Team 17: SkyEye

18-549: Embedded System Design

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Concept & Motivation

An **Autonomous Robot** with the ability to,

navigate in all T**hree Dimensions**.

Existing products are,

limited in mobility to a single surface

easily deterred by ground obstacles

A few without these limitation are,

too loud for indoor use

and have poor operating time

Our Goals

To address all these shortcomings.

Our final product must be able to

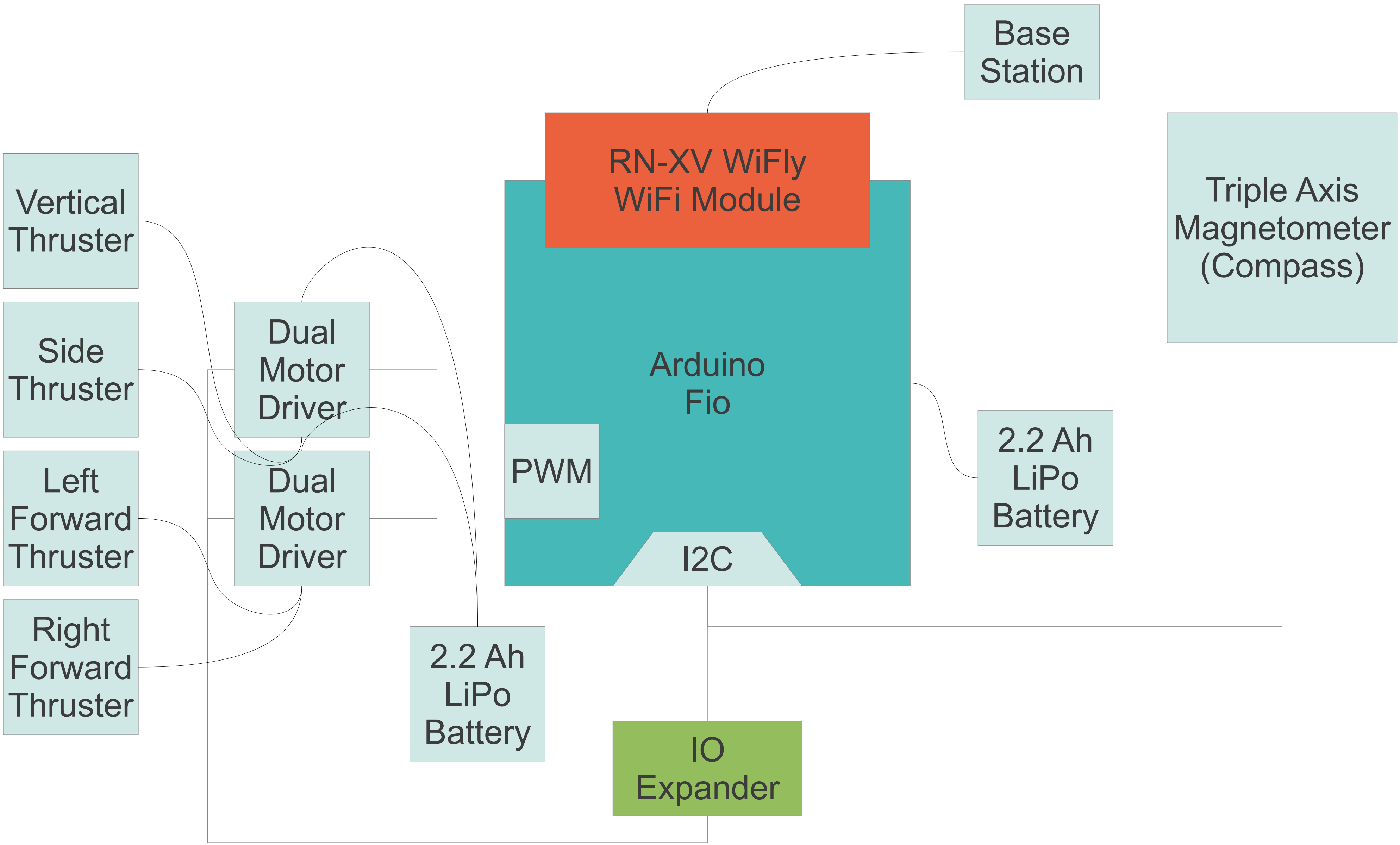
- fly over ground obstacles
- navigate in **all** three dimensions
- operate for at least a hour
- and it must be quiet enough for indoor use

