

UAV Testbed for the CPS Community



Penn
Engineering

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UAV Testbed for the CPS community

- UAVs - interest, opportunities
- VO enables student UAV challenge
 - Software *and* hardware
 - Skillset development on a problem of societal impact
 - Flexible levels of complexity
- One year pilot
 - Lessons learned, and the road ahead.

Goals

Safety-net - Live UAV flights expensive

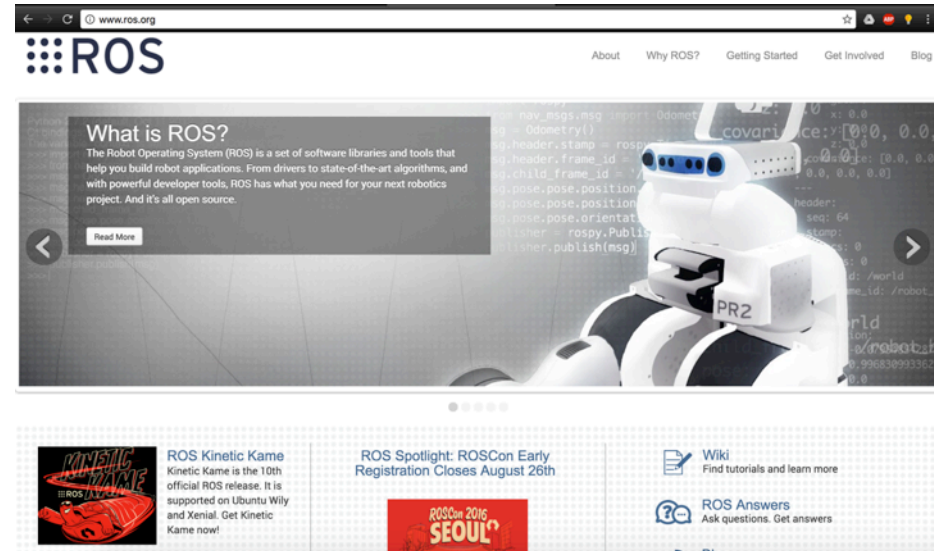
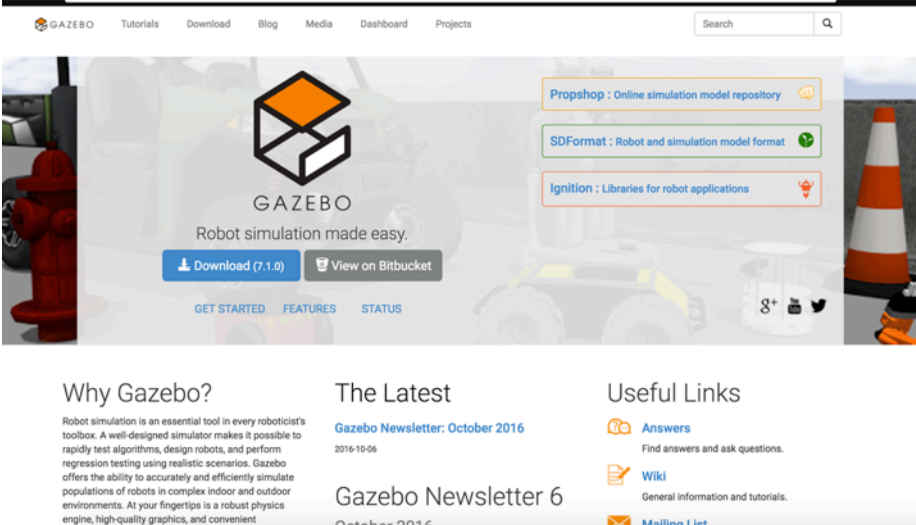
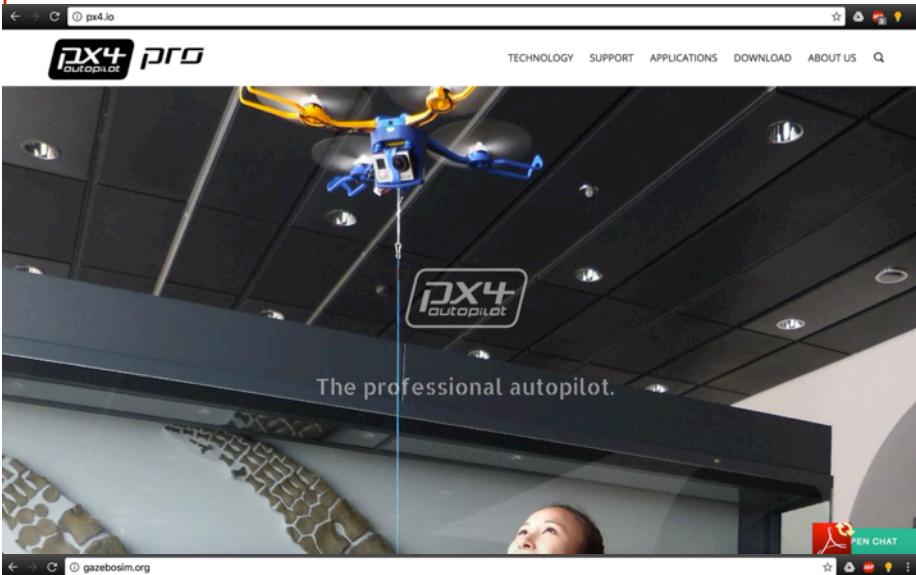
- Accessible technology
- Catastrophic crashes avoided through accurate simulator
- More end-to-end simulations = robustness, clarity

