Accessible Aerial Autonomy?

ARDrone ~ aerial *remote-controlled* platform

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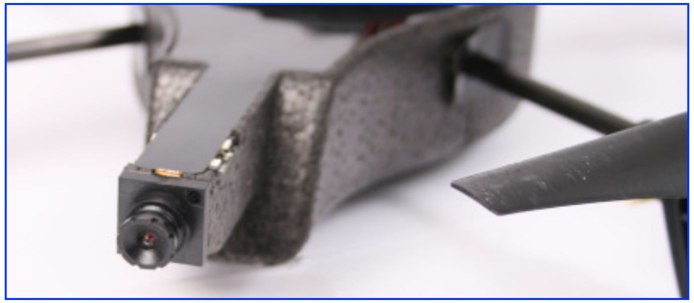
Question

Would the ARDrone make an effective ***robot***?

Raw material:

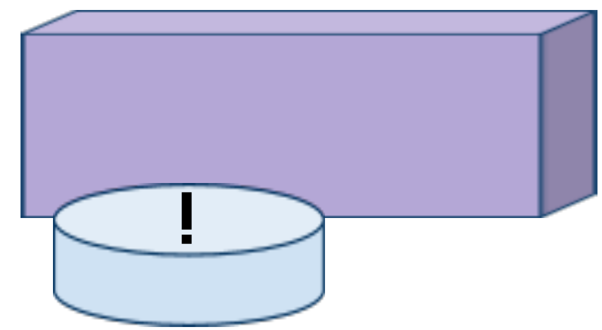
- closed hardware
- but an open, ASCII API
- two cameras



Plan: accomplish tasks with the drone and computer vision

Several tasks tried...

(0) Flight "testing"
(1) Cooperating with the Create
(2) Navigating among landmarks
(3) Localization without landmarks



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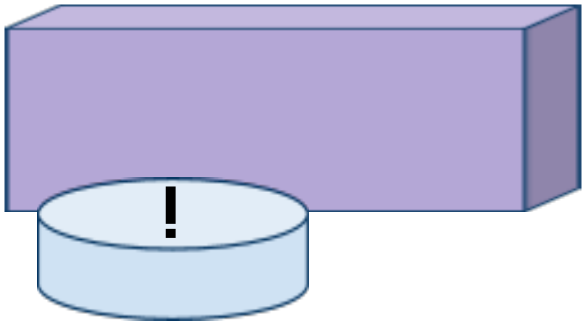
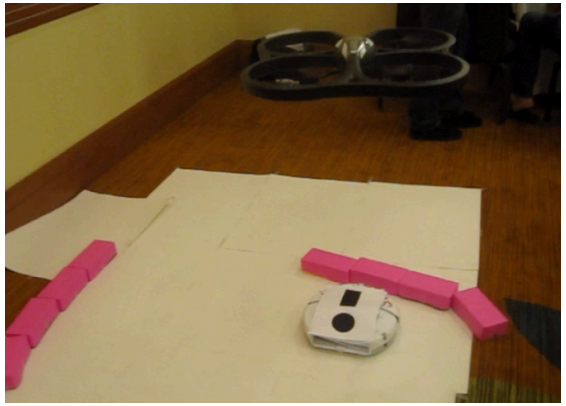
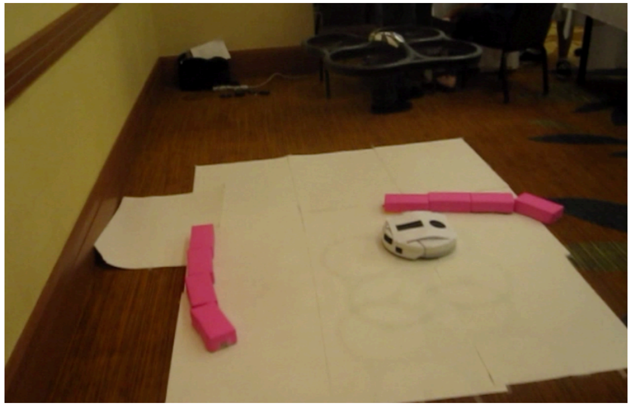
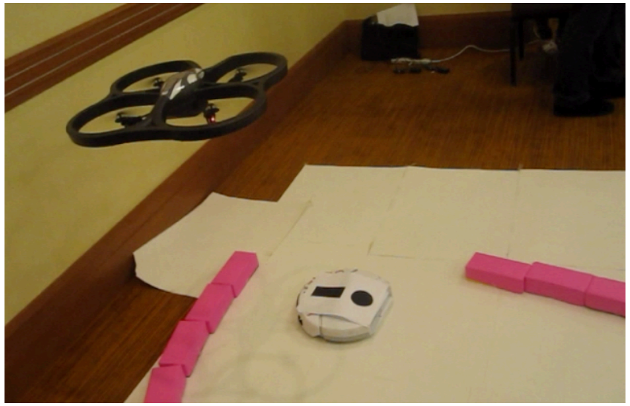




detect + decide



follow



repeat...

