

# Flying Robots

Draft syllabus  
11/28/12

Flying robots, aka Uninhabited Aerial Vehicles (UAVs) or drones, are growing in number and influence in military use. In parallel, the hobbyist community is developing DIY methods, making flying robots more accessible to more people. What is yet to become common is for these DIY aircraft to carry out visions rather than simply take pictures. This course aims to provide the conceptual and technical foundation for using flying robots for visionary purposes. Here, technology is the tool. The air vehicle is the paintbrush, the poster, the camera; visible to some degree but not the purpose. The first step is to strip down the employment of a flying robot to its essence, as a means to gather information or take action at a distance, using an autonomous agent. The group will discuss and expand the current thinking on feasible, worthy objectives for flying robots, from art to science, from observation to communication, from performance to activism. Throughout the course, these conceptual topics will be a backdrop for hands-on projects using accessible technology.

The projects will investigate:

- Performing a task with a flying robot
- Moving information and decision-making
- Making a craft fly autonomously

The projects will be performed in small teams and will require conceptualization, system design, and mechanical, electrical and coding work. The types of small aircraft could include quadcopters, blimps, planes, or less conventional platforms. Flight controls will be done using the Arduino-based ArduPlane and ArduCopter, or other embedded computing platforms. The online DIY/hobbyist community will be used as a resource. Each week, class will include a brief lecture and discussion followed by demonstration and debugging of projects.

For each week, you'll find elements of the following:

- In-class discussion:
- In-class production:
- Production assignments:
- Production demonstrations:
- Blog assignments:

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**Production timeline by week:**

1. Intro, assignment of Project #1: Make a flying robot perform a task
2. Production: focus on basic flight & task as a subsystem
3. Production: focus on task integrated on craft
4. Project #1 demonstration, Assignment of Project #2: Simulate interaction with a remote/autonomous agent
5. Production: refinement
6. Project #2 demonstration, Assignment of Project #3: Make a craft fly autonomously
7. Production: focus on sensing environment
8. Production: focus on navigation code
9. Production: focus on refinement
10. Project #3 demonstration, Assignment of Final Project
11. Present final project concepts. Production: focus on basic elements
12. Production: focus on separate functionality
13. Production: focus on integration and refinement
14. Final Project demonstration

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## Week 1

**In-class discussion:**

- Scope of the course
- What are the elements and concepts behind a flying robot system?
- What can, should, and should not be done with flying robots?

**Production assignments:**

- Project #1: Make a flying robot perform a task

**Blog assignments:**

- For each individual:
  - Look into what's been done using flying robots. Post links to two works that you found successful, and two you found unsuccessful.
- For each team:
  - Post a description of the task your flying robot will perform. What, how and why. Include development steps week by week, and a functional block diagram.
  - Post the anticipated top 5 challenges on your team's project

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## Week 2

**In-class discussion:**

- Mapping out in more detail how remotely controlled and autonomous aircraft work. Internally, interacting with people and interacting with the environment around them.

**In-class production:**

- Basic flight
- Developing task subsystem, (sensor, mechanism, etc.) not yet on the craft

**Blog assignments:**

- For each individual:
  - What do you think will be done with flying robots in 2023?

- Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 3

### In-class discussion:

- What it means to gather information, perform actions, inform decisions and outcomes, all at a distance and with autonomy. What are the ramifications of such a system? Is this as new as it seems?

### In-class production:

- Integrating task subsystem (sensor, mechanism, etc.) on craft

### Blog assignments:

- For each individual:
  - How do you think military drone activity will change in the next 5 years?
  - Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 4

### PRESENT THIS WEEK: Project #1 demonstrations

### Production assignments:

- Project #2: Simulate interaction with a remote/autonomous agent

### Blog assignments:

- For each team:
  - Post your team's concept for a simulation installation / interaction experience. Description, method, message. Include development steps week by week, and a functional block diagram showing movement of information and decision-making steps.
  - Post the anticipated top 5 challenges on your team's project

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## Week 5

### In-class discussion:

- How do autonomous aircraft typically navigate?
- How does GPS work?

### In-class production:

- Testing and refinement of projects

### Blog assignments:

- For each individual:
  - Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 6

PRESENT THIS WEEK: Project #2 demonstrations

Production assignments:

- Project #3: Make a craft fly autonomously

Blog assignments:

- For each team:
  - Post your project plan, including how the craft will observe the world, make navigation decisions, and why. Include development steps week by week, and a functional block diagram.
  - Post the anticipated top 5 challenges on your team's project

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## Week 7

In-class discussion:

- Alternative methods of navigation

In-class production:

- Focus on sensing the environment

Blog assignments:

- For each individual:
  - Post a link to one example of a navigation method you find interesting and describe why
  - Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 8

In-class discussion:

- Understanding air, wind, the atmosphere

In-class production:

- Focus on navigation code

Blog assignments:

- For each individual:
  - Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 9

In-class discussion:

- Task-oriented design vs. technology as performance

In-class production:

- Testing and refinement of projects

**Blog assignments:**

- For each individual:
  - Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 10

**PRESENT THIS WEEK:** Project #3 demonstration

**Production assignments:**

- Final Project: Make a flying robot do something worthwhile/provocative

**Blog assignments:**

- For each team:
  - Post your team's final project concept. What, how, why. Include development steps week by week, and a functional block diagram.
  - Post the anticipated top 5 challenges on your team's project

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## Week 11

**In-class discussion:**

- Safety of the aircraft, people and the environment. How do you design and code for safe, reliable flight?

**In-class production:**

- Refine concept
- Focus on separate elements (subsystems)

**Blog assignments:**

- For each individual:
  - Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 12

**In-class discussion:**

- DIY robotics' lure of newness and retro-futurism vs. timelessness

**In-class production:**

- Focus on finishing subsystems

**Blog assignments:**

- For each individual:
  - What do you think will prove to be timeless traits to the current DIY drones?
  - Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 13

### In-class discussion:

- Assessing the common, rare and not yet existing types of flying robot technologies
- How will technological advancements and DIY method advancements change what DIY drones are capable of?

### In-class production:

- Focus on integration, testing and refinement

### Blog assignments:

- For each individual:
  - Find a compelling technological advancement in the works that will change DIY drones.
  - Post advice for one of the top 5 challenges one of the other teams is dealing with
- For each team:
  - Revise your project plan
  - Post the current top 5 challenges on your team's project

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## Week 14

PRESENT THIS WEEK: Final Project demonstration