UAV Autonomous Landing

Team Expeditus

SDSMT MCS

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UAV Autonomous Landing Project

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Sponsor
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Goal

Demonstrate the capability of a UAV to autonomously take-off, navigate through some waypoints, return to the landing pad, and land with a minimum of distance and orientation error.

Requirements

Goal

- receive a set of waypoints
- autonomously take-off
- navigate through waypoints
- return to launch pad
- **land with $\pm.1$ distance and $\pm 15^\circ$ orientation error**

Limitations

- landing platform is a fixed position
- landing platform is a stable, horizontal surface
- environment is ideal(no wind, gps available, no obstacles)

User Stories/Backlog

- **User 1(U-1):**
  As a user, I want to communicate the waypoints to the UAV.
- **Owner 1(O-1):**
  As an owner, I want the UAV to autonomously take-off from the landing pad.
- **Owner 2(O-2):**
  As an owner, I want the UAV to autonomously navigate through a set of waypoints.
- **Owner 3(O-3):**
  As an owner, I want the UAV to autonomously return to the location of the landing pad.
- **Owner 4(O-4):**
  As an owner, I want the UAV to autonomously land on the landing pad without damaging the craft.
- **Owner 5(O-5):**
  As an owner, I want the UAV to autonomously land on the landing pad with the correct orientation.

As a user, I want to communicate the waypoints to the UAV.

Task No.	Task	Date Completed	Sprint
1	Review previous method/interface for communicating coordinates to UAV.	10/05/15	1
2	Review code that communicates with quadrotor	10/16/15	2
3	Review code that allows a user to input waypoints	10/16/15	2

As an owner, I want the UAV to autonomously take-off from the landing pad.

Task No.	Task	Date Completed	Sprint
1	Review previous implementation for autonomous take-off.	10/05/15	1
2	Review code that enables the quadrotor to autonomously take-off from landing pad	10/16/15	2

As an owner, I want the UAV to autonomously navigate through a set of waypoints.

Task No.	Task	Date Completed	Sprint
1	Review previous implementation for navigating waypoints.	10/05/15	1
2	Review code that enables the quadrotor to autonomously navigate through a series of way-points	10/16/15	2

As an owner, I want the UAV to autonomously return to the location of the landing pad.

Task No.	Task	Date Completed	Sprint
1	Review previous implementation to autonomously return to location of landing pad	10/05/15	1
2	Review code that allows the autonomous return of the UAV to the landing pad.	10/16/15	2

As an owner, I want the UAV to autonomously land on the landing pad without damaging the craft

Task No.	Task	Date Completed	Sprint
1	Review previous implementation for autonomous landing	10/05/15	1
2	Install previous implementation	10/19/15	2
3	Test previous implementation	10/26/15	2

As an owner, I want the UAV to autonomously land on the landing pad with the correct orientation.

Task No.	Task	Date Completed	Sprint
1	Review previous implementation for autonomous landing	10/05/15	1
2	Install previous implementation	10/19/15	2
3	Test previous implementation	10/26/15	2