Task 1: *Follow that !*

We put a ! on the Create to
- help discern location
- help discern orientation

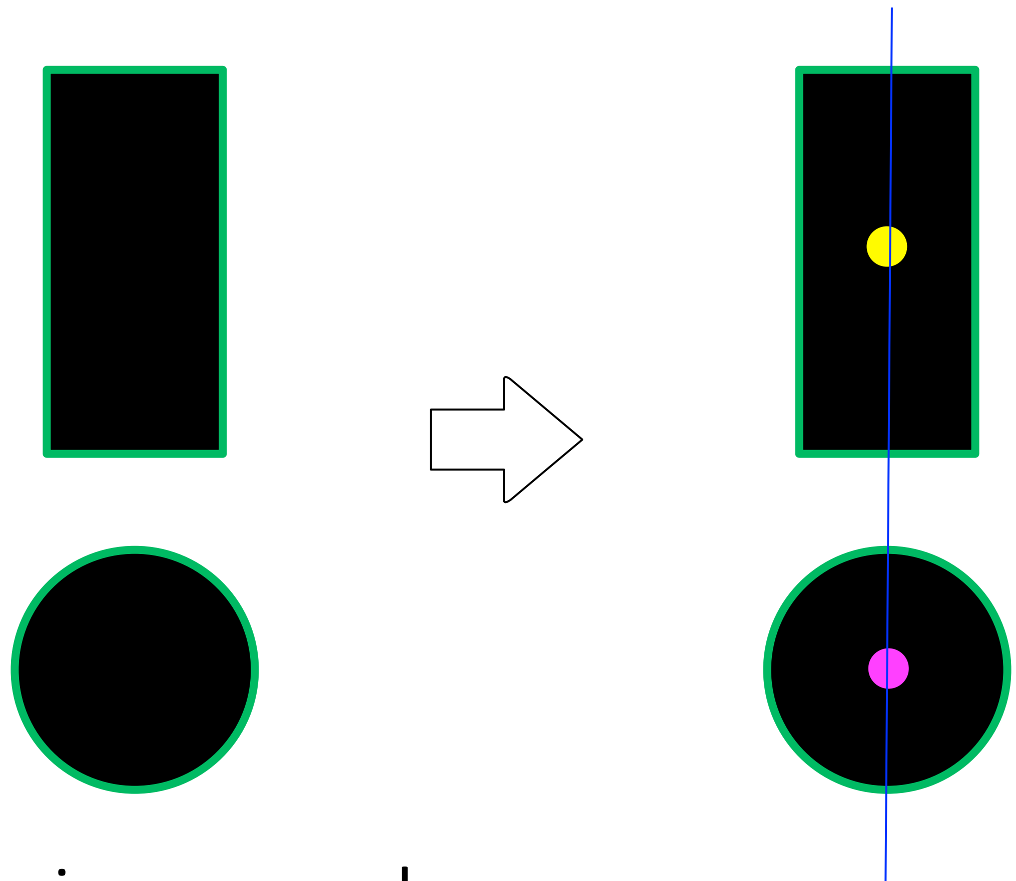


Image processing approach:

(1) threshold image to find dark regions and contours
(2) ***circle?*** compare region with min. enclosing circle
(3) ***rectangle?*** compare region with min. enclosing rect.
(4) filter noise, find centers, and construct heading line

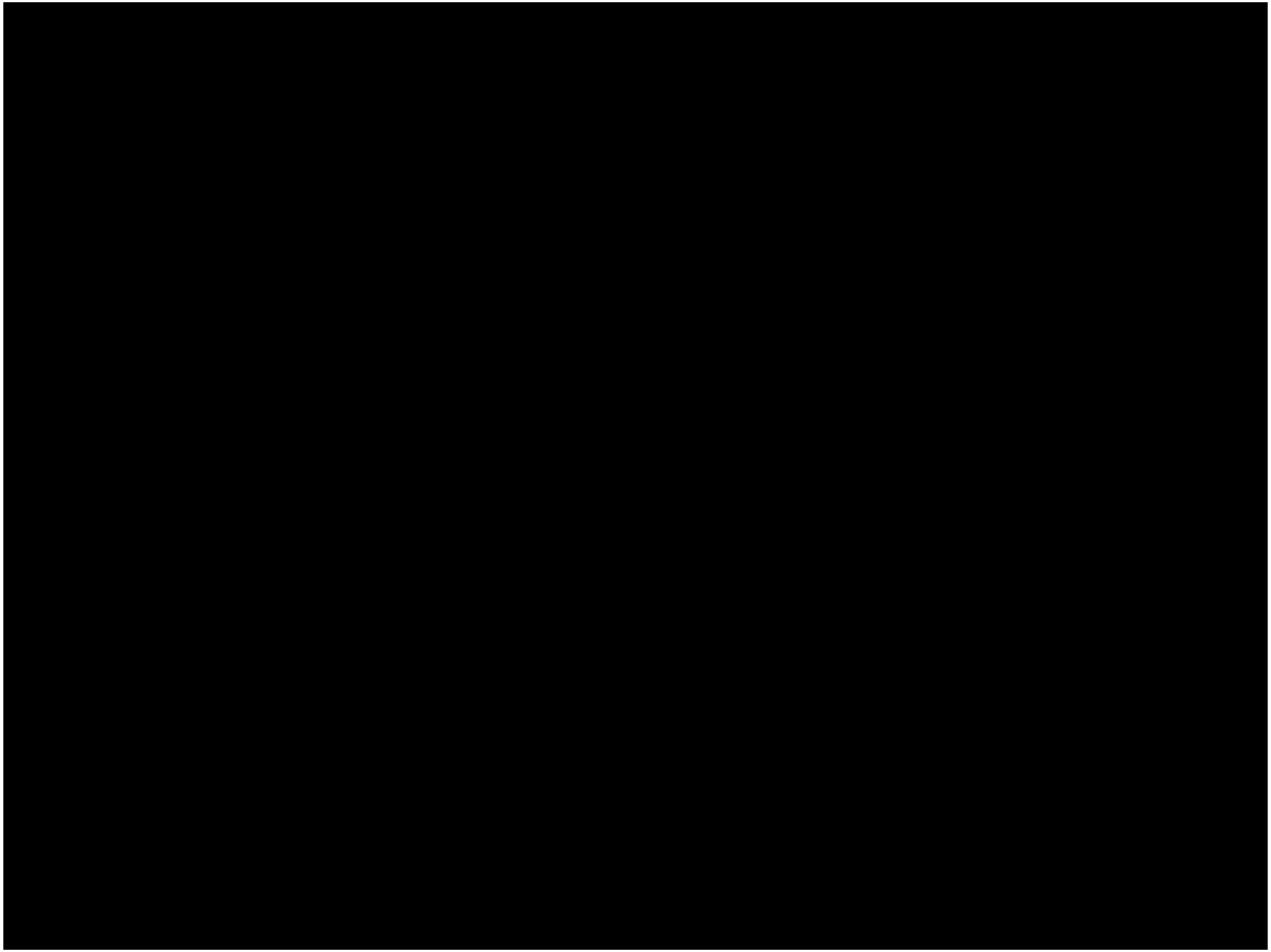
! finding

original

contours

wall segmentation

GCER cooperation demo



2x

Lessons learned

- The ! was far from a perfect landmark
- We wanted to use something more robust that could give us more accurate pose estimation
- We decided to explore **April Tags...**

