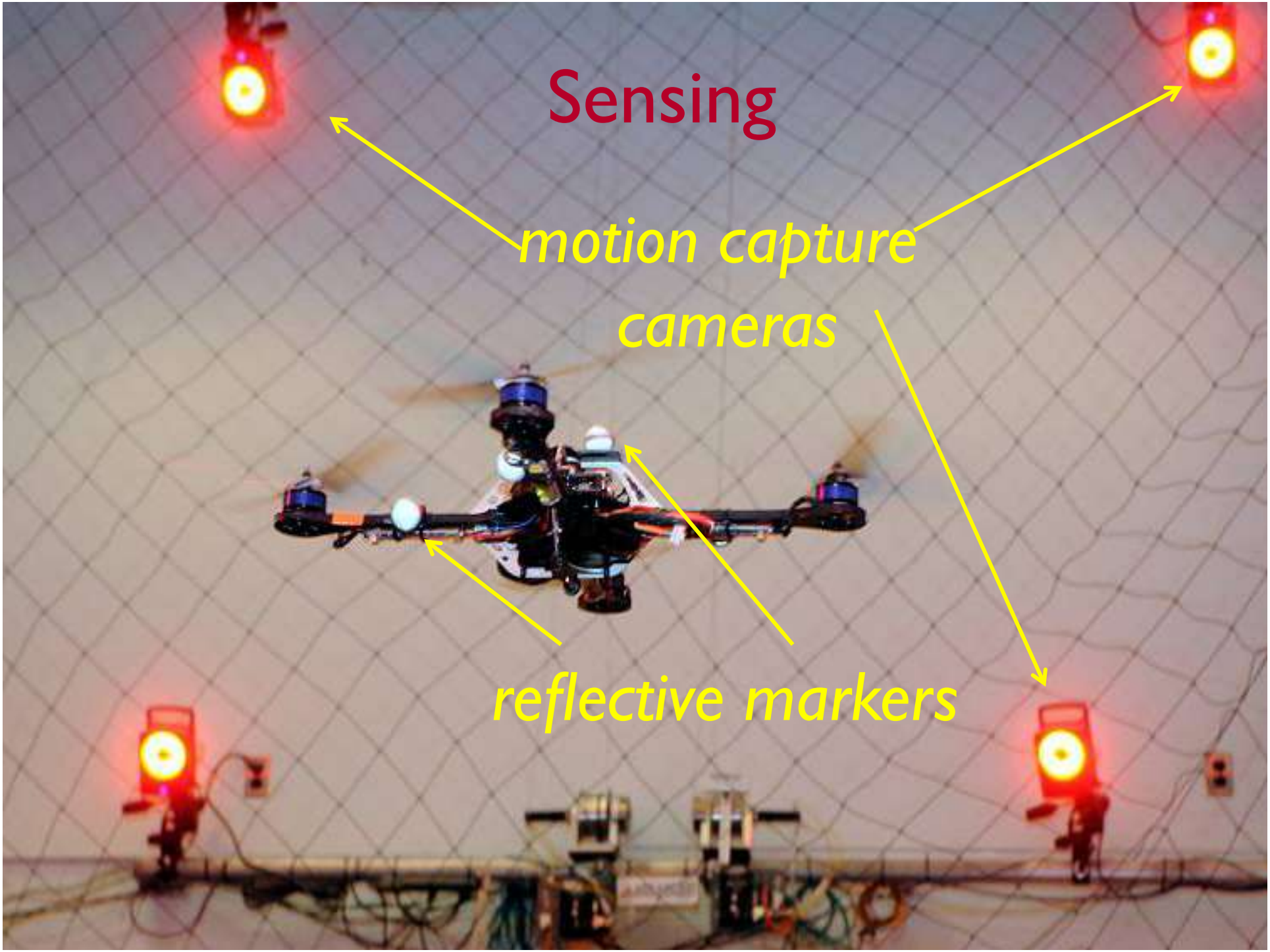
State Estimation

obtain reliable estimates of position and velocity


Sensing
motion capture cameras
reflective markers

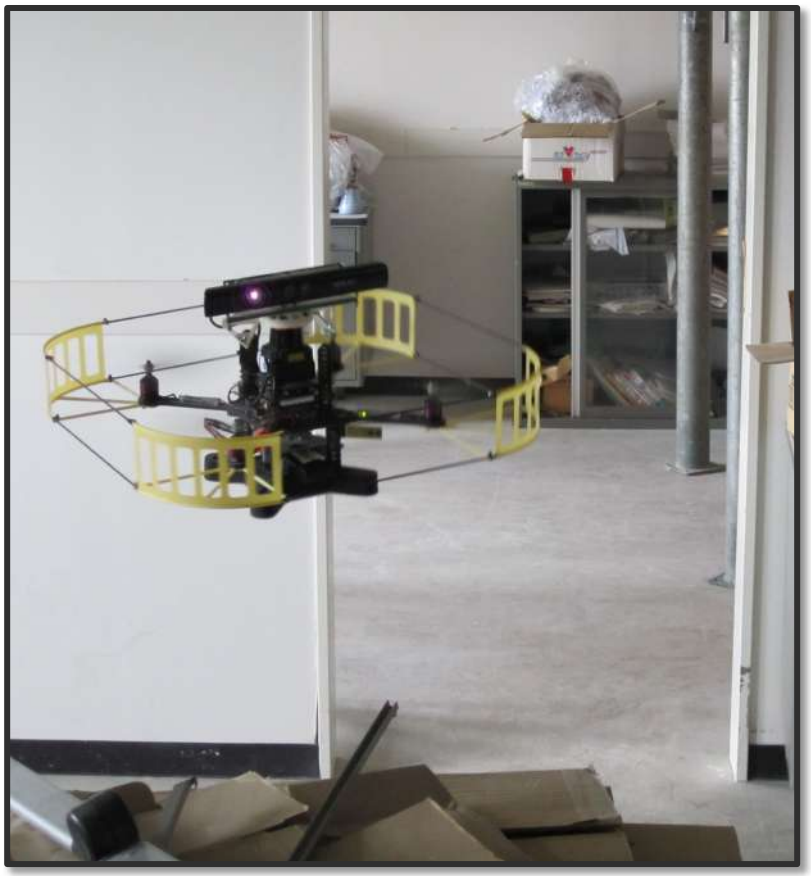
X-47B Wins Popular Mechanics Magazine 2013 Breakthrough Award