Abstractions - minimal code changes from simulation to deployment

Relevance – Open-source technologies, off-the-shelf hardware

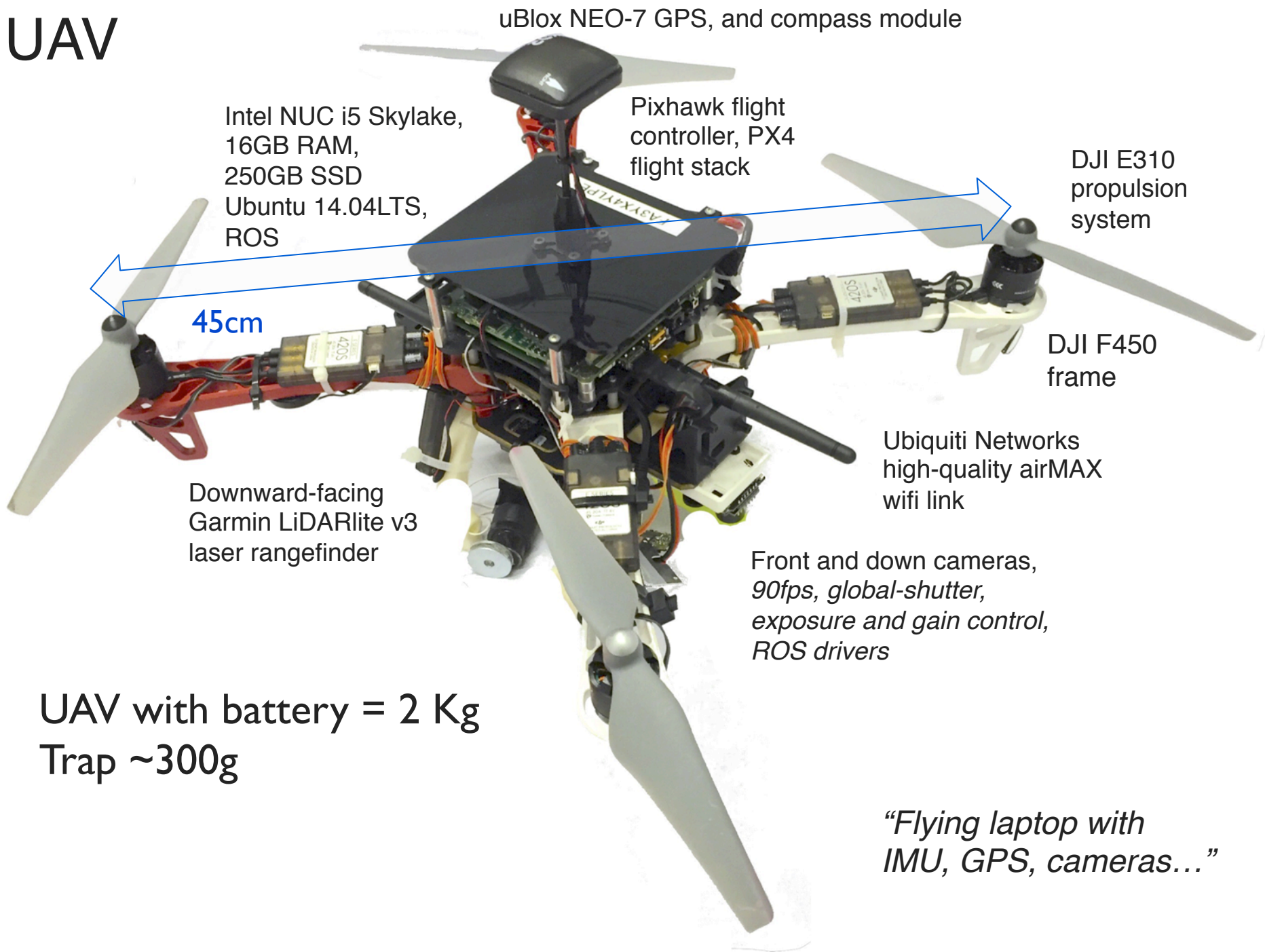
Education - FAA regulations easing up, testbed improves understanding of flight modes and failsafes