APRIL tags

Autonomy, Perception, Robotics, Interfaces, and Learning

Java-based landmark library from U. Michigan

an example tag in the center...

provides full 6 DOF pose and scale

APRIL tags' scale range

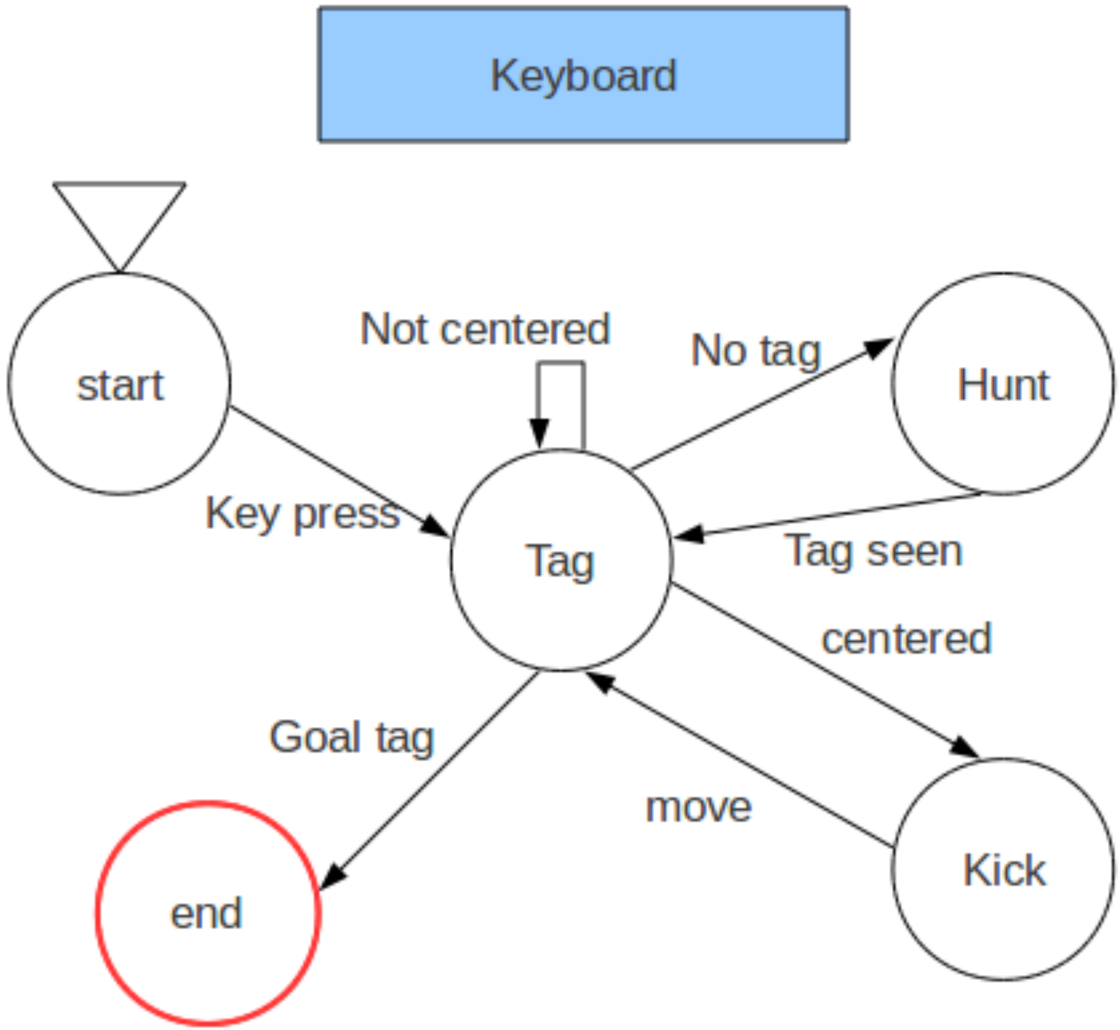
an example tag in the center...