Photograph by Joe McNally

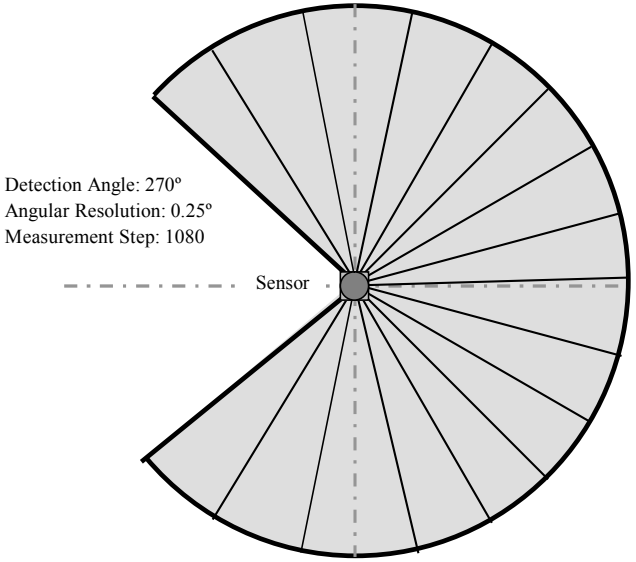
Unreliable GPS

Operate indoors and outdoors
No GPS
Small, maneuverable
Agile, fast

How to navigate without GPS or external motion capture cameras?



