Journal Paper for International Aerial Robotics Competition

California State Univeristy Northridge

ABSTRACT

This abstract is the overview of the project thus far and the ideas of what I should have been given that the structure of the project was formed correctly at this institution. With lack of documentation with previous teams the project could not continue much further than it has this term.

INTRODUCTION

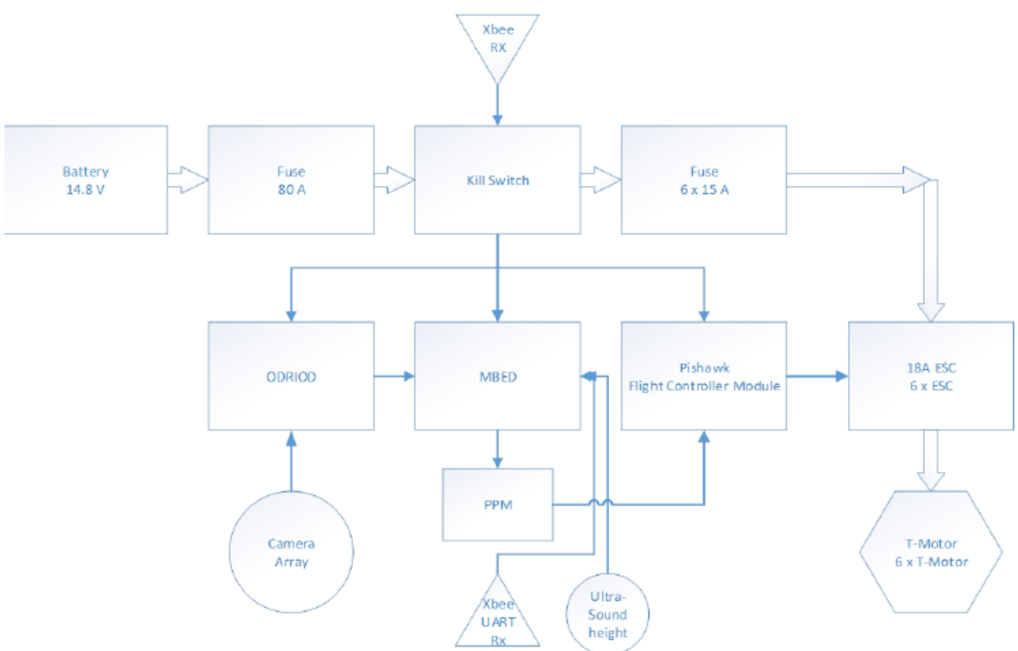
Problem

The problem for this competition is the interaction between aerial robots and moving objects. The navigation will happen without GPS or any point of reference. The other goal is for interaction between other unmanned aerial vehicles.

Conceptual solution to solve the problem

The problem was to be solved creating a unmanned aerial vehicle that would function using an mbed and navigate using a pixycam for image processing along with a pseye for line detection. The pixycam send vectors to the mbed that will use the pixhawk that controls the the motors to center on the vector given from the camera.

Figure of overall system architecture



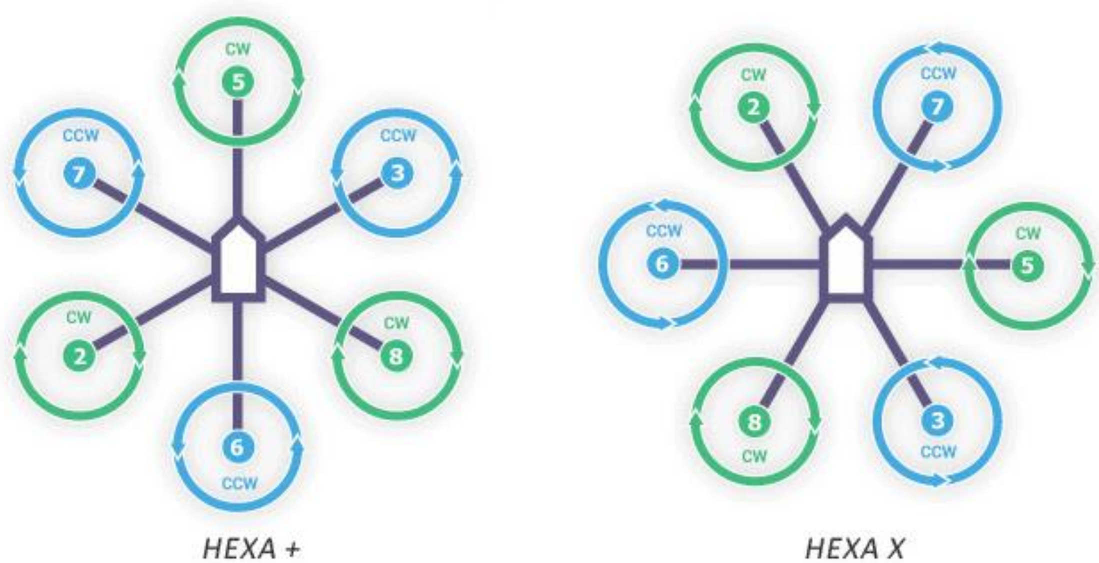
Yearly Milestones

Created a vectoring system that will control the uav to go to a target specificed by a pixycam. Can now detect lines and identify them by color. Fixed stability issues with flight using rc controller.