provides full 6 DOF pose and scale
... *when it's visible*

Task 2: The *Hula-hoop hop*

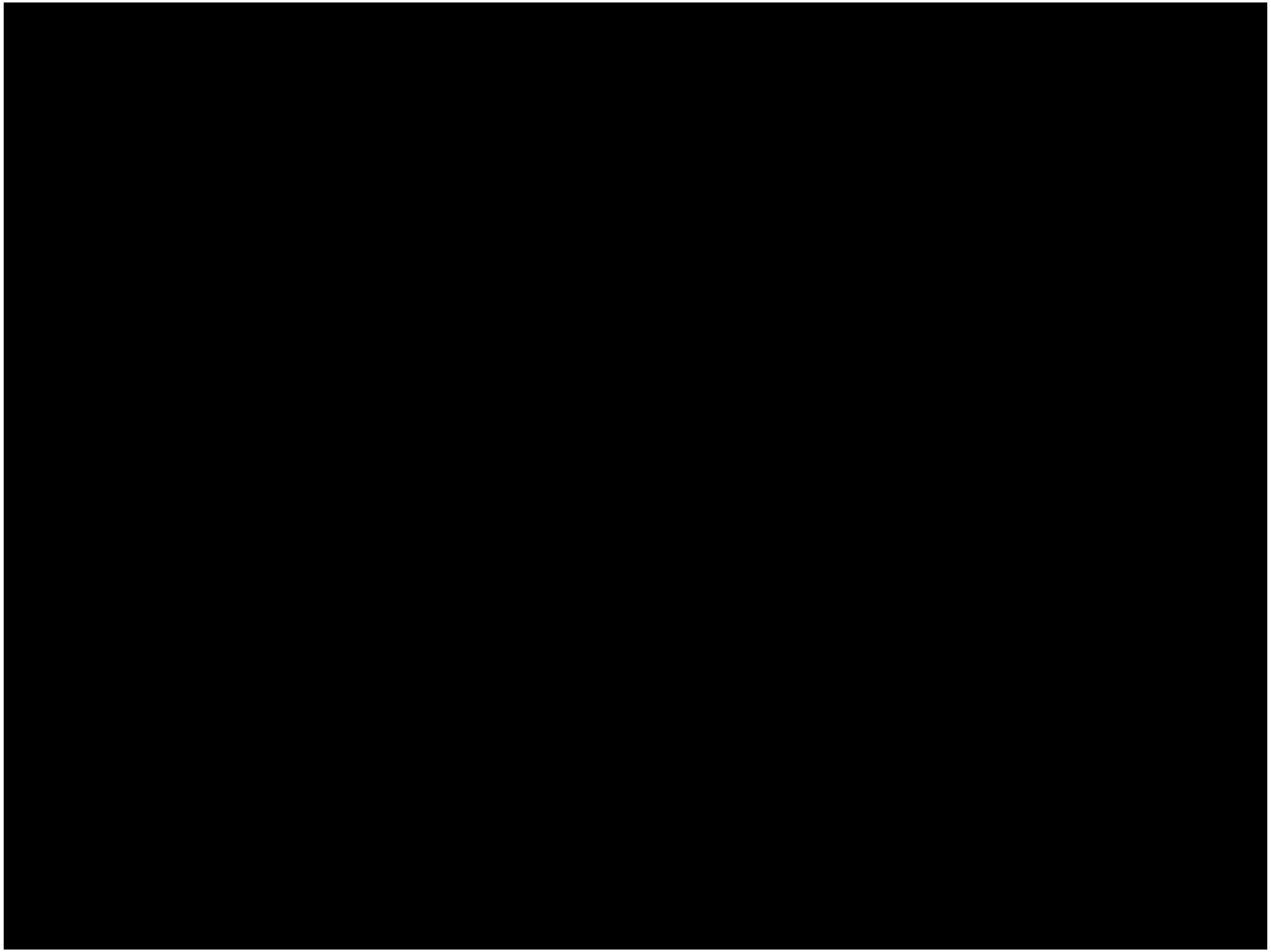
getting from point A to point B

Hula-hop's state machine



all transitions can also be made by the keyboard

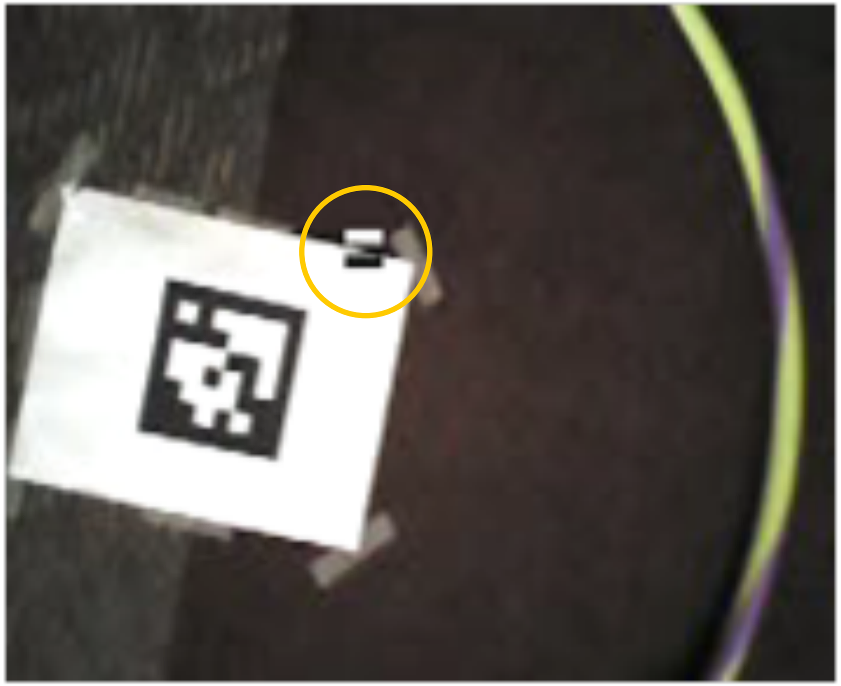
Hula-hop demo



2x

sliding-scale autonomy is crucial

Hula-hop challenges



example encoding (?) artifact

Drone challenges:

