Systems Engineering Presentation 2

1. Requirements to be verified at the Fall Validation Experiment
2. Significant changes to the architectures
3. Work Breakdown Structure
4. Critical path on your schedule
5. Top 3 risks and planned mitigation actions

Requirements to Verify at Fall Validation Experiment

Requirements:

Autonomously Maneuver to Desired Wellhead.

Locate Wellhead

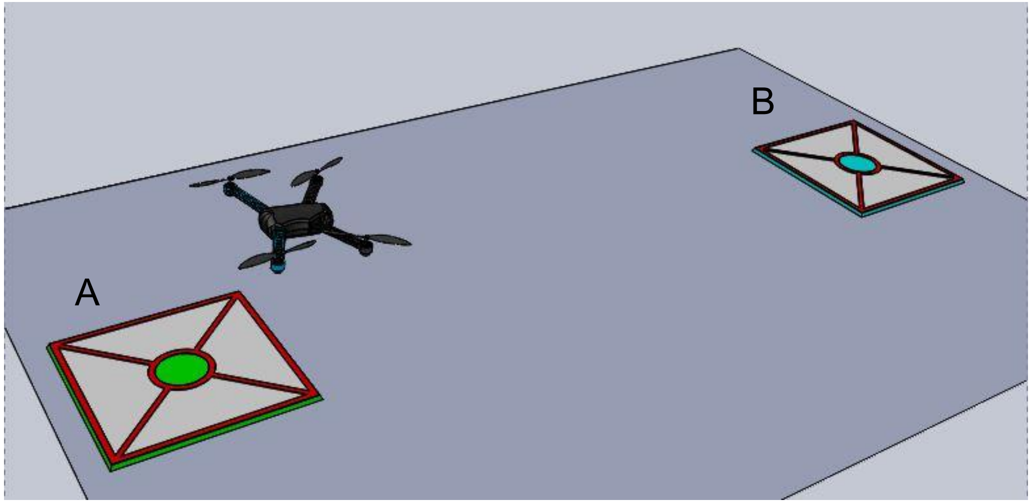
Dock at Wellhead

Requirement 1: Autonomously maneuver to desired wellhead

Position Tracking with AR. Drone2

System must Autonomously maneuver (A) to desired position (B) within +/- 2 ft

Validation: Test - initiate sequence, measure results from point of origin

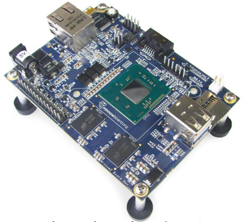


Requirement 2: Locate Wellhead

Hardware Setup on Iris+ Drone

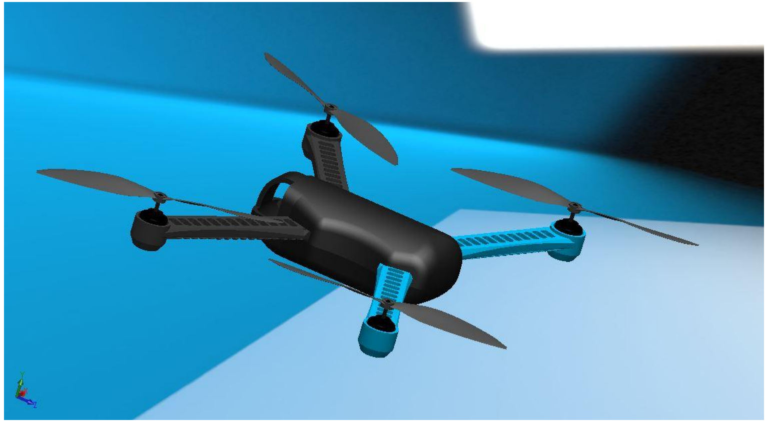
Physical Integration of sensors and computational components on IRIS drone