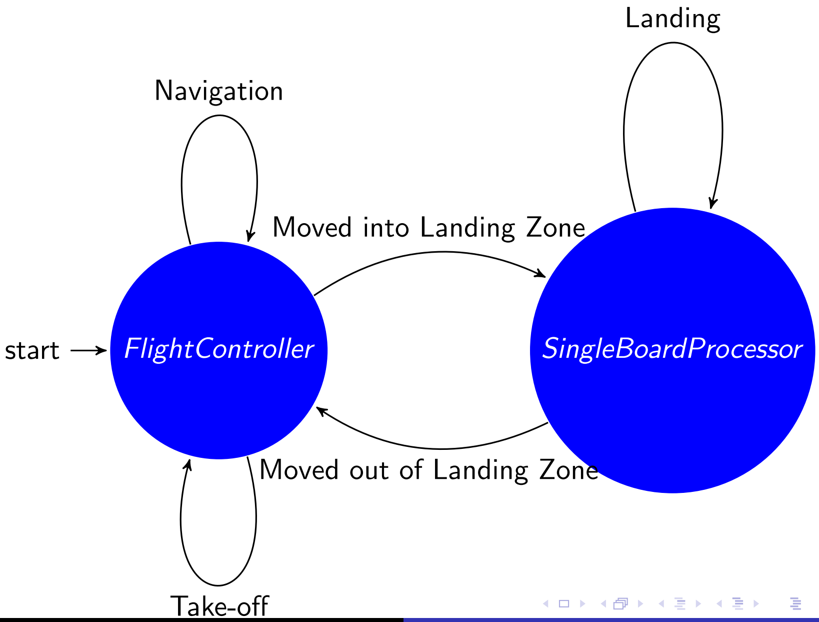
Initial Common Tasks

Task No.	Task	Date Completed	Sprint
1	Install Ubuntu 14.04 or some other ROS Indigo/Jade distro compliant OS.	09/25/15	1
2	Setup Gazebo 6.+	09/25/15	1
3	Download Rviz package	09/25/15	1
4	Setup Simulation Environment	11/02/15	2

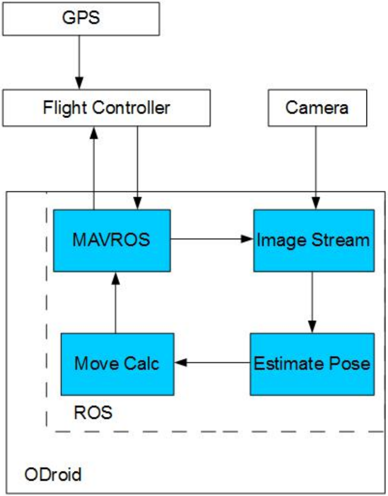
Initial Common Tasks

Task No.	Task	Date Completed	Sprint
5	Review previous iteration of project documentation	09/25/15	1
6	Inspect current quadrotor configuration	09/28/2015	2
7	Identify parts needed for quadrotor	11/02/2015	2
8	Acquire parts needed for hexrotor	12/01/2015	3

Design


Landing
Navigation
Moved into Landing Zone
start
FlightController
SingleBoardProcessor
Moved out of Landing Zone
Take-off

Architecture



Hardware Requirements

- ODroid XU4
- Pixhawk Flight Controller
- GPS peripheral
- Camera
- Battery
- UAV(Frame, Motors, ESCs, Power Distribution Board)

Software Requirements

- Mavlink
- OpenCV
- Robot Operating System(ROS) Indigo/Jade Distro
- Ubuntu 14.04

UAV Design & Tech Specs

Visual Homography Design & Tech Specs

Simulation Design & Tech Specs

Testing

PLACE HOLDER FOR THIS STUFF: Unit or Component Testing, System Testing, System Integration, Remaining backlog, Revised goals and Revised Deliverable

UAV Testing

Manual Flight
Autonomous Flight

Visual Homography Landing Testing

Integration

Remaining Backlog

- **User 1(U-1)**
- **Owner 1(O-1)**
- **Owner 2(O-2)**
- **Owner 3(O-3)**
- **Owner 4(O-4)**
- **Owner 5(O-5)**
- **Common**

Revised Goals

Project Goals remain fixed

Successes and Issues

PLACE HOLDER FOR THIS STUFF: Successes (goals met), Issues or problems (goals not met), Risk Analysis, Risk Mitigation, Timeline, Budget/costs, Intellectual Property Aspects, Licensing

Successes

Parts are now in!!

Issues

- **Simulation:**
  - Prevents testing landing algorithms safely(O-5,O-6)
- **Waiting for Parts:**
  - Prevents HIL Alternative
  - Prevents UAV Manual Flight(C)
  - Prevents UAV Autonomous Flight(U-1,O-1,O-2,O-3)
- **VH Landing Algorithm:**

Risk Analysis

- Simulation: SITL has proven to be problematic
- UAV Build: Borrowing items from UAV Team (Radio and Control)
- UAV Build: One UAV for physical testing and demonstration
- Landing Algorithm: ???