Our Solution

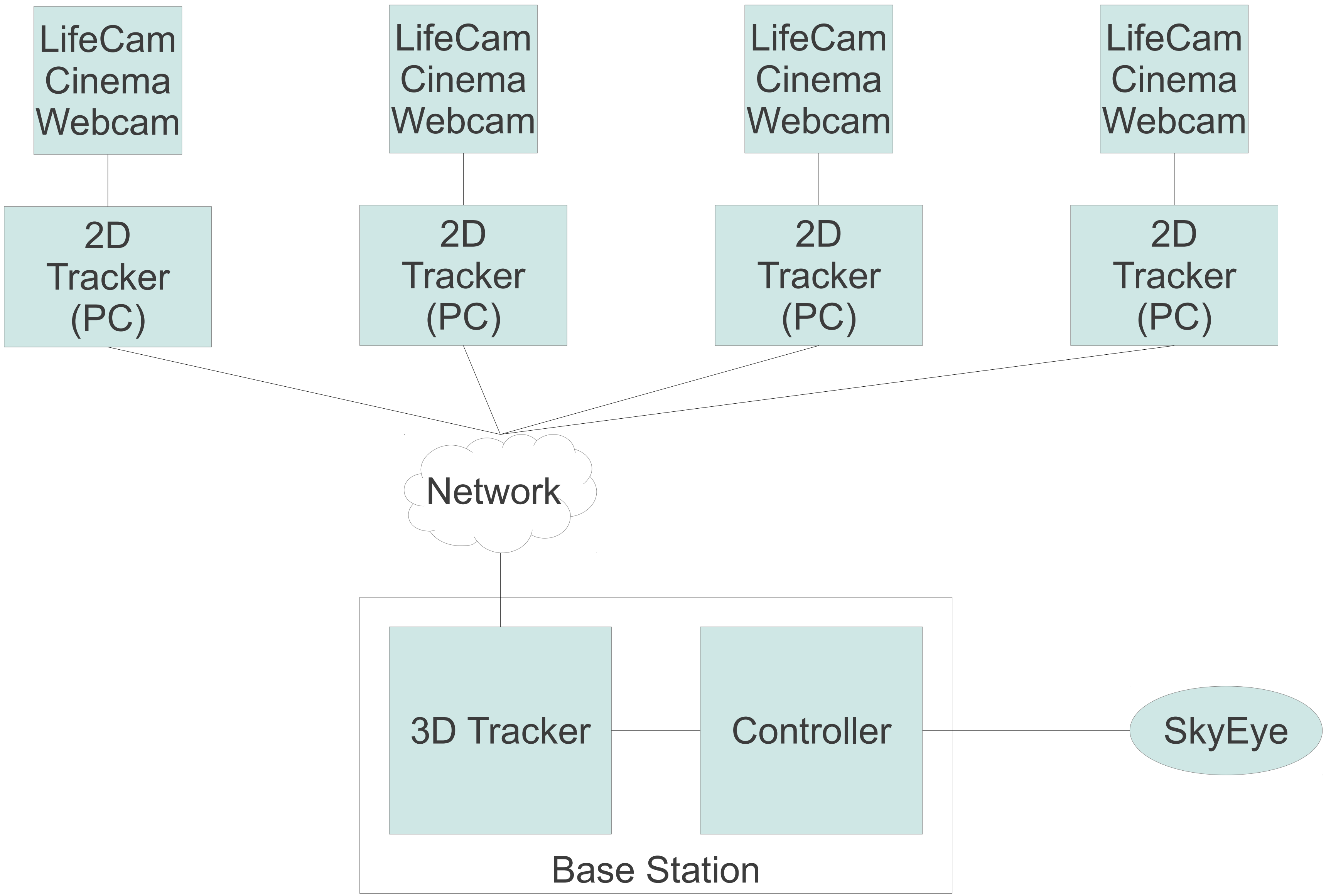
A Robotic Blimp

- aerial
  - no longer bound to a single surface
- lighter than air
  - quiet
  - low power

