Quadcopter Basics: Opportunities and Challenges

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Common terms: Quadcopter, quadrotor, drone, UAV (unmanned/uncrewed aerial vehicle)

Main Components:

- Four motors + propellers
- Four motor controllers
- Electronic stabilization
- Sensors (GPS, accelerometer, barometer, compass)
- Battery
- Receiver/Other Control

Kit or Commodity?

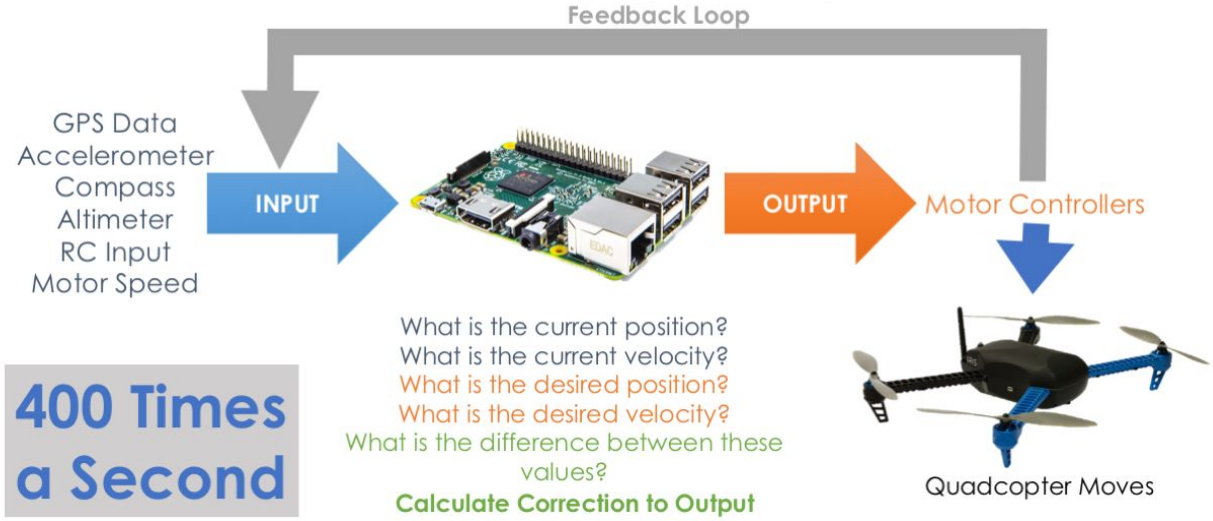
"Build from scratch": $500–$600
- Raspberry Pi-based autopilot
- Fully Customizable

"Buy pre-made": $1000
- 3DR Iris+, GoPro Hero 3+, Tarot Gimbal
- Works out of the box
- 400 g (0.8 lb) payload
- 15-20 minute flying time

How Does a Quadcopter Fly?

A quadcopter flies using *differential thrust*. The motors are controlled by a small, onboard computer running autopilot software designed to stabilize the quadcopter.

We use ArduPilot:
- Developed by CanberraUAV (civilian not-for-profit)
- Won 2012 and 2014 UAV Outback Challenge
- Free and Open-Source

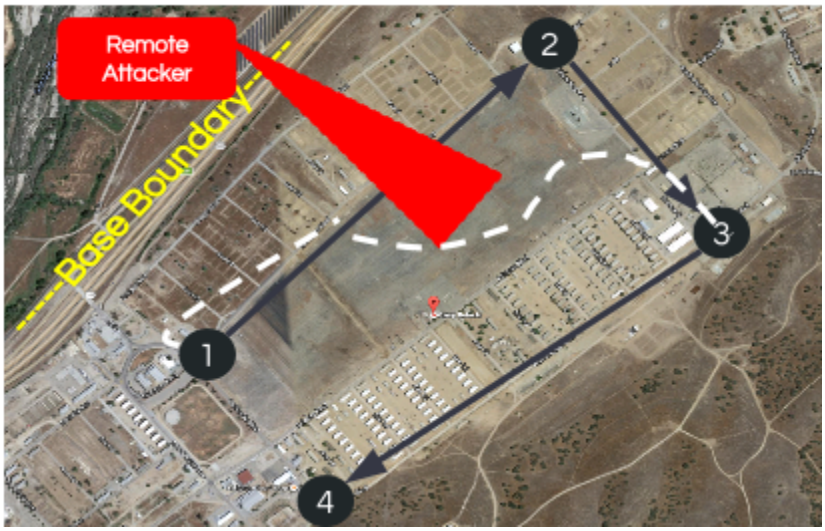


Flying a Mission

- Consist of waypoints (fly to these locations) and actions (take off, land, pause, point camera)
- Created using smart phone or laptop running *Ground Control Station* software
- Sent to quadcopter using *telemetry radio* or wifi

Quadcopters are Vulnerable to Hacks

- Communication with quadcopter over telemetry radios is *unencrypted* (anyone can "listen in")
- "Channel conflicts" mean that anyone could *take over control* of a flying quadcopter
- Example:
  - Quadcopter flies surveillance mission on military base, sending video to ground station
  - Person outside of base (remote attacker) with high-power telemetry radio sends commands to quadcopter
  - Quadcopter obeys new commands and flies past waypoint 2 without surveilling



Our Research: "Your Tax Dollars at Work"

- Air Force, interested in finding ways to protect quadcopters, provides grants to universities (such as UVA) and government contractors.
- Grants cover cost of equipment needed for experiments and subsidizes the cost of education for graduate and undergraduate students conducting research
- We collaborate with other universities and government contractors to develop a system to detect and recover from remote attacks
  - Detect that the quadcopter is no longer flying correct mission
  - Redirect quadcopter to "safe" location
  - Automatically find new mission that avoids attacker, but still surveils correct waypoints
  - Fly new mission and display information to pilot to rebuild confidence that the new mission successfully completes
- Transfer technology back to the Air Force and industry through demonstrations (at Milton Field), open source code, and publications at top-tier academic conferences

Questions?

Ask us about student projects, classroom activities, ways you and your children can get involved, etc.