Risk Mitigation

- Simulation:
  - Attempt HIL as Alternative
- UAV Build(Sharing)
  - Schedule use of tools to prevent conflict
  - Request more funding if schedule is untenable
- UAV Build(One Shot)
  - Integrate manual control override
  - Validate solutions through simulation

Timeline

Sprint 3.5 12/16/15 to 1/10/16

1. Finish UAV Build(C)
2. Manual Flight of UAV(C)
3. Autonomous Flight of UAV(C,U-1,O-1,O-2,O-3)
4. Resolve Simulation Issues(C)

At the end of break, 3 backlog items will have been completed

Sprint 4 1/18/16 2/5/16

1. Finish Landing Algorithm Simulations(O-4,O-5)

At the end of sprint 4, we should have a landing approach validated by simulation.

Timeline...continued

Sprint 5 2/15/16 3/4/16

1. Integration of Landing Autonomy on UAV(O-4,O-5)

At the end of sprint 5, we should have completed the remainder of backlog items.

Sprint 6 3/21/16 4/15/16

1. Refinement

Budget

Item	Qty	Price	Total
Frame	1	$79.99	$79.99
Motors	8	$23.99	$191.92
ESCs	8	$17.78	$142.24
Pixhawk	1	$199.99	$199.99
Power Distribution	1	$19.99	$19.99
GPS Mast	2	$10.00	$20.00
GPS	2	$89.99	$179.98
Power Module	1	$24.99	$24.99
Odroid XU4	1	$75.95	$75.95
Props(set of 4)	3	$7.55	$22.65
TOTAL			$957.70

IP & Licensing

Intellectual Property:
Project is owned by SDSMT

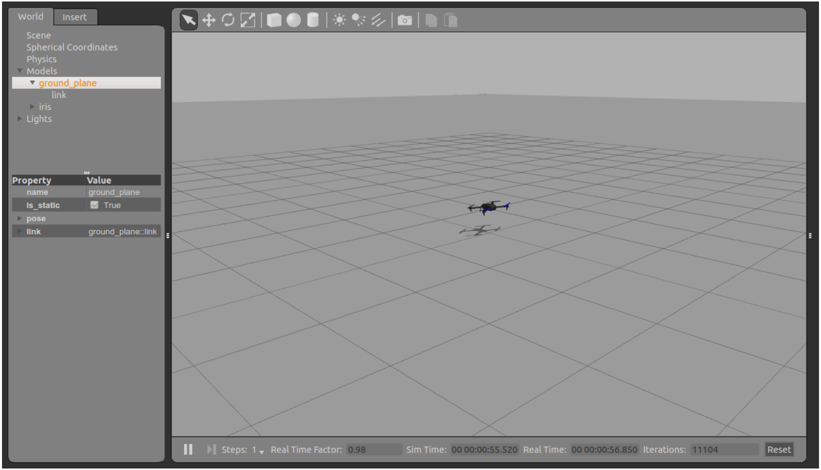
Licensing for Dependencies:

- OpenCV: BSD
- ROS: BSD
- Mavlink: LGPL
- QGroundControl: GPL

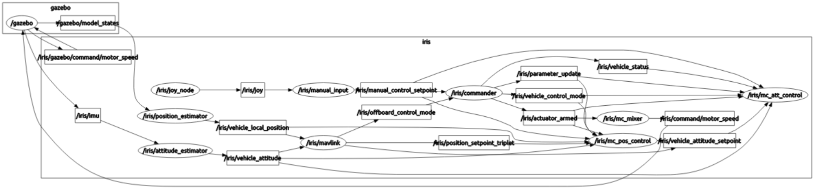
Prototypes and Demos

PLACE HOLDER FOR THIS STUFF: Demos!!