Validation: Proper powering and initialization of sensors and onboard processor. Rigidly Mounted component, ready for flight



http://www.minnowboard.org/meet-minnowboard-max/

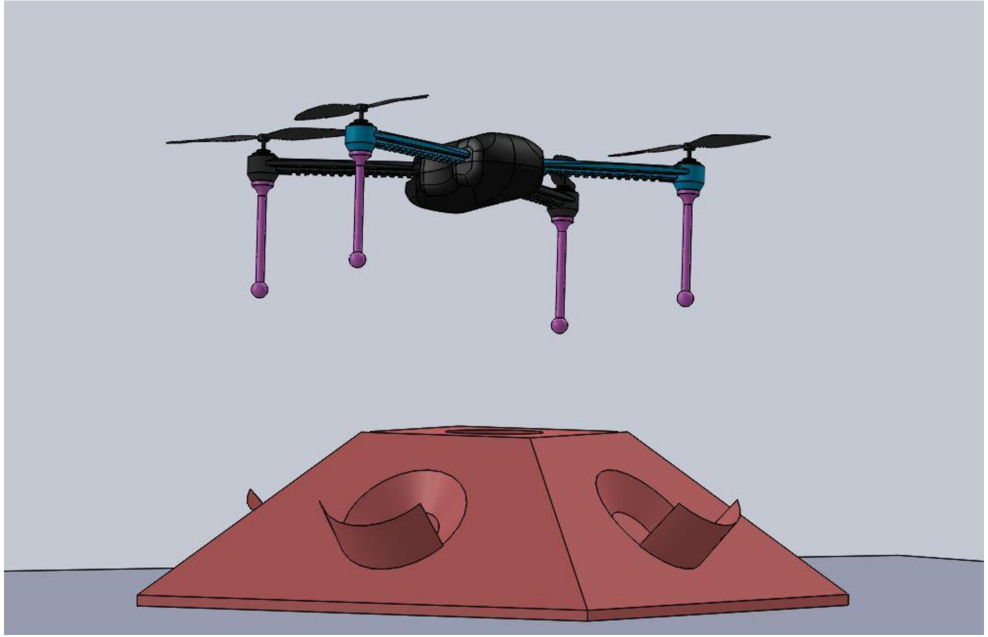
https://masterthesisiseeyouthere.wordpress.com/