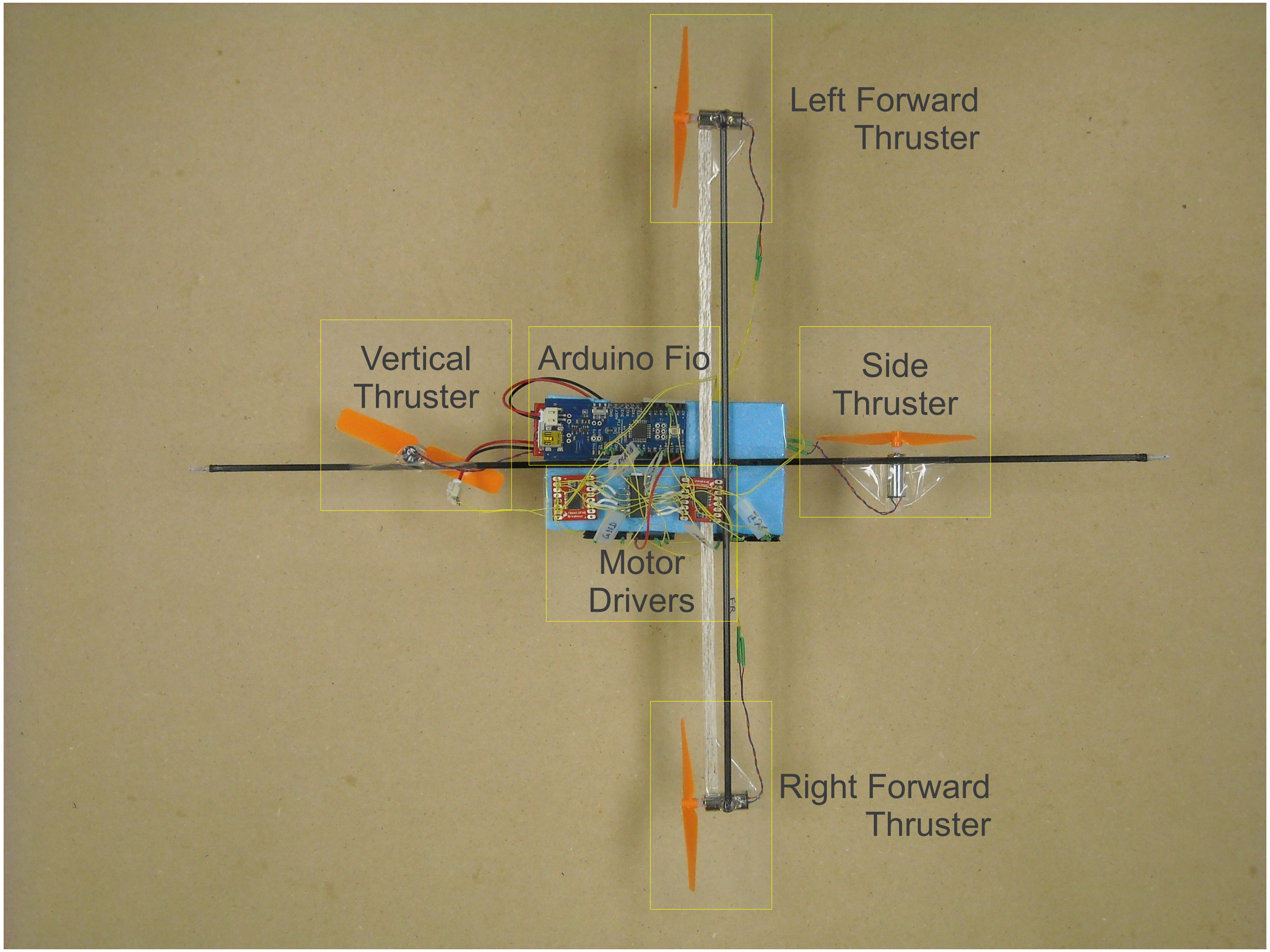
What's On-Board



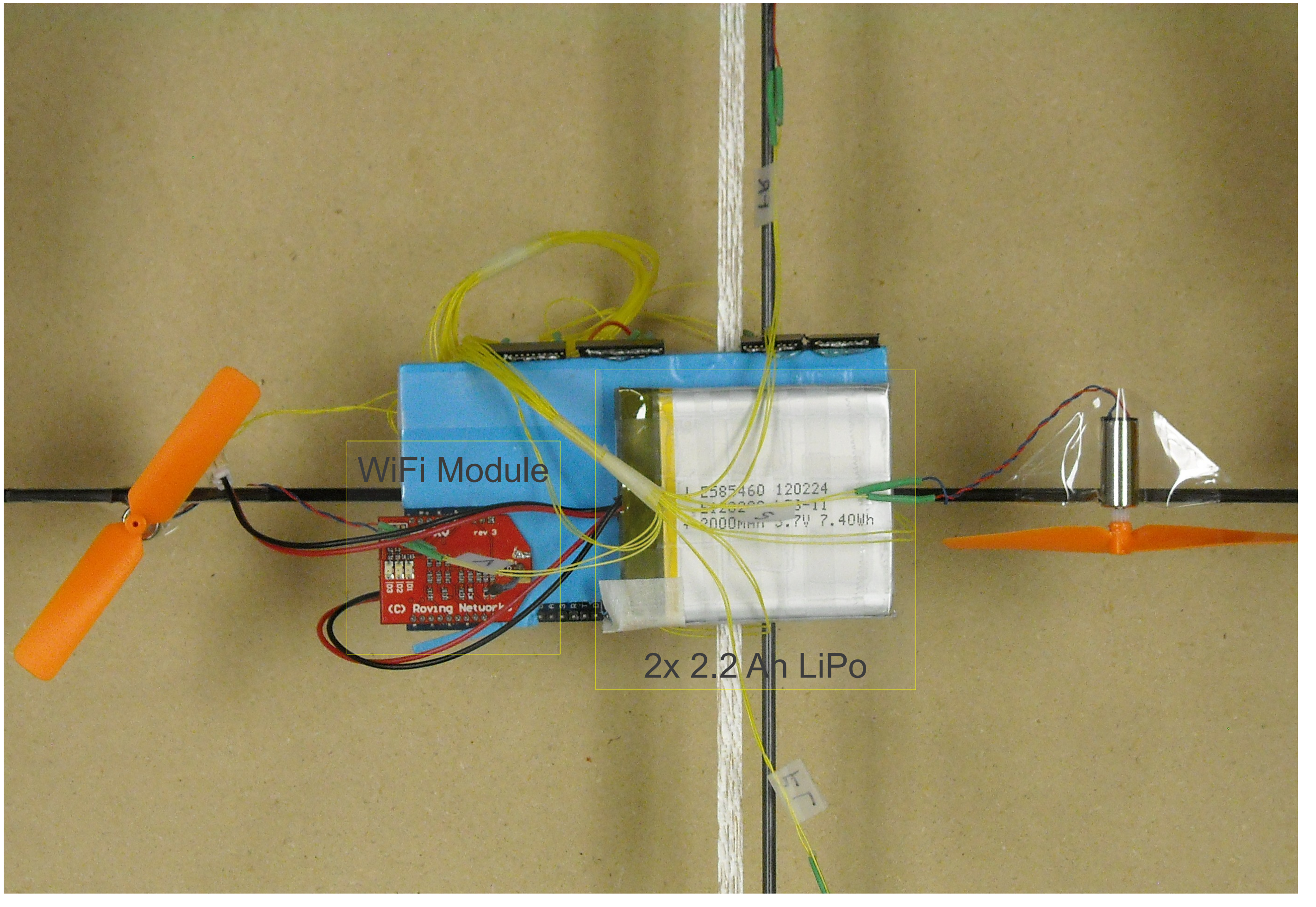
What's Off-Board



Canopy – Top


Left Forward
Thruster
Vertical
Thruster
Arduino Fio
Side
Thruster
Motor
Drivers
Right Forward
Thruster

Canopy - Bottom



Quality Assurance

What's important?