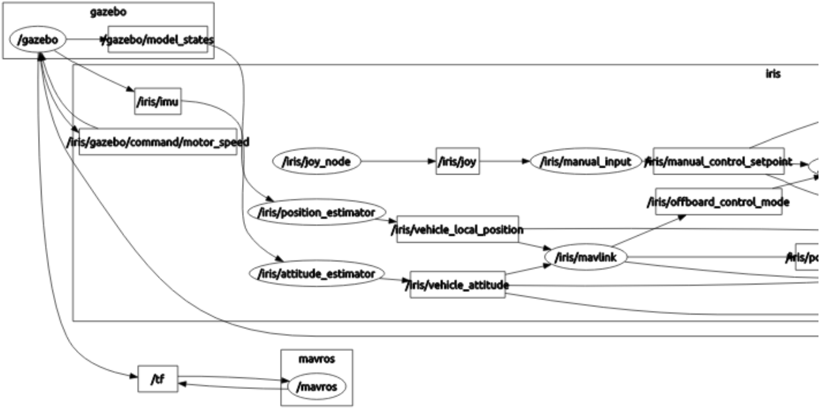
Simulation - PX4 ROS SITL



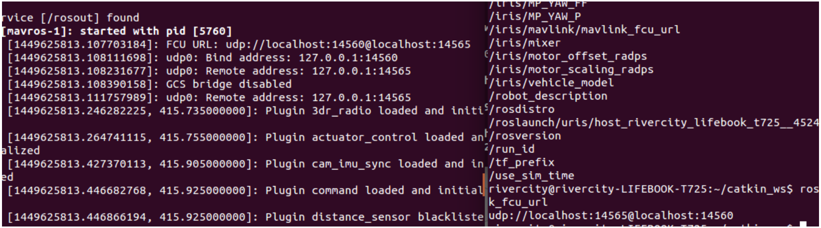
PX4 ROS SITL...continued



PX4 ROS SITL...continued

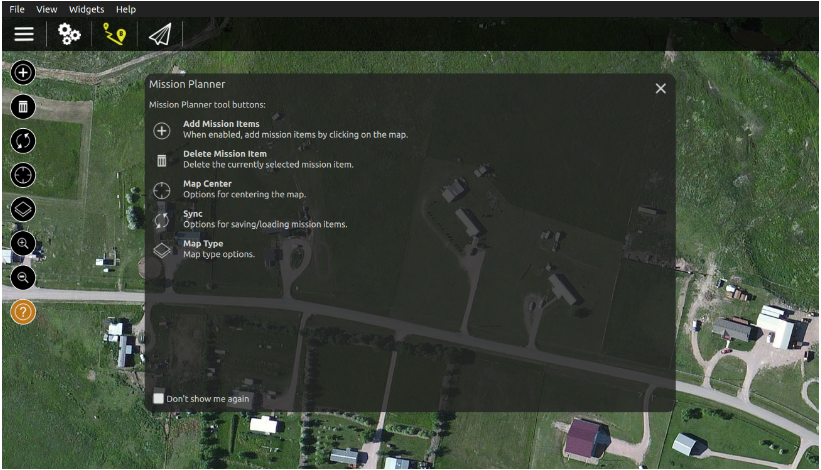


PX4 ROS SITL...continued

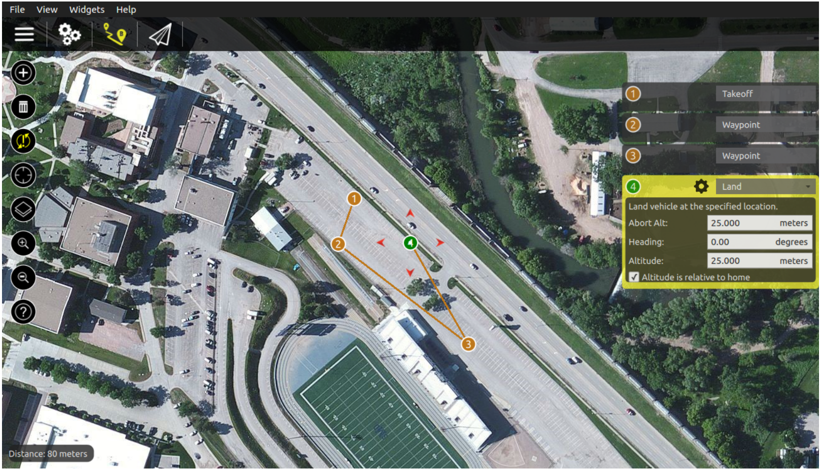


Ground Control Station - QGroundControl

Ground Control Station...continued



Ground Control Station...continued



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