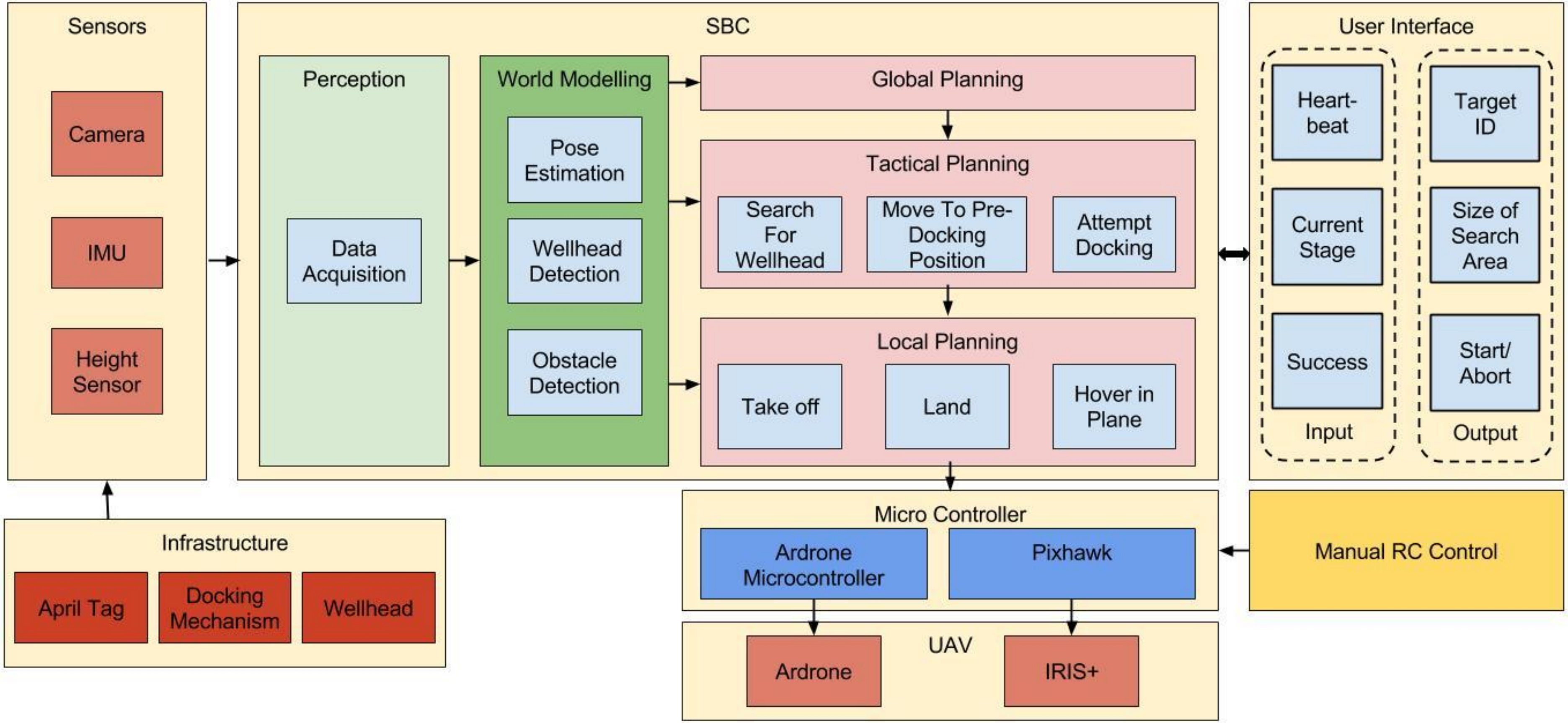
Requirement 3: Dock with Wellhead

Deliverable: Dock prototype

Validation: Drone can be manually docked and rigidly constrained in 5DOF.



Cyber-physical Architecture



Work Breakdown Structure

Demo	No.	Functionality	Status
Demo Functionality Simple Description	1.1	Description of functionality chunk one	Started
			Done
			Started
			Not S
			Not S
			Not S
			Not S
	1.2	Description of functionality chunk two	Not S
			Not S

Demo	No.	Functionality	Status
Position tracking: Demonstration of optical odometry accuracy. Manual control of drone.	1.1	Display calculated position estimate against known baseline with Iris+	S D S N N N
	1.2	Aquire sensor information from camera and position sensors	N N
Hardware setup on Iris+ Drone: Demonstrate camera feed, data feed, SBC talking to Pixhawk	2.1	Mount sensors and SBC on IRIS	N N N N
	2.2	Develop electronics for power and interfacing	S S N N
	2.3	Develop communication interface	N N N N N N

Demo	No.	Functionality	Status
Prototype of dock: Demonstrate one proof of concept, one actual prototype	3.2	Prototype of dock sub-system	N N
	3.1	Manual docking at wellhead (iris+)	N N
Open-loop ARDrone Control: Demonstrate takeoff, move, land at push of ROS button	4.1	Display ROS node graph	S
	4.2	Low-level open-loop control of drone / takeoff via ROS (AR drone)	Done Half Started N N N
Non-Demo Focus Areas: Critical work, but may not be ready for fall demo	5.1	Low-level open-loop control of Iris+ (ROHAN)	N N N
	5.1	Automated takeoff / land Iris+ (ROHAN)	N N