AIR VEHICLE

Propulsion & Lift System

Hexacopter design has a lesser probability of failure versus a quadcopter: failure of single motor can be compensated by the other motors

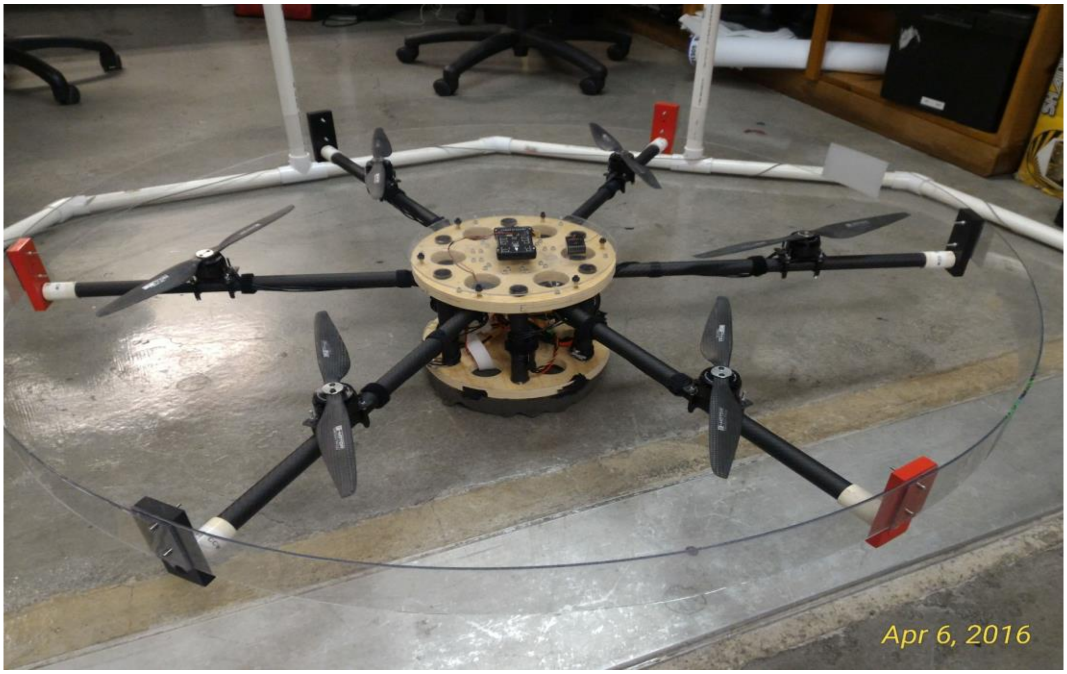


Motor rotations by maneuver:

- Vertical motion

- Yaw motion

- Pitch/Roll motion



Item No.	Volts (V)	Prop	Throttle	Amps (A)	Watts (W)	Thrust (G)	RPM	Efficiency (G/W)	Operating temperature(℃)
U3 KV700	11.1 (3S)	T-MOTOR 12*4CF	50%	2.5	27.75	350	4000	12.61	40
			65%	4.8	53.28	550	4900	10.32	
			75%	6.6	73.26	700	5500	9.56	
			85%	9.1	101.01	870	6300	8.61	
			100%	11.1	123.21	1000	6600	8.12	
		T-MOTOR 13*4.4CF	50%	2.9	32.19	400	3800	12.43	42
			65%	5.6	62.16	650	4900	10.46	
			75%	7.9	87.69	830	5300	9.47	
			85%	10.5	116.55	1000	6000	8.58	
			100%	12.6	139.86	1100	6400	7.87	
		T-MOTOR 14*4.8CF	50%	4.1	45.51	550	3500	12.09	43
			65%	7.7	85.47	890	4500	10.41	
			75%	10.7	118.77	1060	4900	8.92	
			85%	14.5	160.95	1300	5500	8.08	
			100%	17.3	192.03	1460	5800	7.60	
	14.8 (4S)	T-MOTOR 11*3.7CF	50%	3.2	47.36	460	5300	9.71	43
			65%	6	88.80	710	6500	8.00	
			75%	8.2	121.36	870	7500	7.17	
			85%	11	162.80	1080	8200	6.63	
			100%	13	192.40	1230	8700	6.39	
		T-MOTOR 12*4CF	50%	3.8	56.24	580	5000	10.31	43
			65%	7.4	109.52	880	6300	8.04	
			75%	10.3	152.44	1100	7300	7.22	
			85%	14	207.20	1360	7700	6.56	
			100%	16.8	248.64	1600	8300	6.44	
		T-MOTOR 13*4.4CF	50%	4.7	69.56	730	4900	10.49	47
			65%	9	133.20	1120	6100	8.41	
			75%	12.3	182.04	1400	6800	7.69	
			85%	16	236.80	1600	7400	6.76	
			100%	19.4	287.12	1800	7850	6.27	