Hokuyo UTM-30LX Scanning Laser Rangefinder

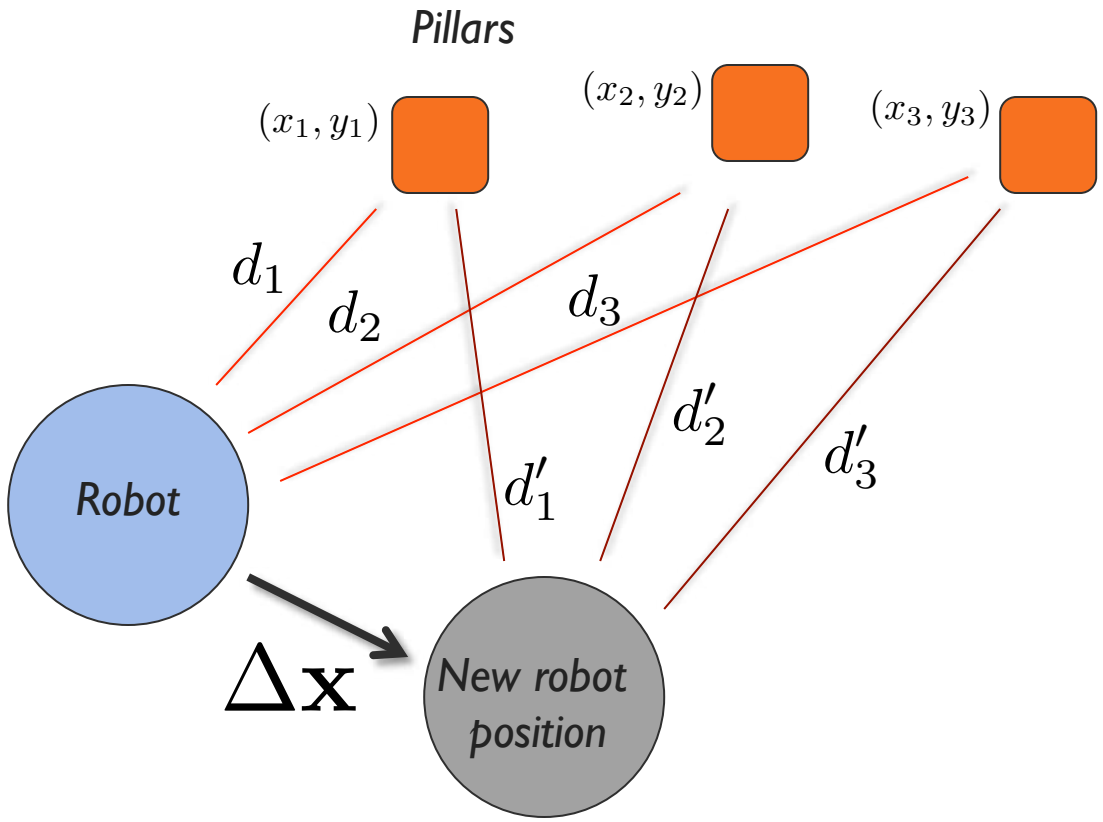


mvBlueFox USB camera

Kinect sensor for XBOX 360

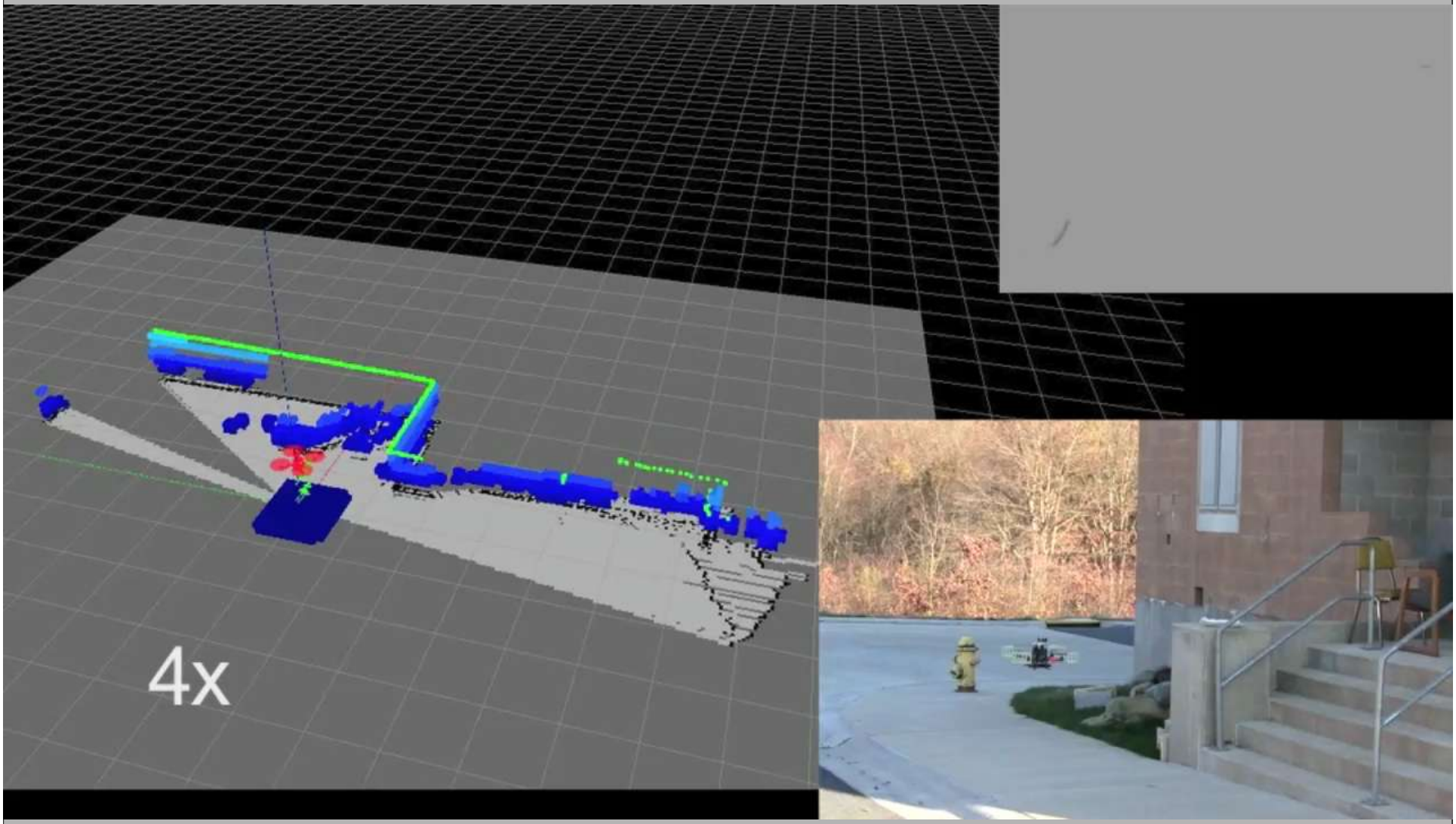
Penn Engineering

Simultaneous Localization And Mapping



Concurrently estimate

- Locations of pillars (6)
- Displacement of the robot (2)