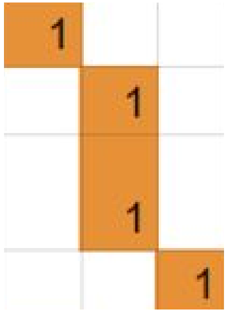
Critical Path on Schedule

Must be done first ->

Must follow first cell ->

Same as above ->

Must follow all cells ->



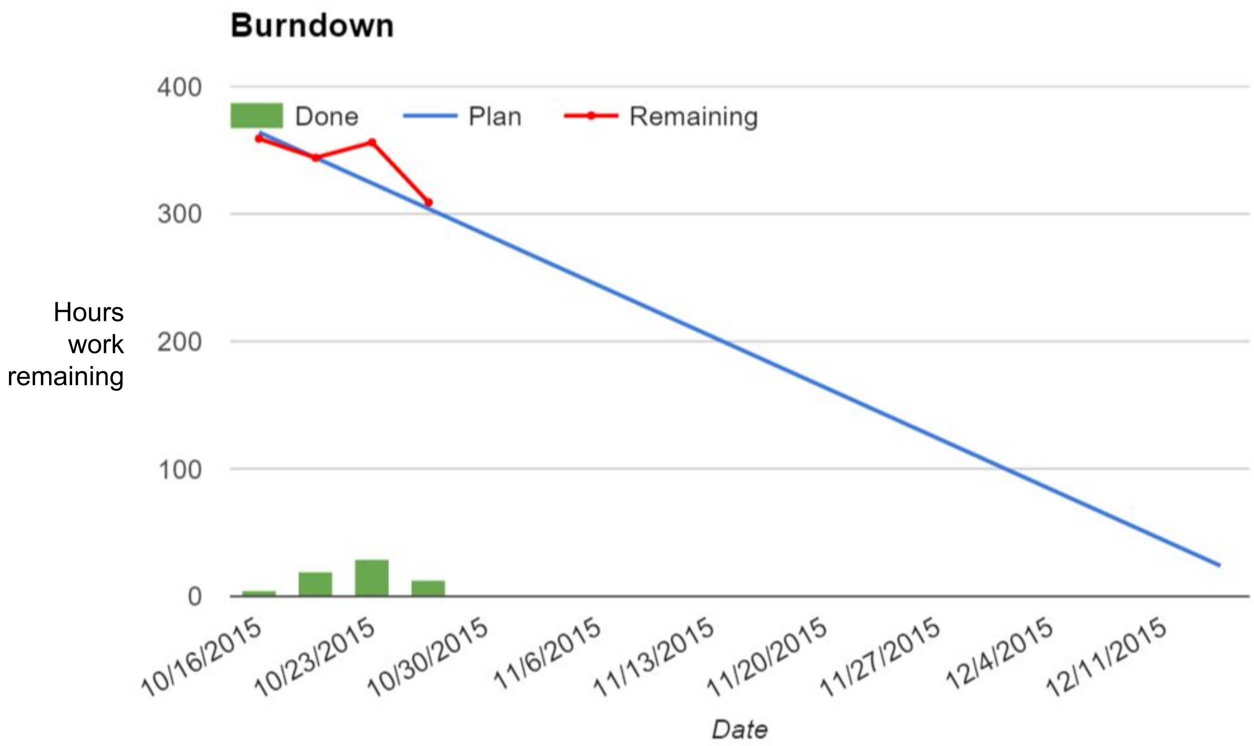
Demo	No.	Functionality		Sprint	Status	Est. Work	Remaining	Done	Critical Path		
Position tracking: Demonstration of optical odometry accuracy. Manual control of drone.	1.1	Display calculated position estimate against known baseline with Iris+	Research exsisting methods of visual odometry and sensor fusion	2	S	4	2	2	7		
			Research + document robot_localization package	1	D	2	0	2			
			Implement 2d x,y map display in ROS	2	S	4	2	4			
			Test various algorithms on existing datasets	2	N	8	8				
			Implement algorithm on PC (for AR.Drone)		N	16	16			7	
			Re-implement algorithms on Iris+ SBC			4	4				7
			Evaluate estimate against global position		N	8	8				7
	1.2	Aquire sensor information from camera and position sensors	Acquire camera feed from AR.Drone		N	2	2		7		
			Acquire camera feed from Pixhawk camera		N	8	8				
Hardware setup on Iris+ Drone: Demonstrate camera feed, data feed, SBC talking to Pixhawk	2.1	Mount sensors and SBC on IRIS	Decide on sensors and purchase (CAMERA)		N	8	8		1		
			Design mounting hardware		N	4	4			1	
			Modify hardware to fit safely on Iris+ with not jutting edges and loose wires		N	2	2			1	
			Fabricate and assemble		N	8	8				1
	2.2	Develop electronics for power and interfacing	Evaluate onboard pixhawk power supply	2	S	2	1	1	2		
			Evaluate power protection needed	2	S	2	2		2		
			Design power circuit			4	4			2	
			Fabricate and assemble power circuit		N	2	2				2
			Wire up power for SBC / Sensors.		N	4	4				2
	2.3	Develop communication interface	Setup serial communication between sensors and processor		N	8	8			1	
			Setup communication protocols between pixhawk and SBC		N	8	8		4		
			Develop ABORT button		N	8	8			2	
			Develop LAUNCH button		N	8	8			4	
			Setup manual control / auto control switching		N	4	4				
			Publish video feed over network		N	4	4				1