- Accuracy
  - Does the SkyEye take you to where you want to go?
- Quality
  - How straight is the path it takes from A to B.
- Speed
  - How long does it take to get you from A to B?

Accuracy

Recorded locations of teams' booths on demo day via the tracking system.

Sent the SkyEye to each team's booth.

Was able to reach all the booths and hold it position.

- Drifted less than it's body length (1 meter).

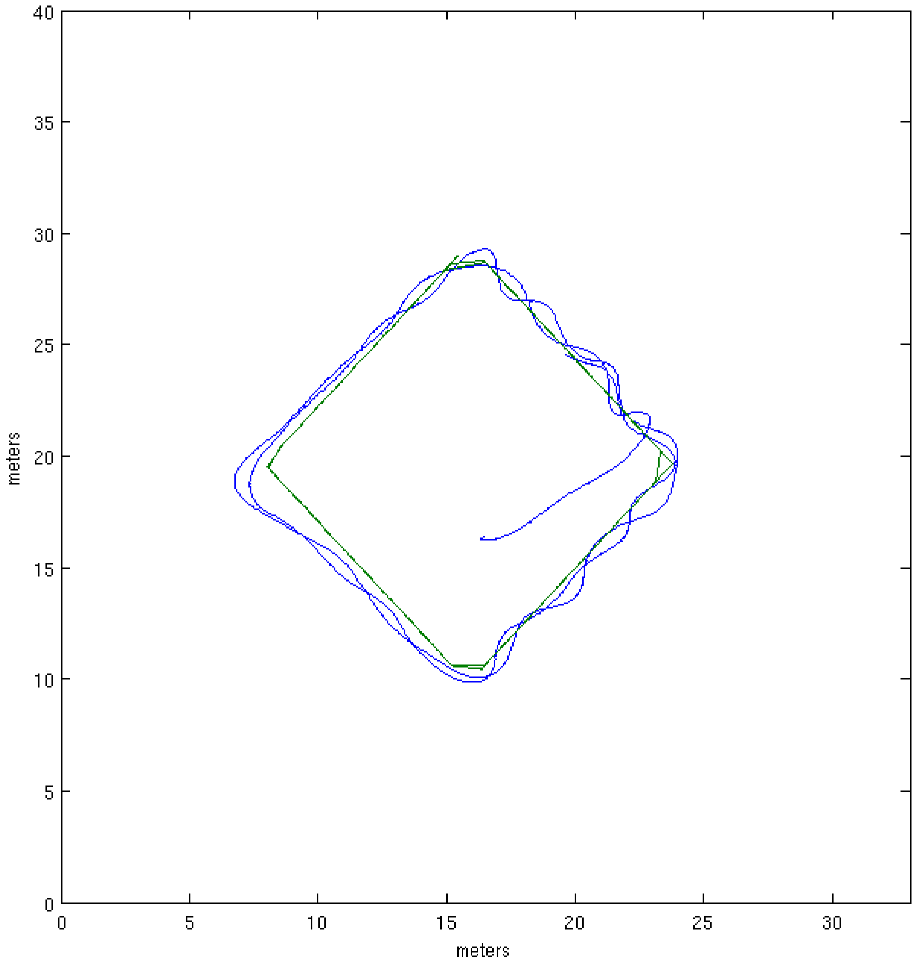
Quality

Run in a diamond formation.

Measure how far off-course SkyEye drifts.

Stayed within 1 meter of the desired course the majority of the time.

Largest error saw was less than 2 meters off-course.