Technologies



- Availability
- Support
- Growth
- Community

UAV



UAV testbed architecture

Hardware abstraction

Real world and UAV



Simulated world and UAV

PX4
autopilot
simulator

Gazebo
Simulator

Simulations stack
and mission logic

ROS

mavlink



MAVROS



Camera
and additional
Sensor
streams

OpenCV

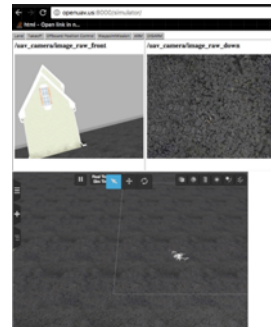
Web-interface

ROS web
Suite

Gazebo-web
(gzweb)

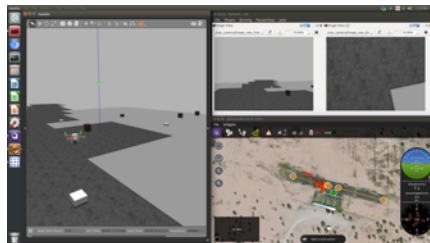
internet

Web-based
simulation
environment



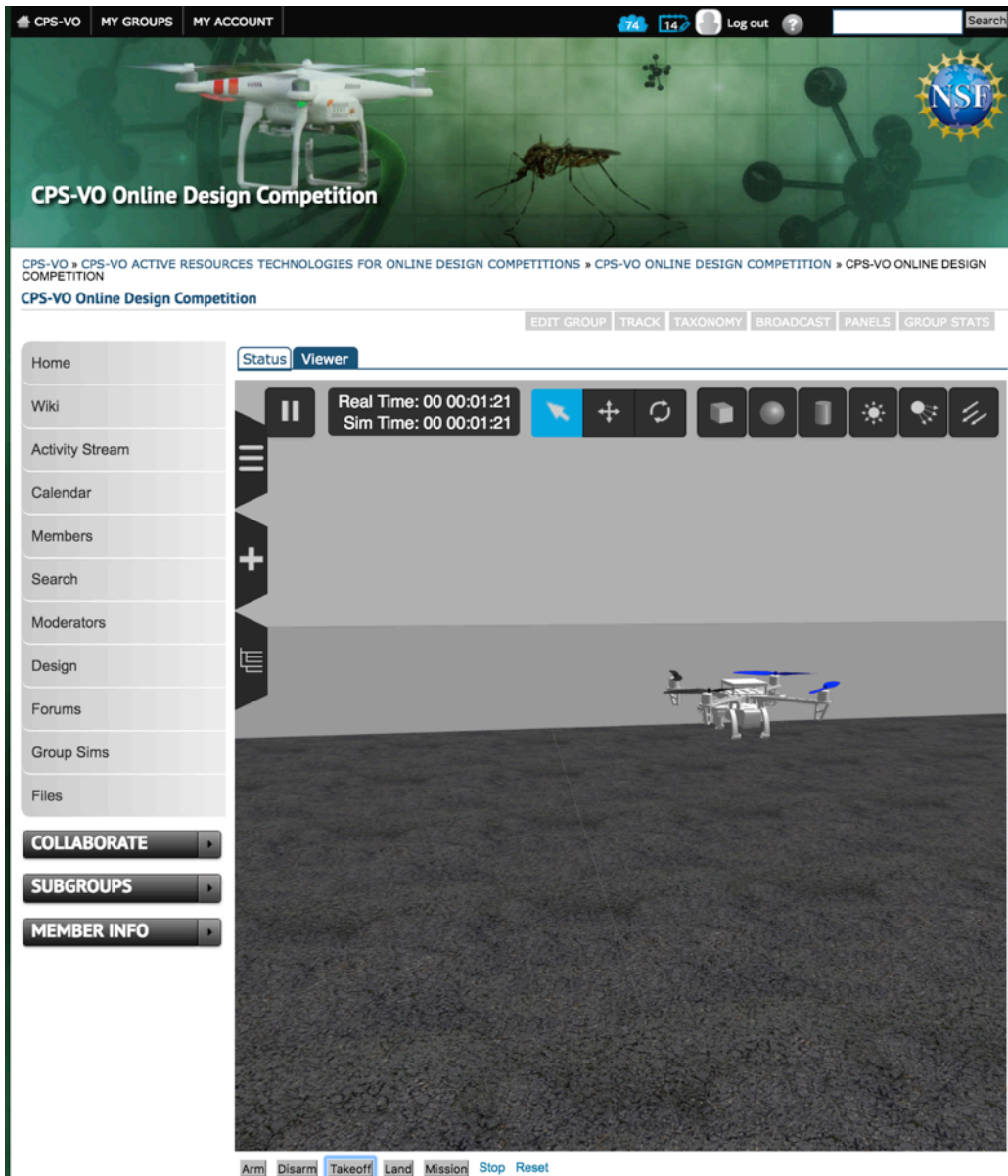
CPS-VO active
resource

*browsers, or
mobile devices*

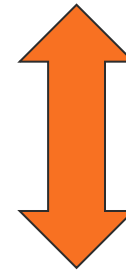


Vision