Demo	No.	Functionality		Sprint	Status	Est. Work	Remaining	Done	Critical Path			
Prototype of dock: Demonstrate one proof of concept, one actual prototype	3.2	Prototype of dock sub-system	Iterate dock concepts / design		N	4	4		3			
			Design, fabricate, build, develop rough prototype.		N	8	8			3		
	3.1	Manual docking at wellhead (iris+)	Develop safety protocols		N	2	2					
			Test manual docking		N	2	2				3	
Open-loop ARDrone Control: Demonstrate takeoff, move, land at push of ROS button	4.1	Display ROS node graph	Setup launch script for nodes and topics	2	S	2	1	1	5			
	4.2	Low-level open-loop control of drone / takeoff via ROS (AR drone)	Set up ROS framework / GIT repo	1	Done	4	0	3	5			
			Write READER node to acquire AR.Drone data	2	Half	8	1	8		5		
			Design and write MOVER node to issue commands	2	Started	8	6	4		5		
			Document and share READER interfaces	2		1	1				5	
			Document and share MOVER interfaces	2	N	1	1				5	
			Integrate and test control script	2	N	8	8				5	
			Add takeoff / land / abort features to MOVER	2	N	4	4				5	

The critical path is hardware setup on Iris+ (2.1 ~ 2.3) and dependent tasks below

Non-Demo Focus Areas: Critical work, but may not be ready for fall demo	5.1	Low-level open-loop control of Iris+ (ROHAN)	Write node to acquire Iris data		N	16	16		6		
			Modify MOVER / READER interfaces		N	4	4			6	
			Write test script to show control		N	8	8				6
	5.1	Automated takeoff / land Iris+ (ROHAN)	Ensure stability		N	32	32			6	
			Ensure gradual landing		N	16	16				6

On track for completion working at 40hr/week (total)