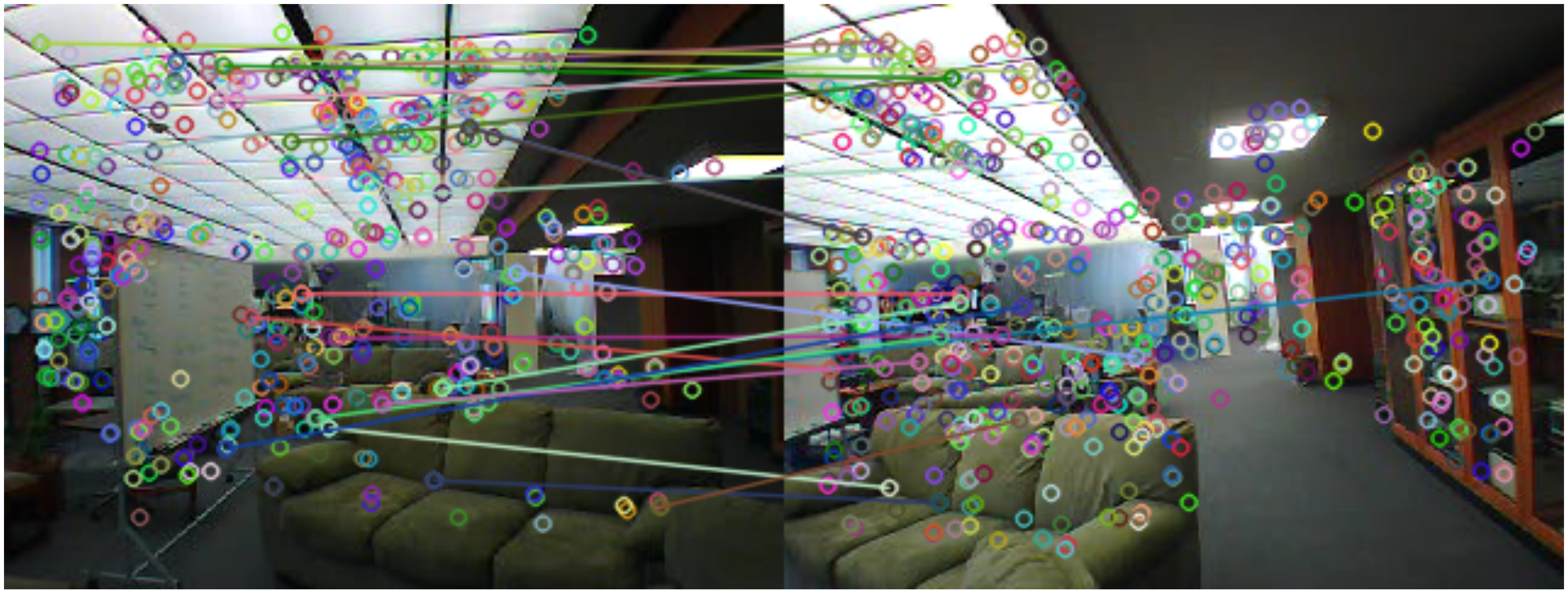
- *drift* ~ not easily positionable
- *connection* ~ video freezes
- *artifacts* ~ image stream noise

APRIL tag challenges:

- too narrow a field of view: height/scale tradeoffs
- call to APRIL library is slow (.5 second/image)
- *unmodifiable environments?*

Could we do ***without*** tags?

Localization *without* tags?



SURF features

- locally unique image patches
- fast libraries for extraction
- each SURF feature is described with a 64-dimensional vector that encodes size and local edge orientations

- *in general, similar descriptor vectors are likely to be similar (or identical) image features*

Localization plan

new image | map images + matches

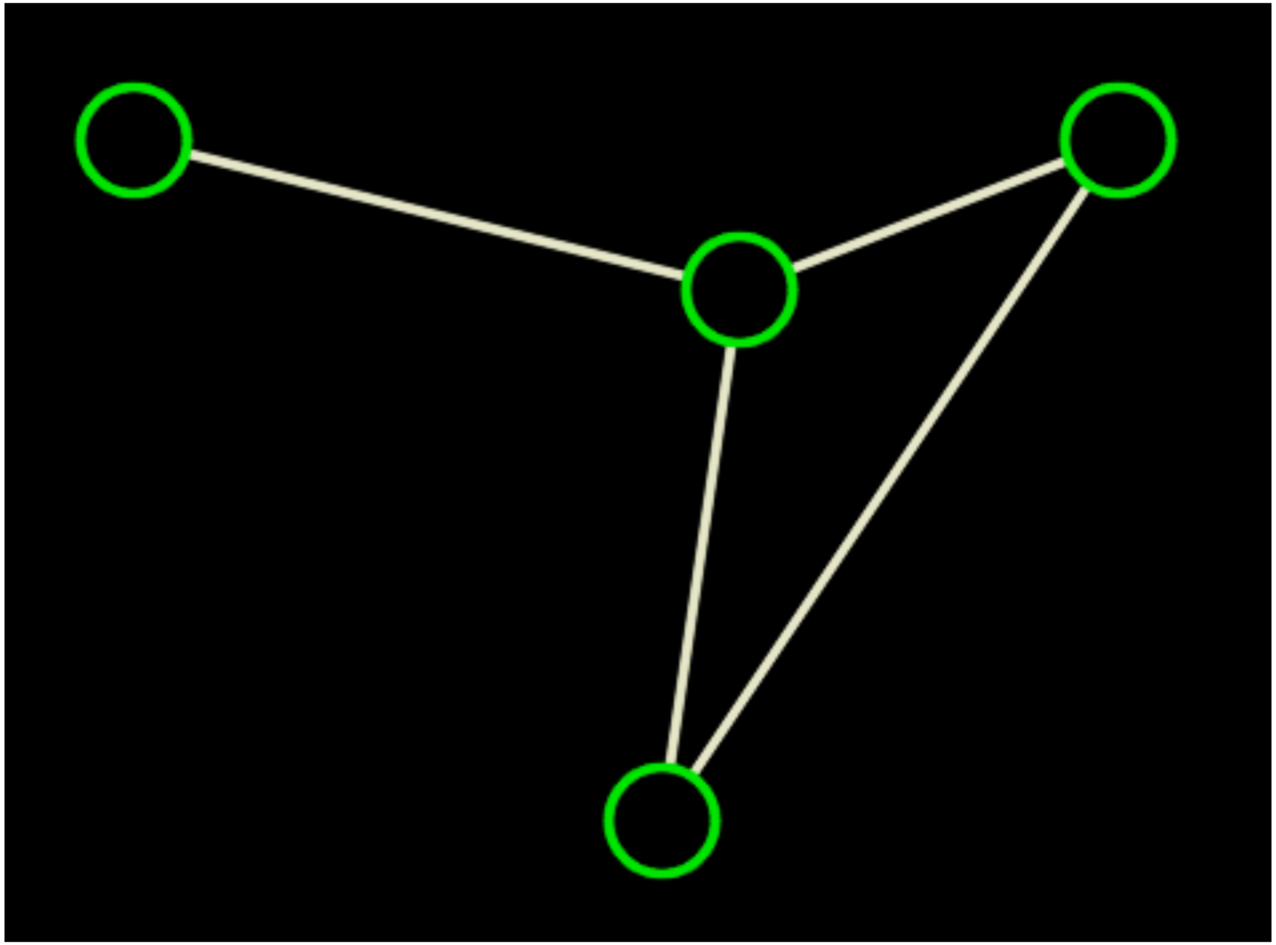
Mapping (by hand)