PHASE I



UAV testbed on the Cloud

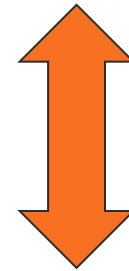
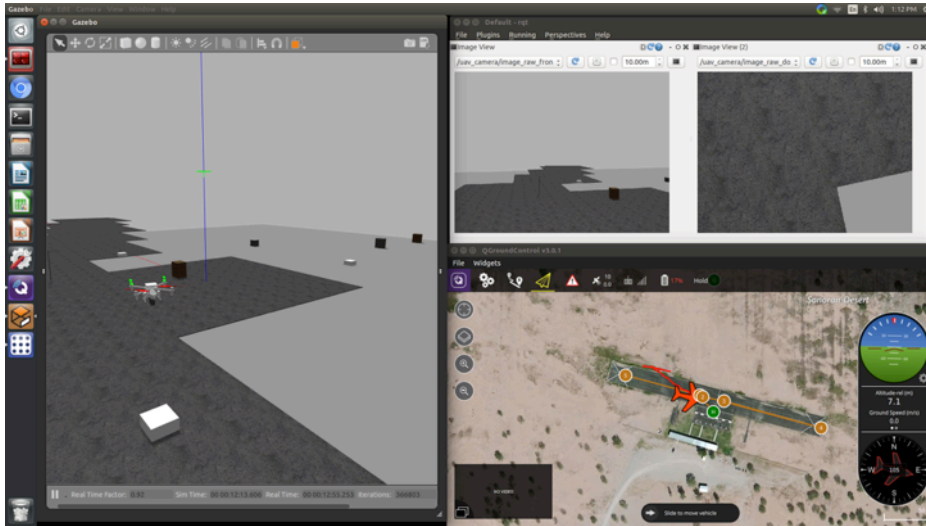


UAV design studio
(web frontend)

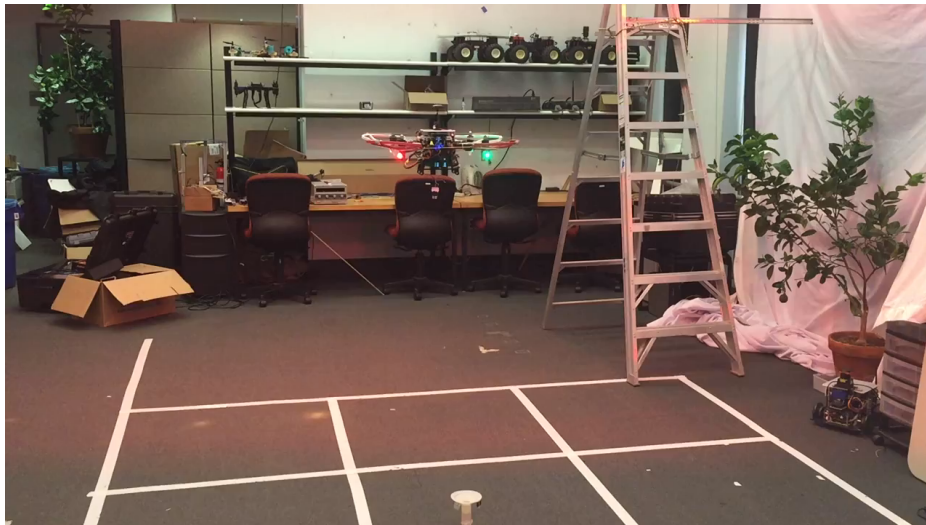
Simulated UAV flights

Vision

PHASE II



UAV
SITL and
HIL suite



UAV flight tests in simulation
(in preparation of realworld flights)

Vision

PHASE III



Outdoor UAV flights



Penn Aerial team at TIMPA airfield

Lessons Learned

Non-trivial

- bleeding-edge technology, impact, pain
- group effort, collaboration and sharing

Scale-up

- Simulation compute resources at scale
- Example solutions
- Off-the-shelf compatible hardware

Demo 5p-7p today!