
Indoor Stability	optical flow or Tags	AR Tags

INDOOR STABILITY



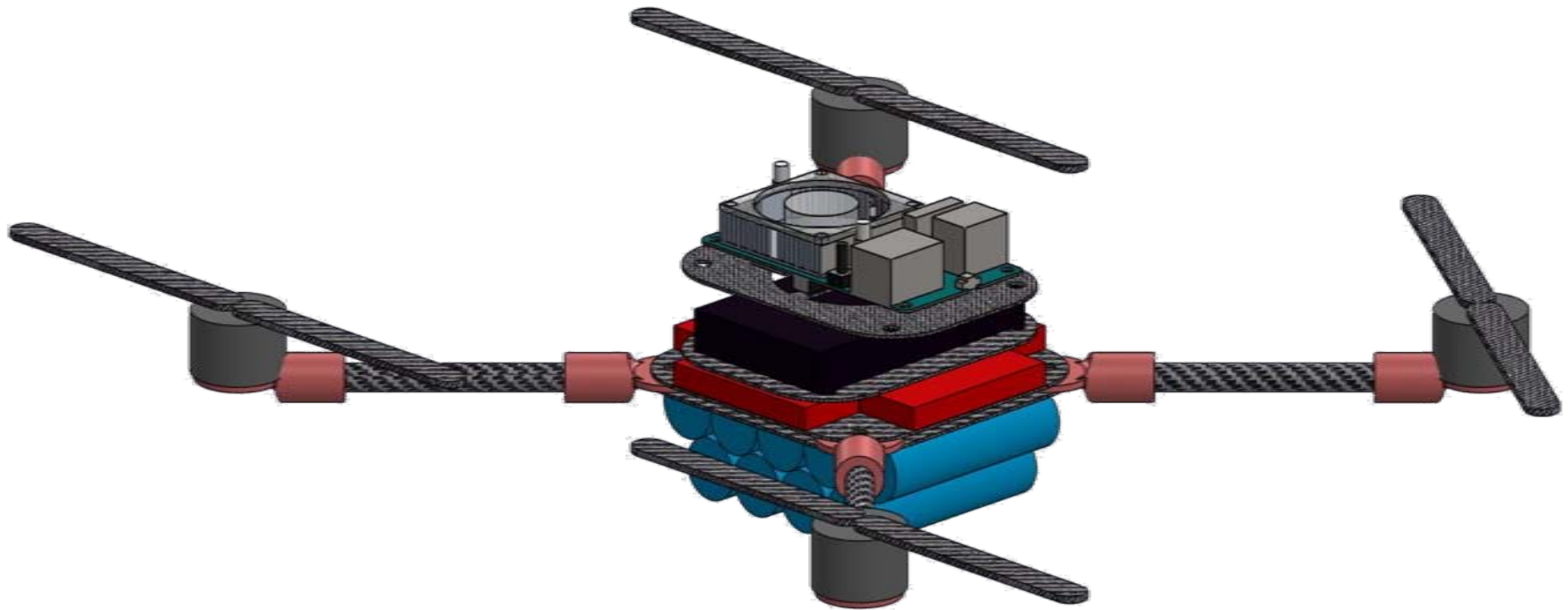
OPEN SOURCING

github.com/thedinuka/ReCOPTER

- Hardware – Cad files for frame v1, Electronics
- Complete parts list with approx cost and where to buy
- Paper and presentation
- Software components are already open source

To Do: Build Guide?

FUTURE - RECOPTER V2

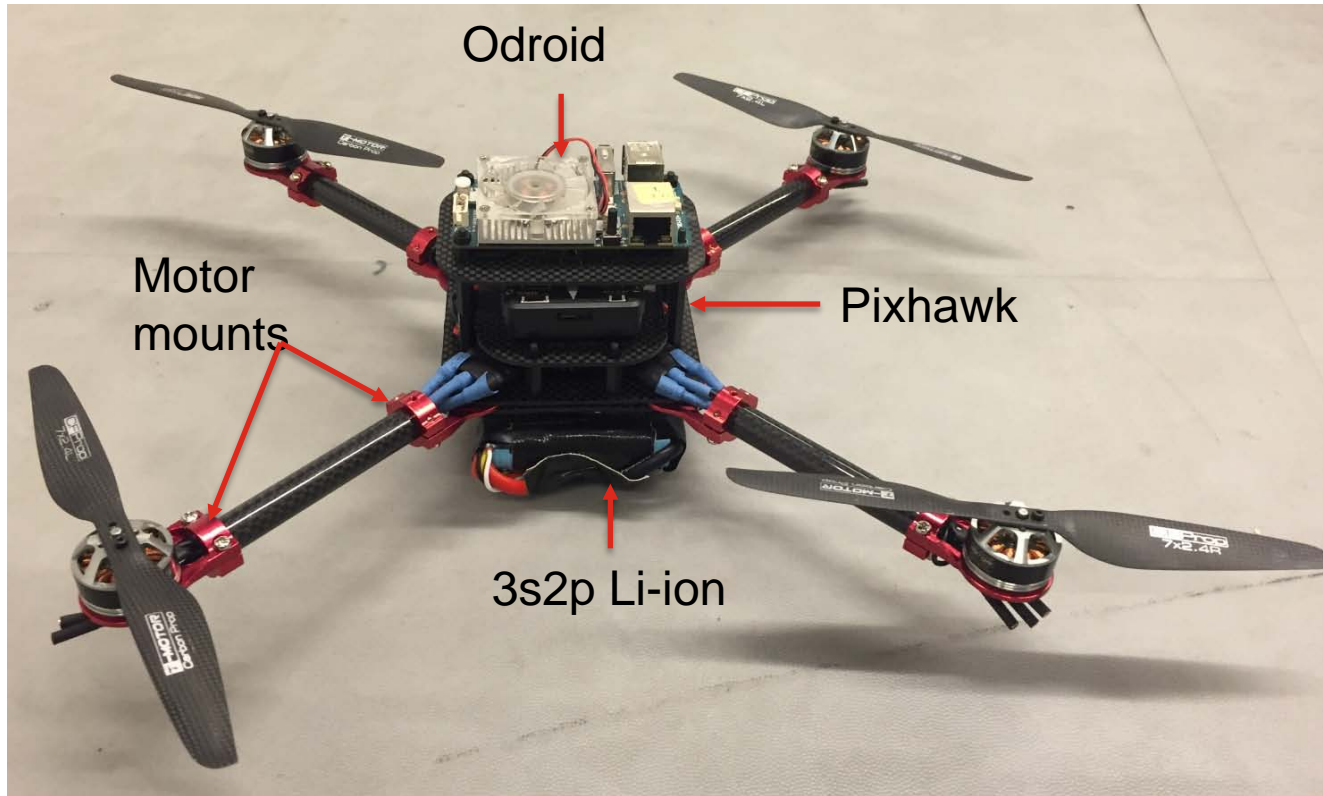


Increased modularity

Decreased dead weight

Simplified frame design

FUTURE - RECOPTER V2



- ~250g reduction in dead weight
- Build time reduced from 4 hours to 2 hour
- Not flight tested yet