4x

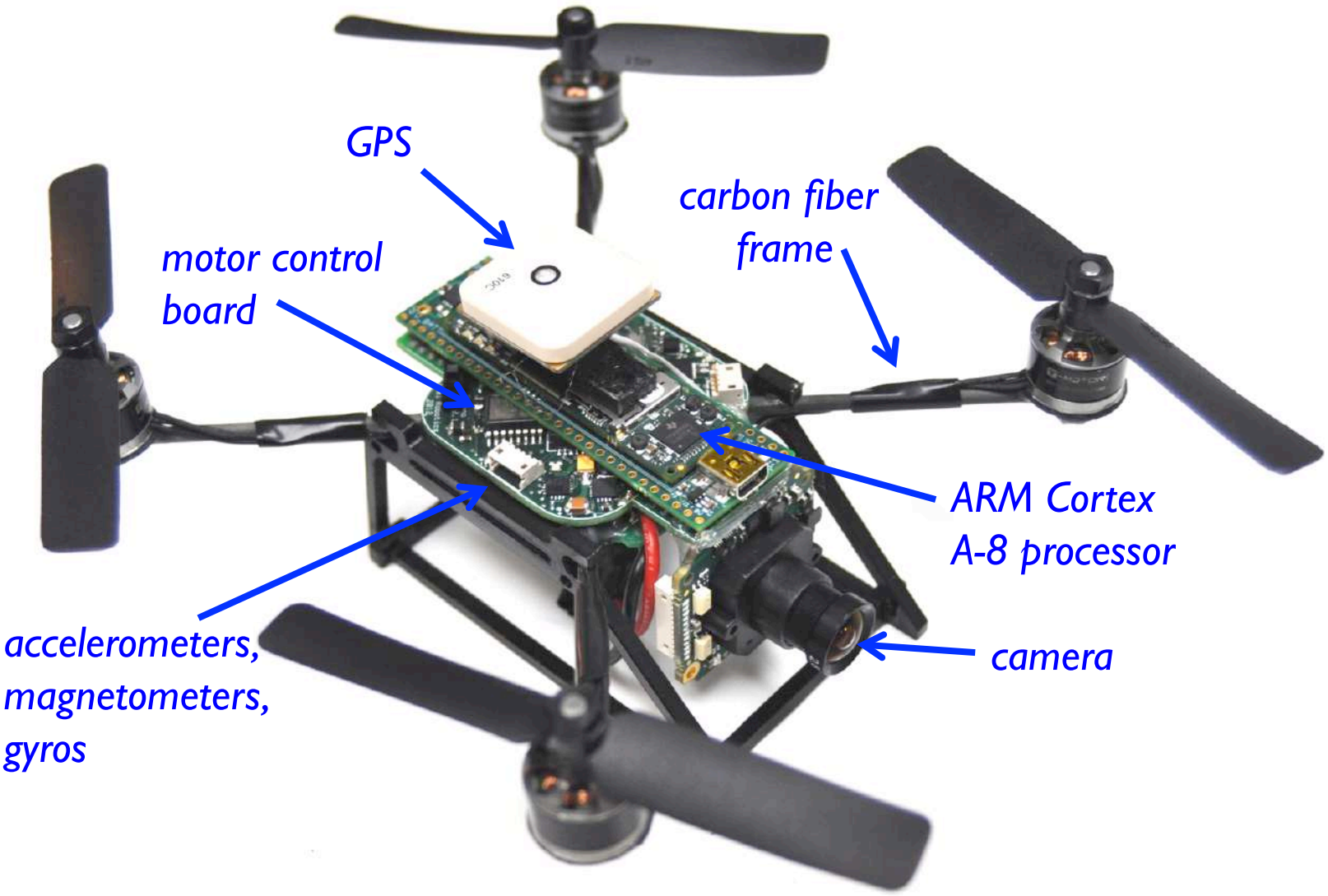
1750 g (laser, 3 cameras, GPS, IMU)

650 g (camera, IMU)

740 g (2 cameras, IMU)