- collect images and positions
- extract & store SURF features

Localization

- take a new image
- extract SURF features
- match them against the map
- estimate a pose distribution

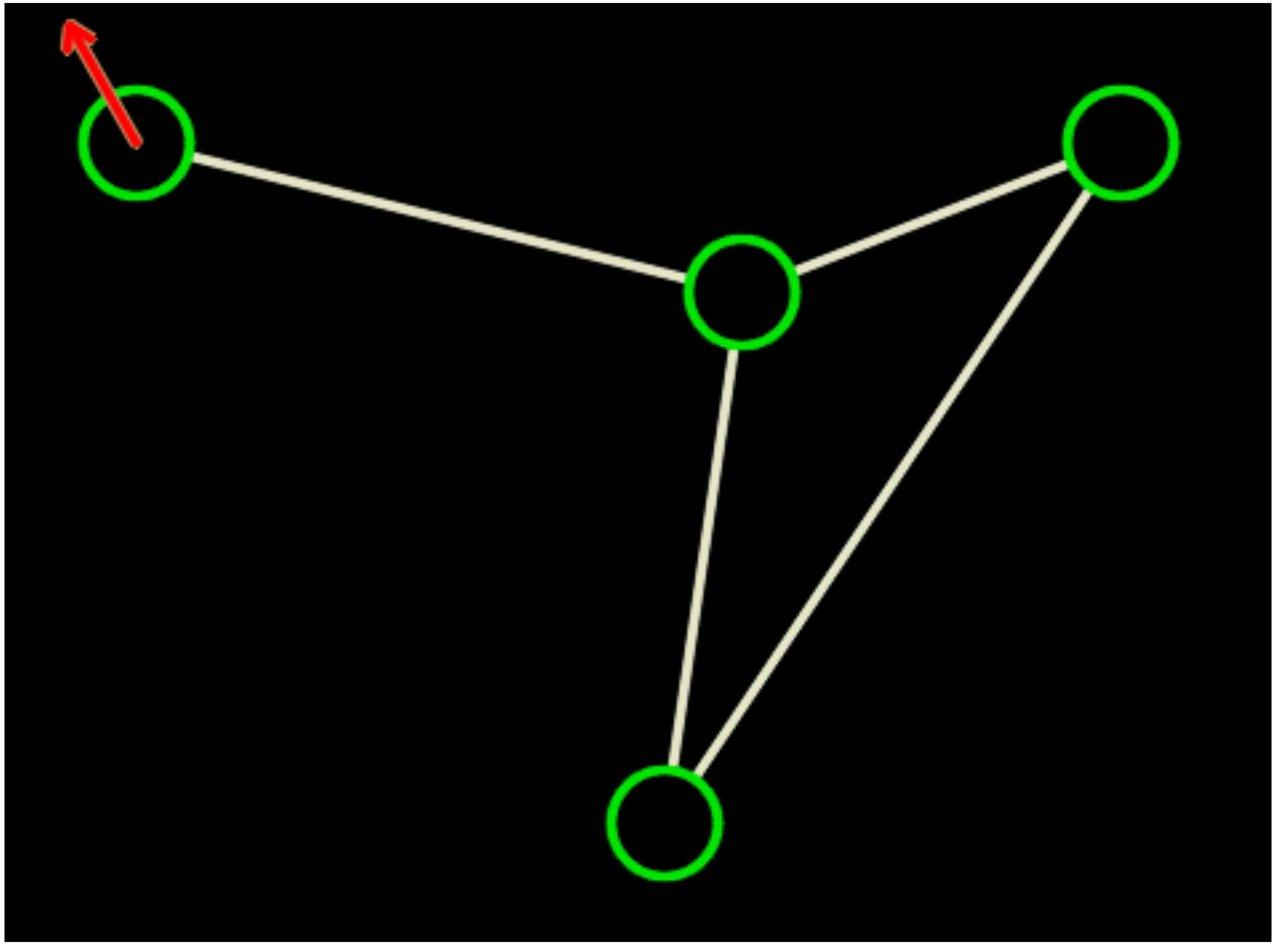
Image-based map...



four locations in the NW corner of Sprague

Locations with stored images == nodes in a graph

Image-based map...