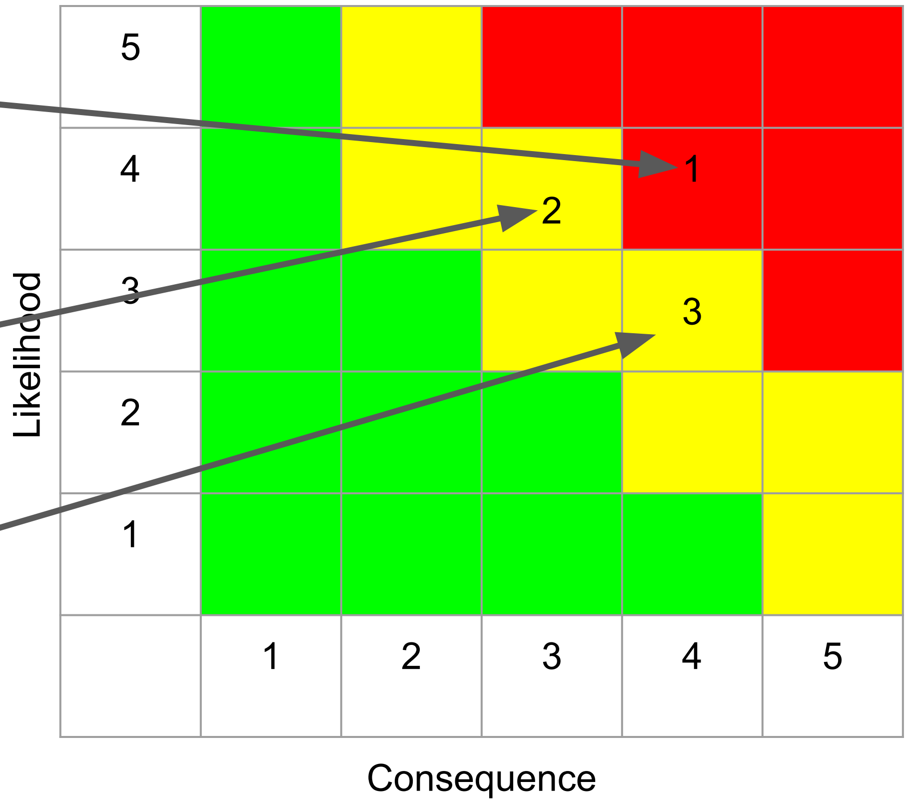


Three Top Risks

- We cannot get the UAV to dock successfully
- UAV goes wild during the run damaging itself or someone/something else
- Extra payload on UAV throws off dynamics of system

Consequence Likelihood Matrix

1. We cannot get the UAV to dock successfully
2. Extra payload on UAV throws off dynamics of system
3. UAV goes wild during the run damaging itself or someone/something else



Risk Mitigation Strategies

Risk ID:	Risk Title:	Risk Owner:	Date Submitted:	Date Updated:
6	Cannot get UAV to successfully dock	Job	10/21/2015	10/25/2015

Description:
Dock design and manufacturing does not have the properties needed to successfully dock, or the quadcopters dynamics or structural properties stop the quad from successfully docking.

Consequences:	Risk Type:	Risk Level:
The quadcopter will not be able to dock, and a major performance requirement will not be able to be accomplished	- Technical - Programmatic	16

Risk Reduction Plan	Expected Outcome:	Comments
1. Prototype multiple dock designs early and often 2. Focus resources on precision landing 3. Maintain existing AR.Drone system as fallback	Majority of work time spent on developing controls and hardware of dock	

Risk Mitigation Strategies

Risk ID:	Risk Title:	Risk Owner:	Date Submitted:	Date Updated:
2	Extra payload on UAV throws off dynamics	Rohan	10/21/2015	10/25/2015

Description:
The extra payload on the quadcopter might change the dynamics of the system and will require modification of controller

Consequences:	Risk Type:	Risk Level:
The UAV will not move in expected way and will not be able to complete its task	- Technical	12

Risk Reduction Plan	Expected Outcome:	Comments
1. Test manual dynamics with weights as soon as possible 2. Test integrated control systems as soon as possible 3. Use AR.Drone as back up	Controls will need to be tweaked significantly to handle the extra payload. Will cost time	