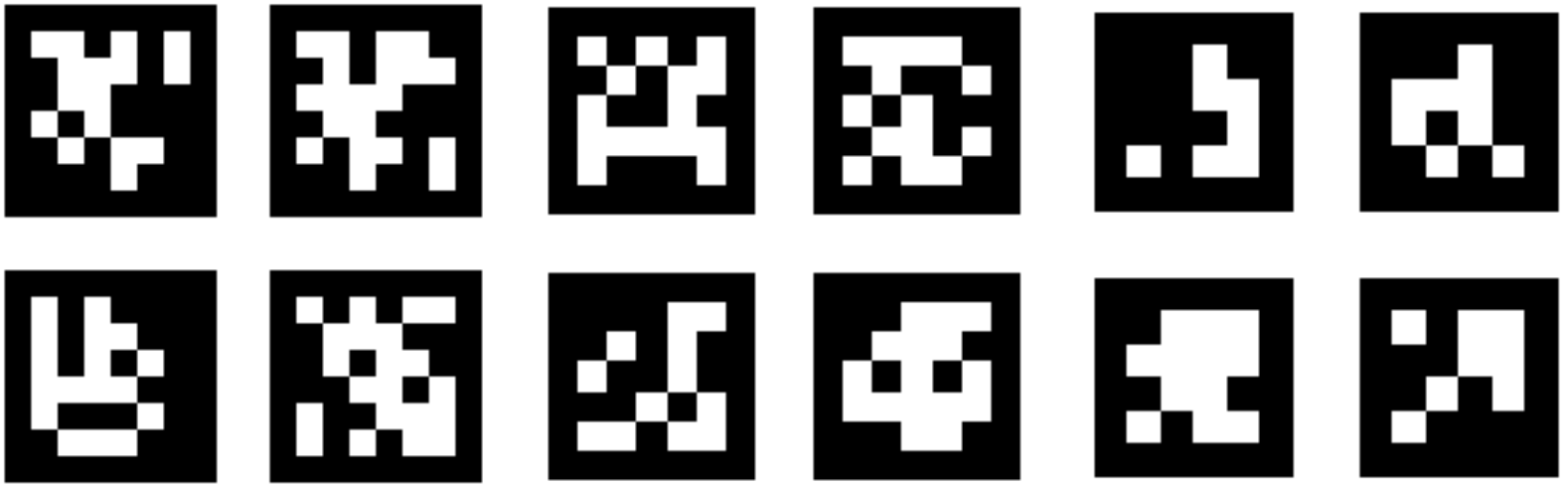
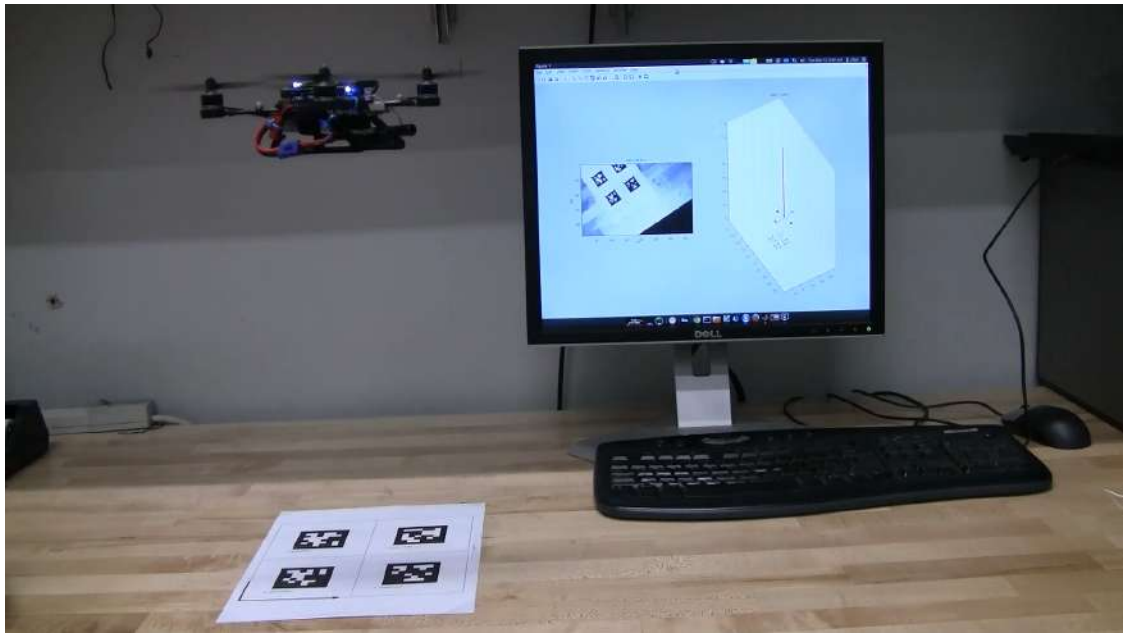
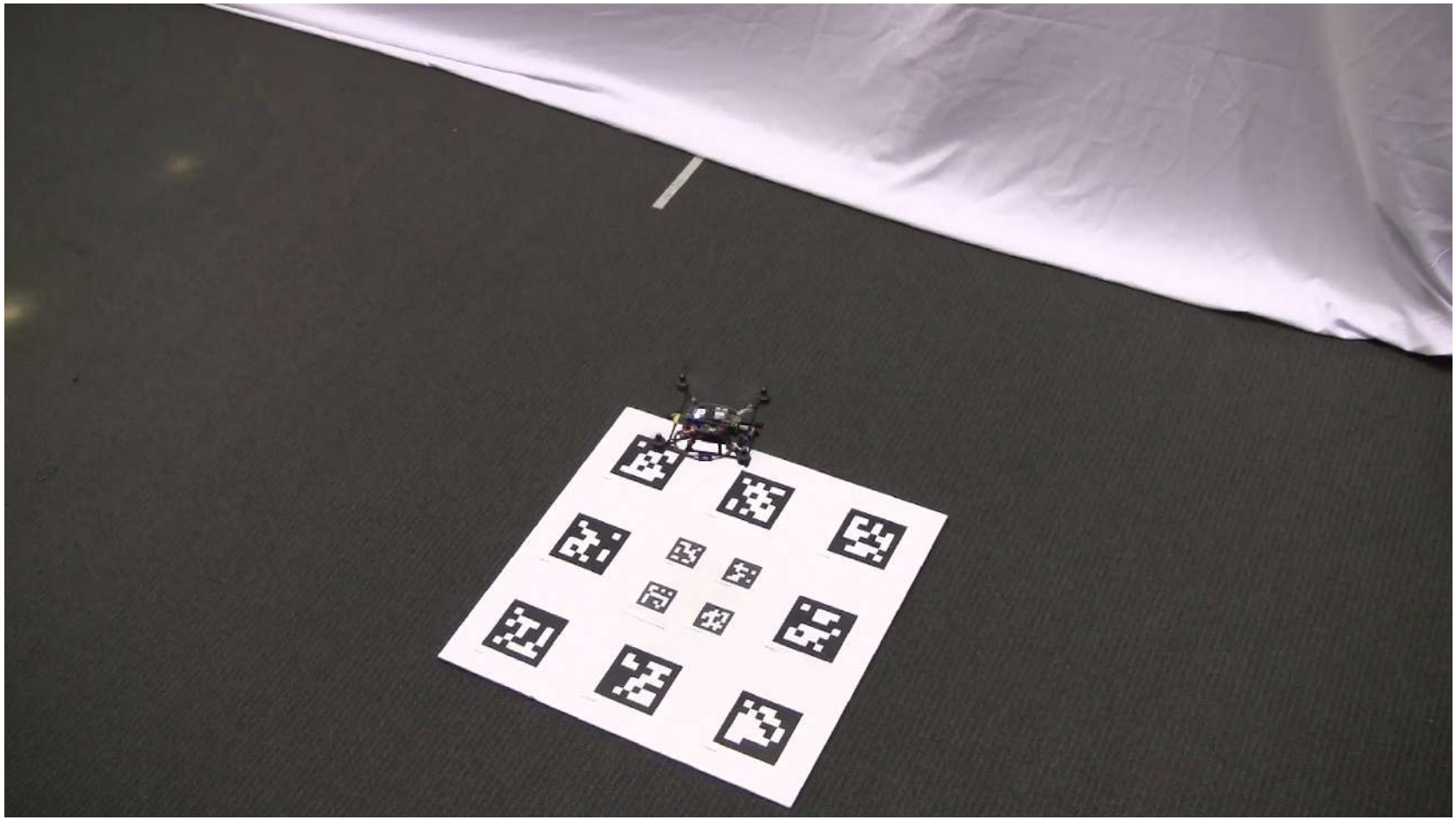