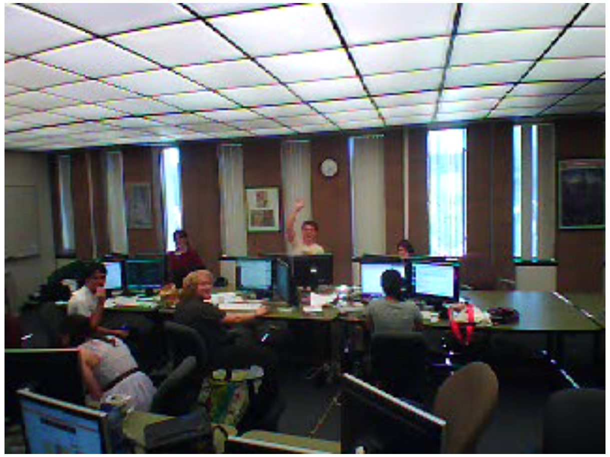
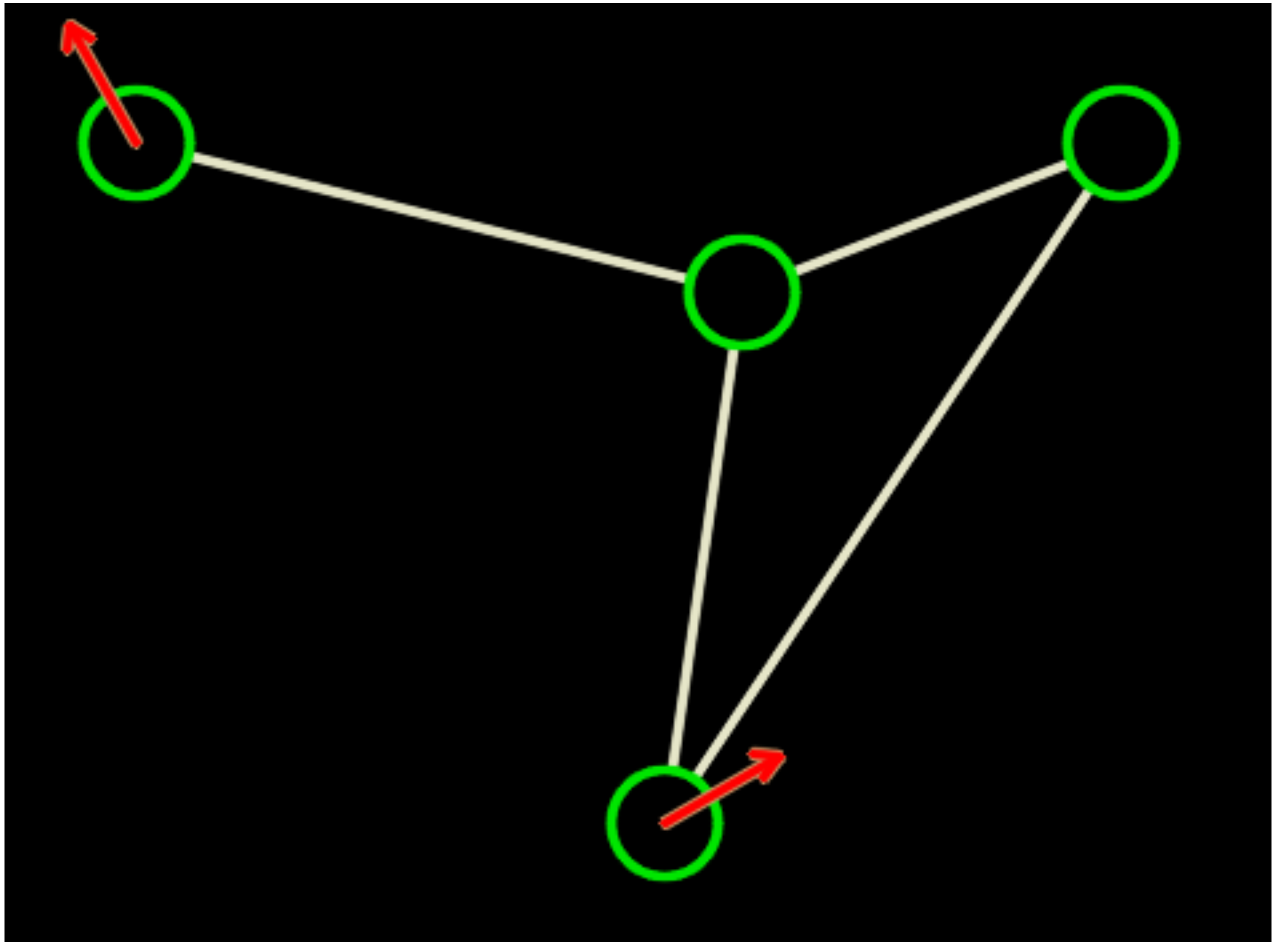
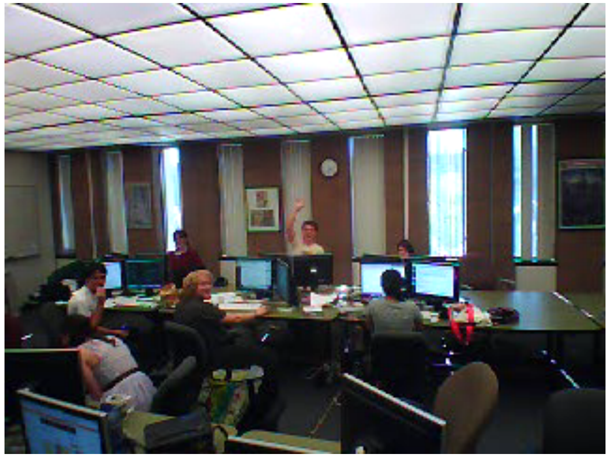
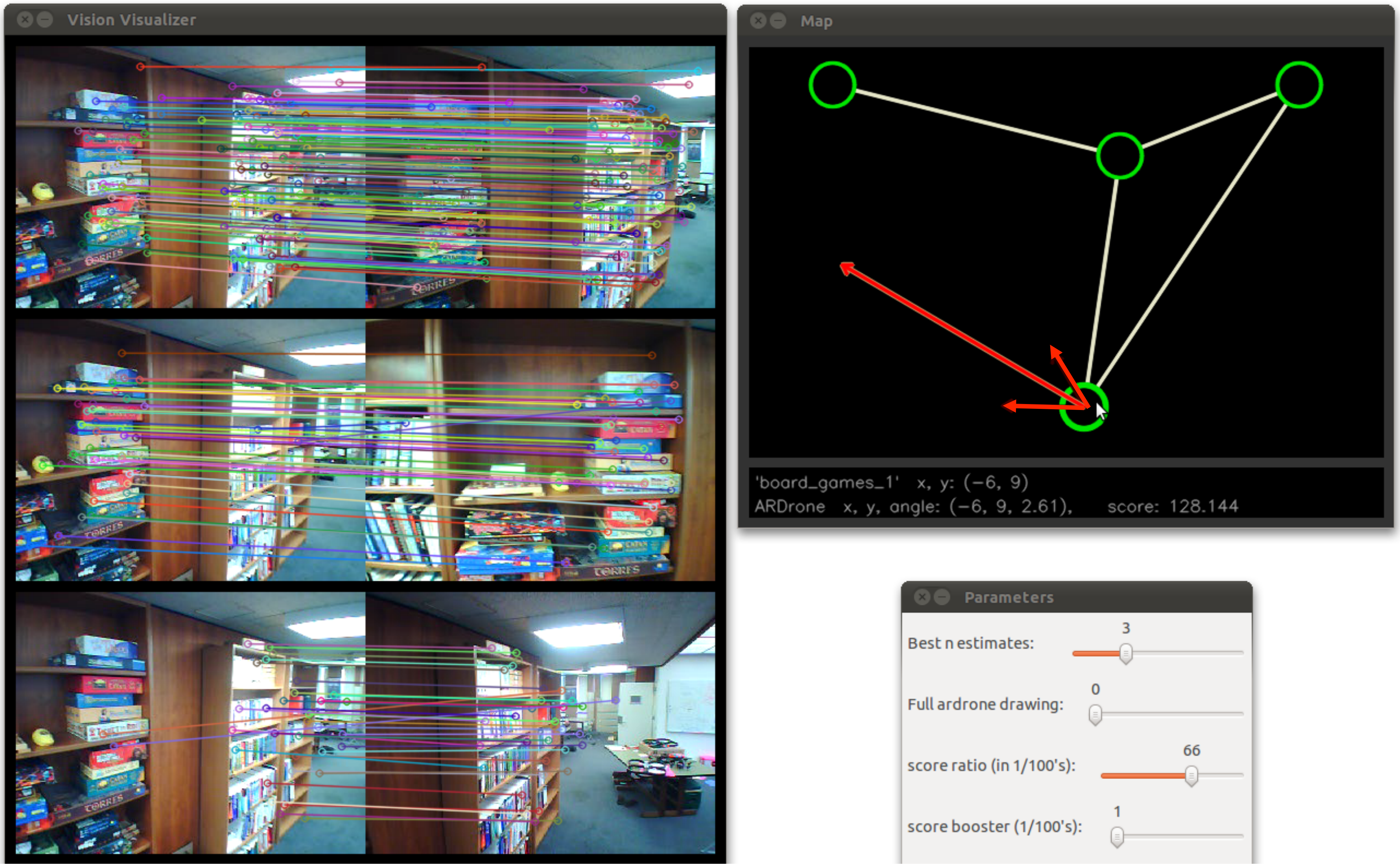