Risk Mitigation Strategies

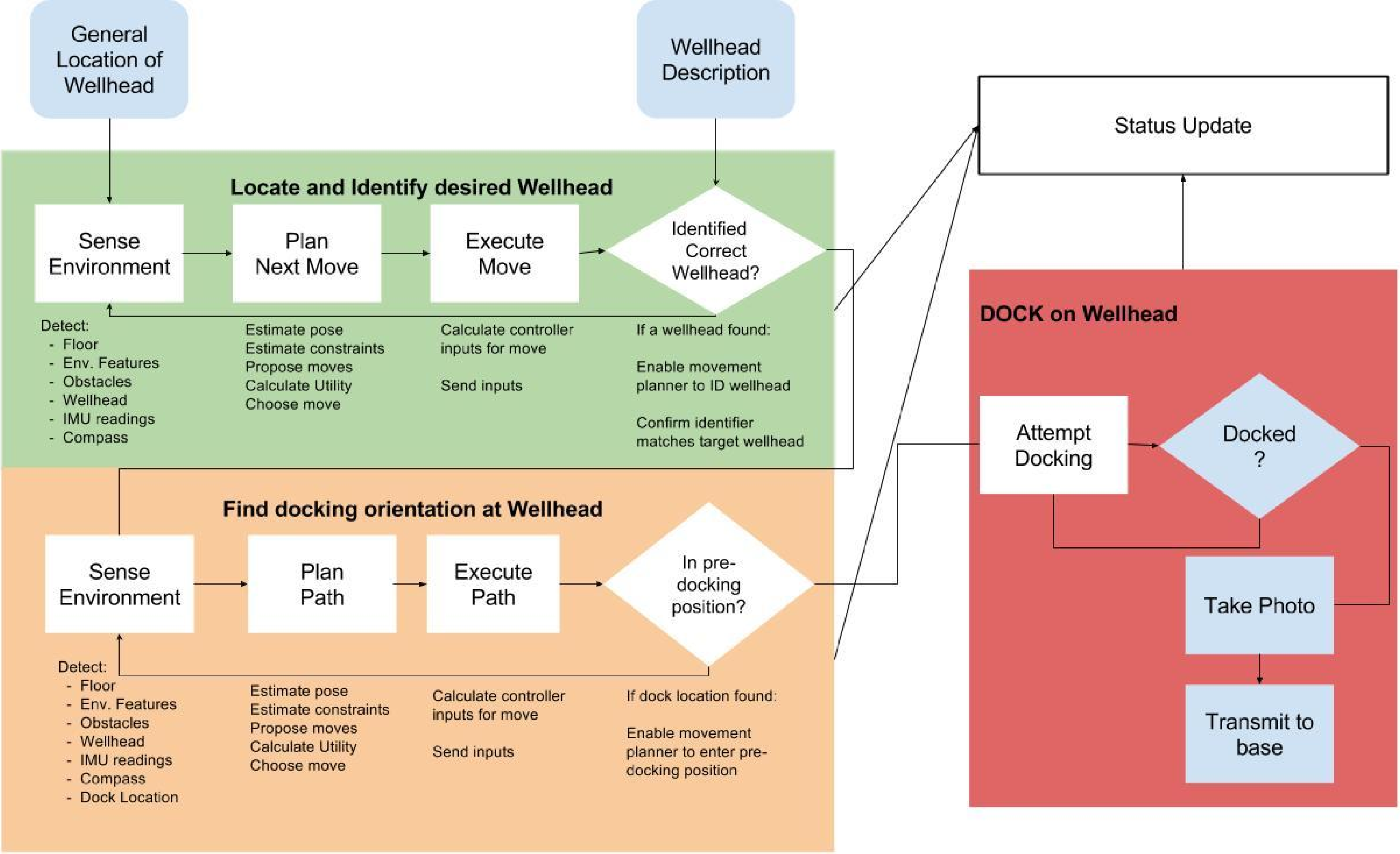
Risk ID:	Risk Title:	Risk Owner:	Date Submitted:	Date Updated:
14	UAV runs wild and damages itself or someone/something else	Cole	10/21/2015	10/25/2015

Description:
Quadcopter has unexpected motion that can be damaging to the quad or others around it

Consequences:	Risk Type:	Risk Level:
Quadcopter could damage itself or other structure and cause significant costs or harm someone physically	- Schedule - Cost	12

Risk Reduction Plan	Expected Outcome:	Comments
1. Use a net while testing 2. Buy multiple backup parts 3. Save around $600 in budget for replacement drone	Some drone parts will break and need to be replaced. Will lose time and money.	

QUESTIONS


General Location of Wellhead
Wellhead Description
Status Update
Locate and Identify desired Wellhead
Sense Environment
Plan Next Move
Execute Move
Identified Correct Wellhead?
Detect:
- Floor
- Env. Features
- Obstacles
- Wellhead
- IMU readings
- Compass
Estimate pose
Estimate constraints
Propose moves
Calculate Utility
Choose move
Calculate controller inputs for move
Send inputs
If a wellhead found:
Enable movement planner to ID wellhead
Confirm identifier matches target wellhead
DOCK on Wellhead
Attempt Docking
Docked ?
Take Photo
Transmit to base
Find docking orientation at Wellhead
Sense Environment
Plan Path
Execute Path
In pre-docking position?
Detect:
- Floor
- Env. Features
- Obstacles
- Wellhead
- IMU readings
- Compass
- Dock Location
Estimate pose
Estimate constraints
Propose moves
Calculate Utility
Choose move
Calculate controller inputs for move
Send inputs
If dock location found:
Enable movement planner to enter pre-docking position