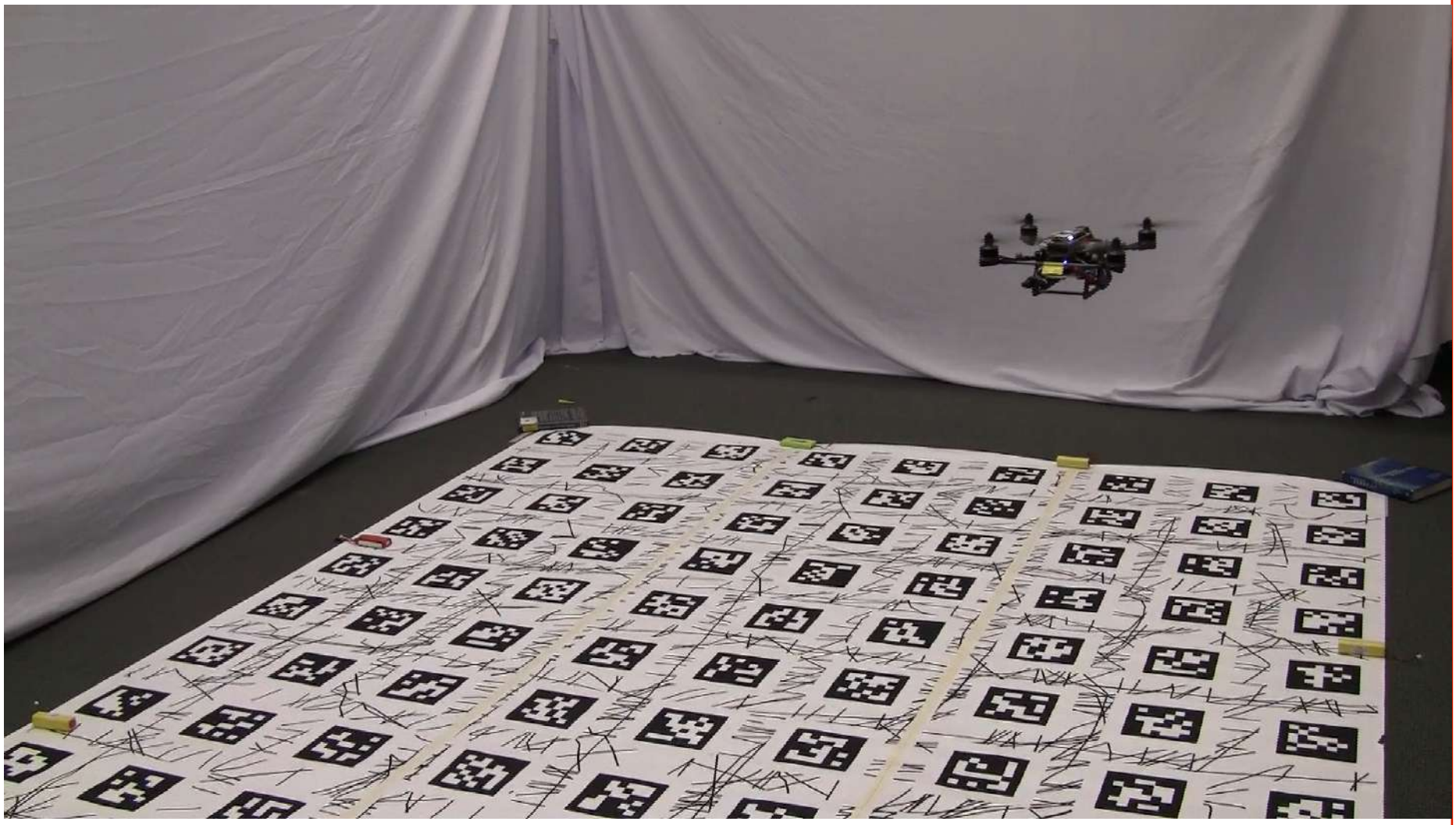
1800 g (laser, Kinect, IMU)

Experimental Platform



KMel Robotics
www.kmelrobotics.com

Beacons that are easy to recognize



http://april.eecs.umich.edu/wiki/images/9/94/Tagsampler.png