

Testing Autonomous Hover Algorithms using a Quad Rotor

In conjunction with the Distributed [Multi-Vehicle] Space System Lab

MS4



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The Current Conflict

- Plant Model is complete
- Controller is *finally* in a working state
 - First iteration used P-D
 - Now we're using Full-State feedback with a gain matrix determined by LQR
- Vicon System is set up and recording Data

Where We Stand

- Actually on Schedule!
 - The first thing we did was get the Hardware Implemented.
 - This put us behind for MS2 and MS3 but now we're in a good position.
- Ran first Test last night...
- Schedule has evolved over time.

Final Schedule

	VICON	Model Validation	Waypoint Tracking	LAB VISIT & Final Report
WEEK 8 (MS4)				
WEEK 9				
WEEK 10				
WEEK 11 (MS5)				

For the demo, we hope to show:

- Open-loop Joystick Control (for comparison)
- Closed Loop Control
 - Auto-Hover
 - Joystick Control
 - Unit step in X, Y, Z, ψ
 - 3-D Auto Tracking

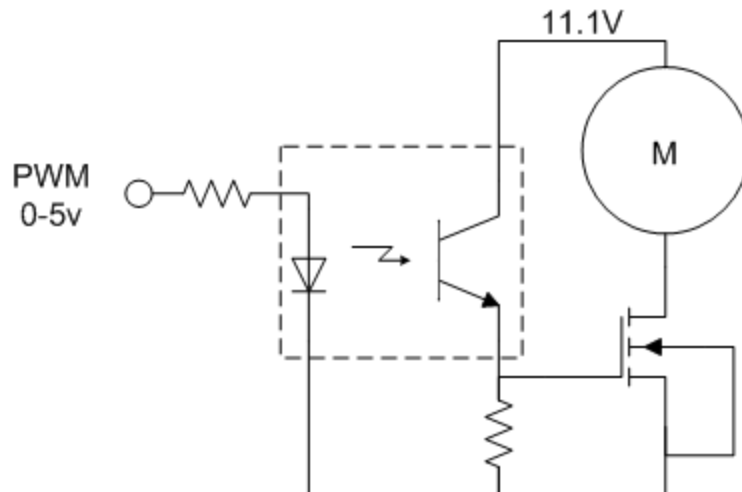
Hardware- Motor Control & Power

MOSFETs – MTP3055

- 12A max current
- $0.15\ \Omega$ on Resistance
- Ideal for switching

Opto-Isolator – LTV-847 (Lite-On)

- Quad-package
- $4\mu\text{s}$ rise-time (25x base freq.)
- Cheap! (\$0.75)
- Battery – Li-Polymer 3 Cell
- 2100 mAhr (~40 min of flight)