Image-based map...



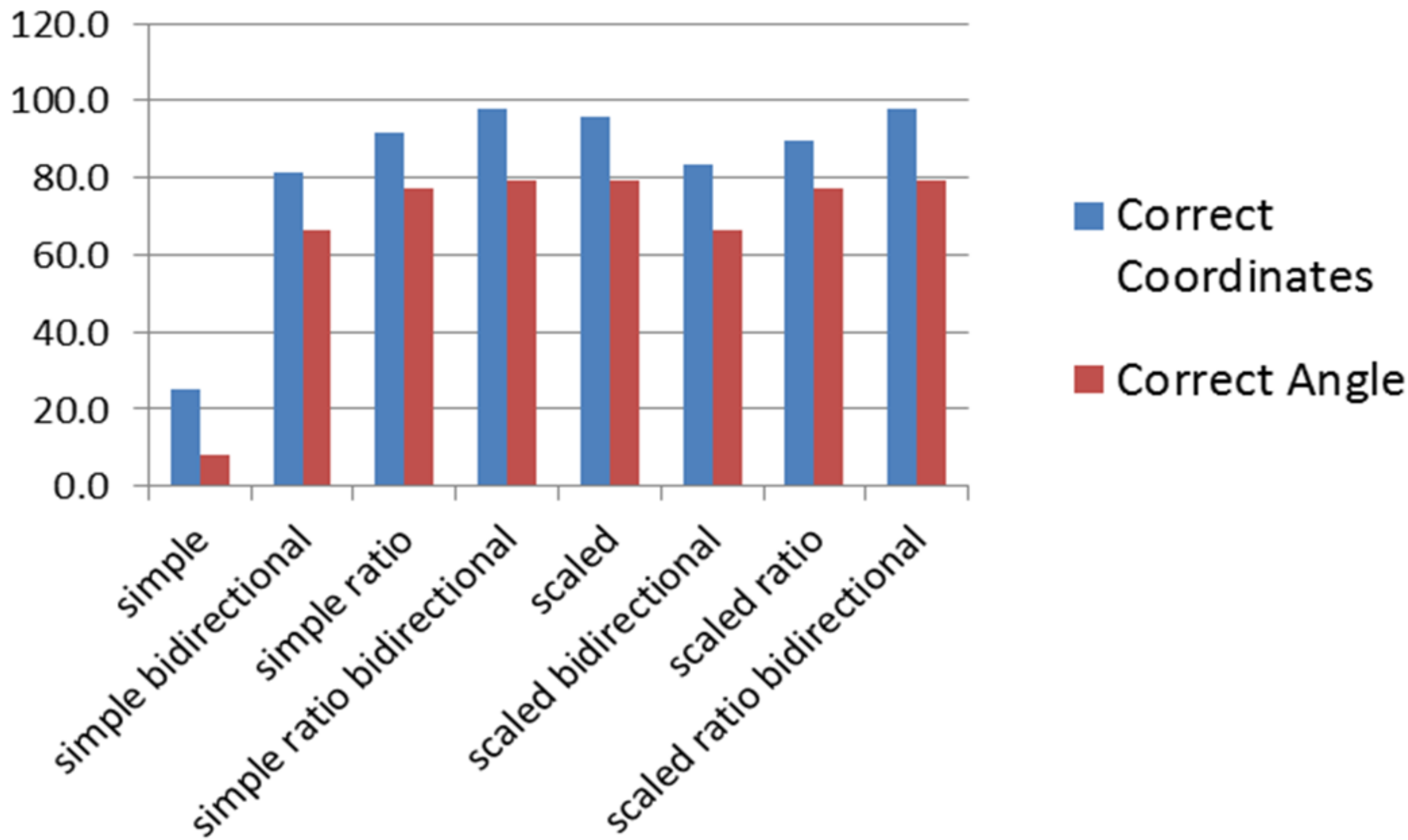


Live localization



top three matches and their likelihood distribution plotted on the map

Comparative results



Verdicts?

The **AR Drone** is a capable platform
-- as long as precise positioning is not required

Options:
- research to improve localization
- tasks that do not require precision

Questions?