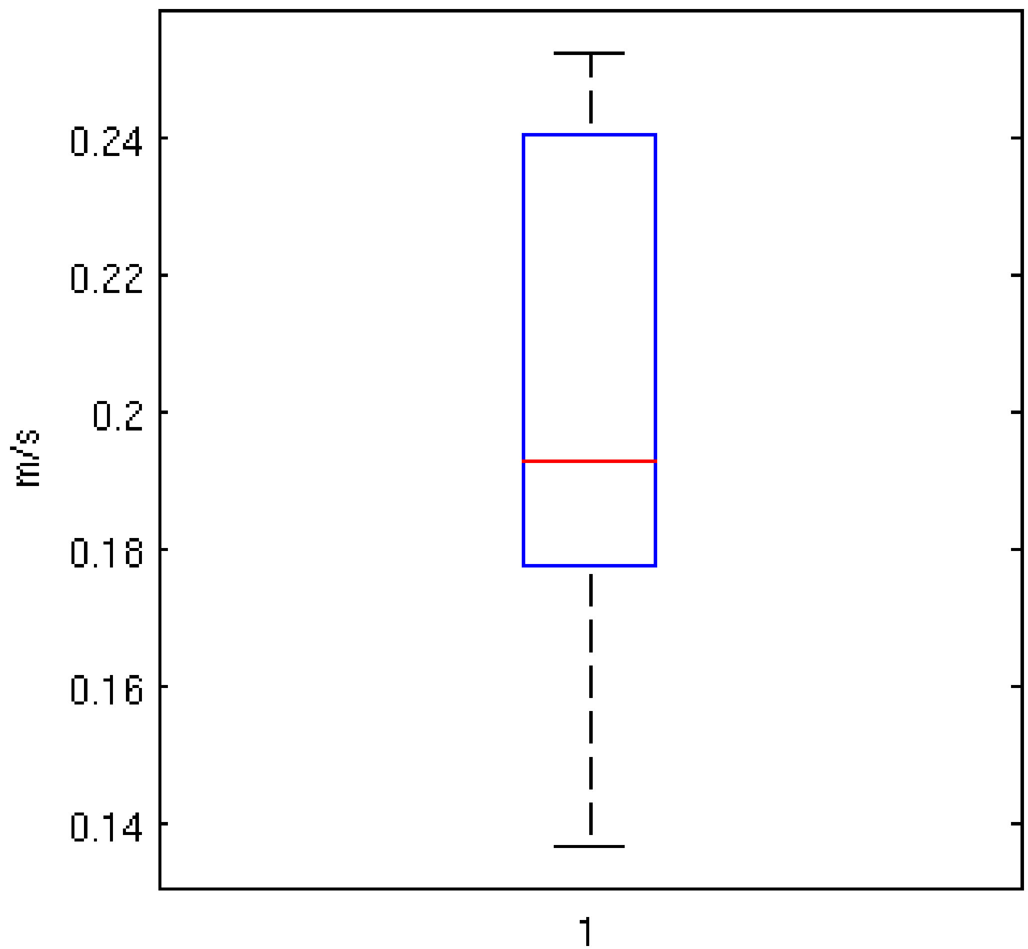


Speed

Measured time to transverse the gym from team to team.

Average speed: 0.2 meters per second

- Way below walking speed (1.25 m/s)



What the Numbers Say

SkyEye is good at,

Getting you to a specific place.

It has some trouble,

Following a straight path.

And does a poor job at,

Getting there quickly.

Room for Improvement

Mechanical Design

- Use a single balloon
  - reduces drag, increase speed and responsiveness
- Brush-less motors
  - increase efficiency, speed and responsiveness
- Mount the thrusters closer to the center of mass/drag/
  - lower pendulum effect

Electrical Design

- ZigBee instead of WiFi
  - low latency, controller can increase speed without worry about overshoot
- Tilt-compensated magnetometer
  - More accurate heading data, less interference from the pendulum effect
- Detect battery status
  - more reliable failsafe

Room for Improvement

Tracking System

- performed well with two webcams (in a 40x40 meter environment)

- but very sensitive to light condition
- and environment cannot have large objects of single color

Alternatives

- fiducial markers
- ultrasonic localization
  - both could be on-board instead of ground-based

Honorable Mention

Client-Server

the **tracking system** is a **server** providing position data

the **blimp** is a **server** accepting control data

the **controller** is a **client** of both systems

Simulator

created a **simulator** to test our controller and UI

helped us design a control scheme that could deal with high network latencies (>2 second)