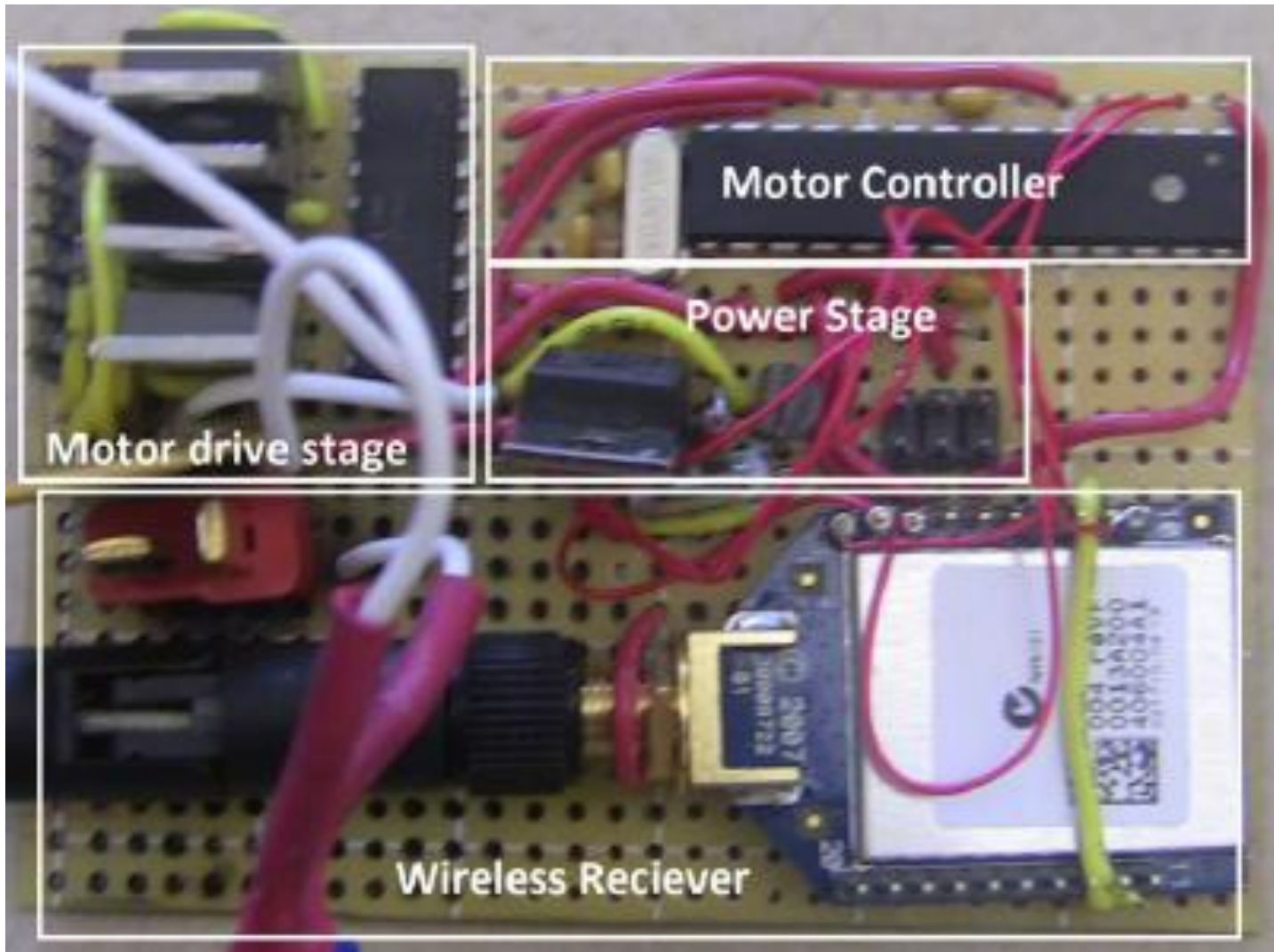


Hardware - Communication

- Vicon Camera System
 - “0.1mm” accuracy
 - 120fps
 - Expensive – DSSL lab already has
- Laptop Running Matlab
- ZigBee Wireless
 - 900MHz
 - Easy to Implement
 - High Baud Rate (100kBaud)
- Network Link
- Atmel ATMEGA328 microcontroller
 - Familiarity
 - Relatively cheap
 - Has all the functionality
 - PWM (we’re using 10Khz)
 - Analog in
 - Already had programmer and working development Environment