Notes:The test condition of temperature is motor surface temperature in 100% throttle while the motor run 10 min.

Guidance and Control

Auto Pilot: 3DR Pixhawk

- Open source, mature firmware
- Highly Programmable
- Versatile IO and protocol capabilities
- Dual Gyroscopes and accelerometer
- MAVLINK protocol ready

Flight controller: mbed

- Middle man between target acquisition and Pixhawk flight controller
- Receives MAVLINK data for inspection, and commands Pixhawk based on current conditions and target location
- Low Power, versatile IO capability

Navigation: CMU Cam5 Pixy

Image Detection Camera

- Lens FOV: 75° horizontal, 47° vertical (replaced with wide-angle lens: 128° H, 96° V)
- Interfaces include USB, UART, SPI, I²C, RC Servo
- Power consumption: 140 mA typical
- Resolution: 640x400 px at 50 FPS
- Can track up to 7 color signatures

Navigation: CMU Playstation Eye

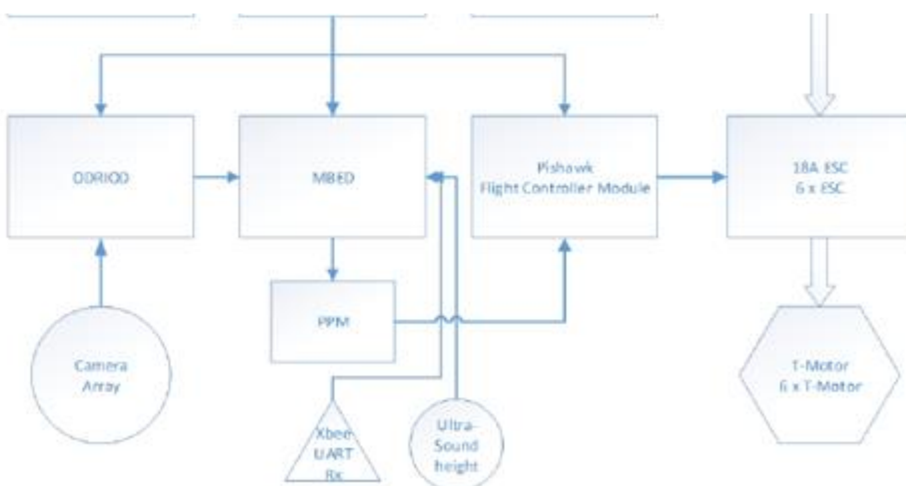
Line Detection Camera

- Lens FOV: 56º horizontal(Close up), 75ºhorizontal(Wide angle)
- Interface USB 2.0
- Power consumption: DC5V, Max. 500mA
- Video format: Uncompressed or JPEG
- Resolution: 640 x 400 at 60 FPS
  320 x 320 at 120FPS

Algorithm

Tracks color signature of ground targets. Detections are done onboard of the PixyCam. Playstaion3Eye camera handles the line detections. Each line has a unique signature. As the UAV identifies where the boundaries are through the Playstation3Eye it sees valid targets and goes for them within the bounds of the arena.

Figure of Control System Architecture



Flight Termination System

None.

PAYLOAD

Same as above.

OPERATIONS

Autonomous flight not yet capabale. Runs through a terminal on station. Which enables copter and starts motors then after the system will engage depending on what the camera sees.

RISK REDUCTION

Kill Switch created by the competition is the only thing that is being implemented to make sure that the UAV when it goes out of control will be disabled. It is still to be built and tested on the vehicle. Testing has only been done on the flight which can be seen online. The image processing has been tested and vectoring works the only problem is the communication with the flight controller to enable the copter is not there and therefore cannot continue the progress of our entry.

CONCLUSION

The entry is nowhere near completion and is not even able to arm via ground station. It was working last semester, but since no documentation was left when anything is needed for troubleshooting it cannot be done.