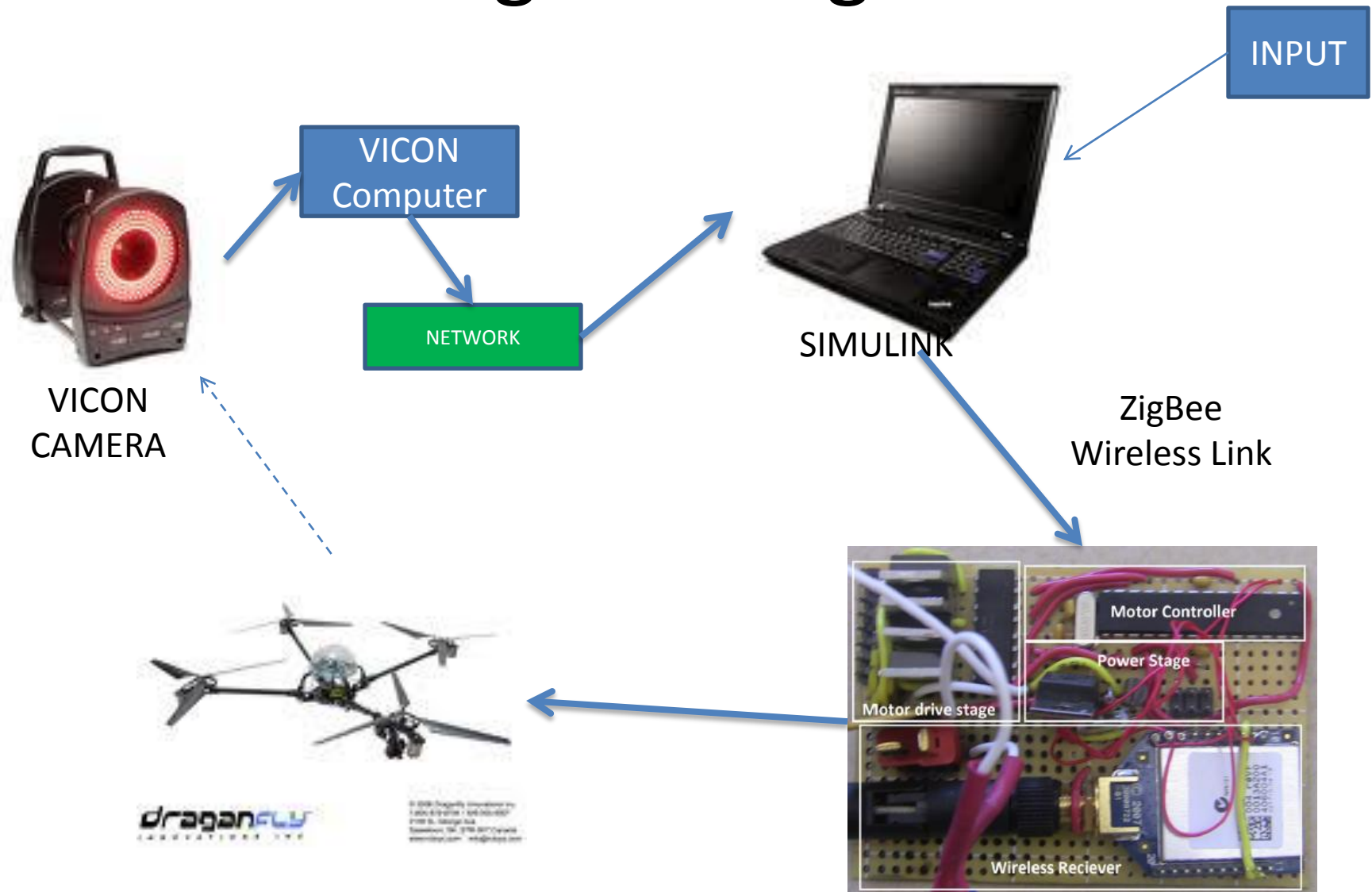
PC Board Layout



Software

- Feedback currently implented in Simulink
 - Allows Simulation and implementation in same package
 - Good for rapid prototyping
 - Input: From Vicon
 - Requires S-Function written in C to interface with binary .dll
 - Output: Serial port communication to Xbee

Putting it all Together



References

- [1] B. Heemstra. (2010) *Linear Quadratic Methods Applied to Quad rotor Control*. Unpublished Masters thesis. University of Washington.
- [2] C. Balas. (2007) *Modeling and Linear Control of a Quadrotor*. Unpublished Masters thesis. Cranfield University.
<https://dspace.lib.cranfield.ac.uk/bitstream/1826/2417/1/Modelling%20and%20Linear%20Control%20of%20a%20Quadrotor.pdf>
- [3] S. Bouabdallah, A. Noth, and R. Siegwart, "PID vs LQ control techniques applied to an indoor micro quadrotor", 2004 IEEE/RSJ International Conference on Intelligent Robots and Systems, 2004.(IROS 2004). Proceedings, vol. 3, pp. 1-6.
P. Castillo, A. Dzul, and R. Lozano, "Real-Time Stabilization and Tracking of a Four-Rotor Mini Rotorcraft", IEEE Transactions on Control Systems Technology, Vol 12, No 4, July, 2004.
- [4] McKerrow, P. (2004), "Modelling the Draganflyer four rotor helicopter", 2004 IEEE International Conference on Robotics and Automation, April 2004, New Orleans, pp. 3596.
- [5] Observability. (2010, March 29). In *Wikipedia, The Free Encyclopedia*. Retrieved 00:26, April 24, 2010, from <http://en.wikipedia.org/w/index.php?title=Observability&oldid=352709914>