



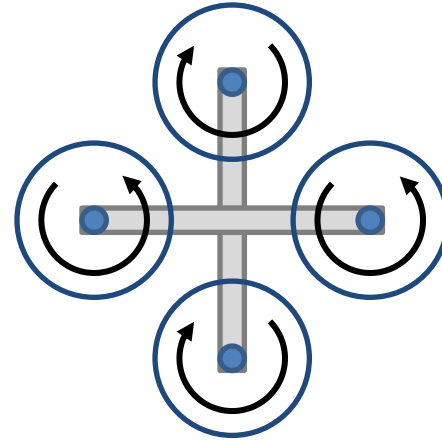
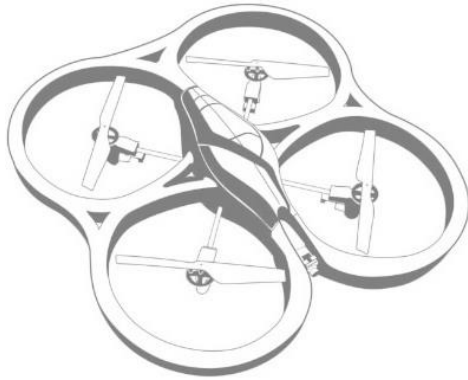
# Autonomous Navigation for Flying Robots

## Lecture 1.3: Flying Principle of a Quadrotor

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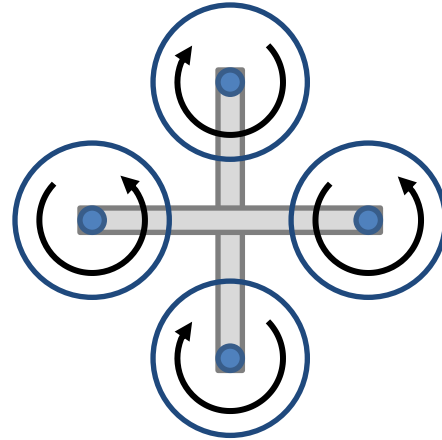
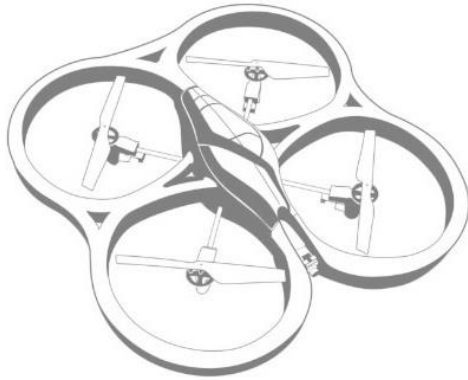
# Quadrotor: Flying Principle



<http://blog.parrot.com/2010/02/10/macworld-2010-fly-the-parrot-ardrone/>

What do we need to do to keep the position?

# Quadrotor: Flying Principle

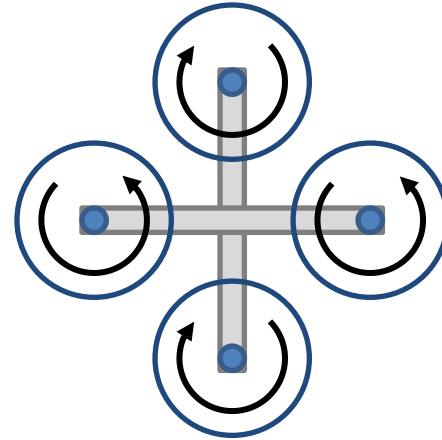
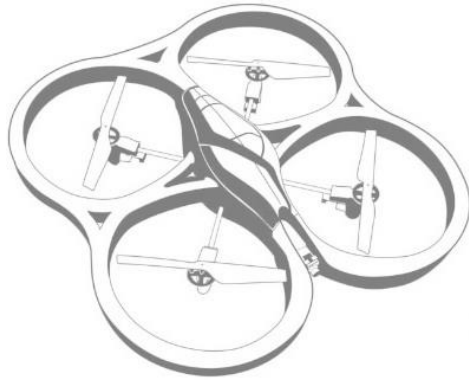


<http://blog.parrot.com/2010/02/10/macworld-2010-fly-the-parrot-ardrone/>

Keep position:

- Thrust compensates for earth gravity

# Quadrotor: Flying Principle

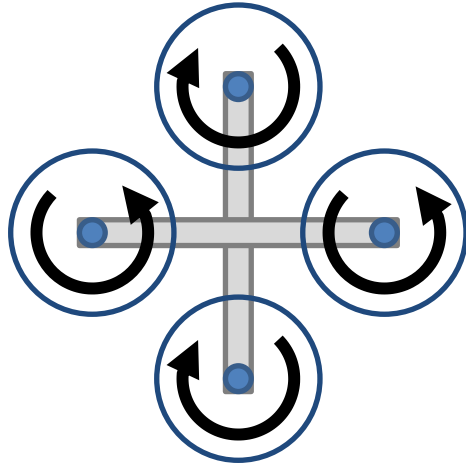


<http://blog.parrot.com/2010/02/10/macworld-2010-fly-the-parrot-ardrone/>

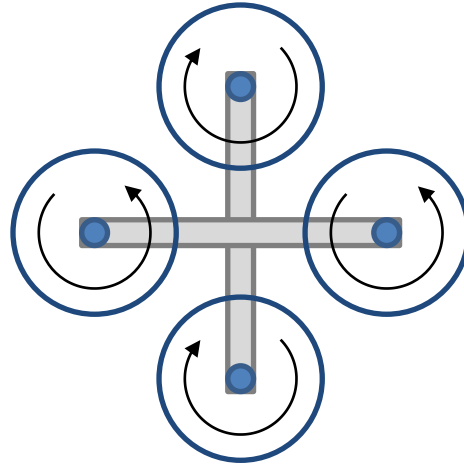
Keep position:

- Thrust compensates for earth gravity
- Torques of all four rotors sum to zero

# Quadrotor: Basic Motions

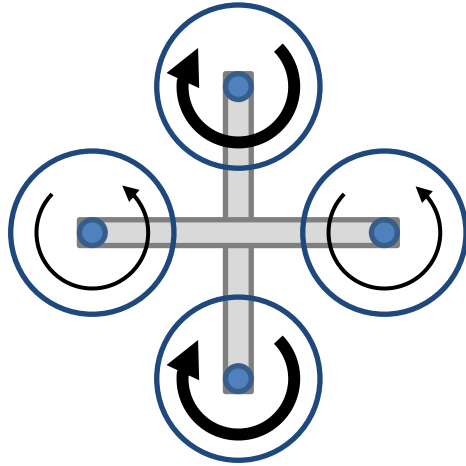


Ascend

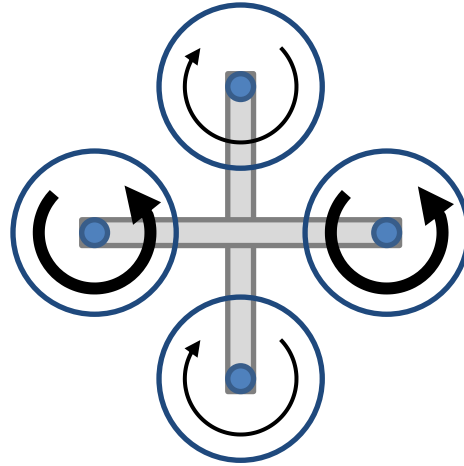


Descend

# Quadrotor: Basic Motions

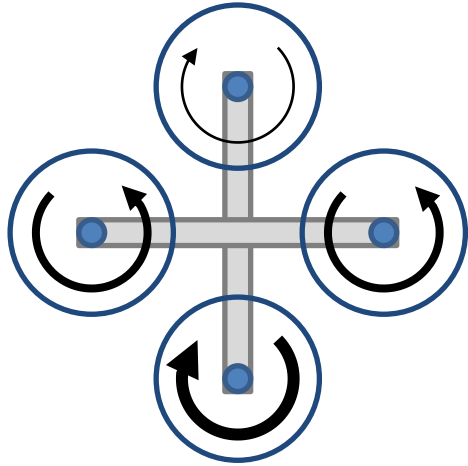


Turn Left

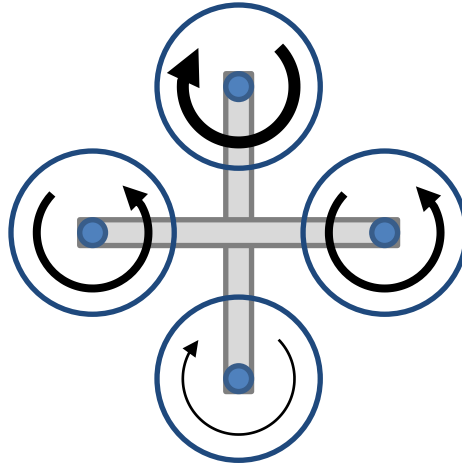


Turn Right

# Quadrotor: Basic Motions

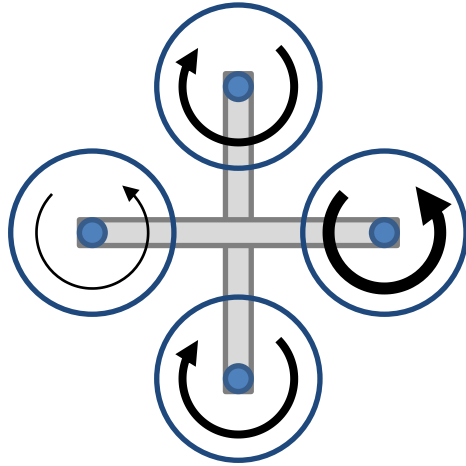


Move forward

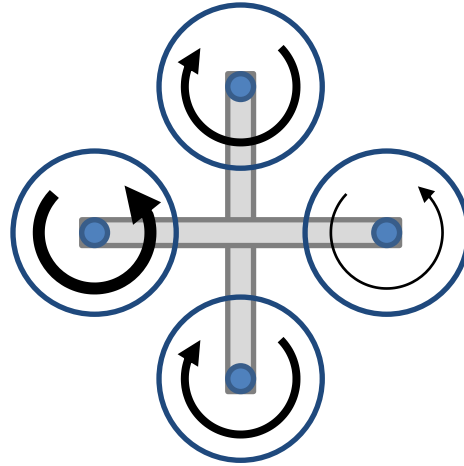


Move backwards

# Quadrotor: Basic Motions



Move left



Move right



# Example: Parrot Ardrone 2.0

- Actuators
  - 4 brushless motors, 14.5W
  - AVR CPU motor controllers
  - LiPo battery, 1000mAh



<http://ardrone2.parrot.com/ardrone-2/specifications/>

# Example: Parrot Ardrone 2.0

- Sensors
  - Gyroscope, accelerometer, magnetometer (IMU)
  - Ultrasound height sensor
  - Pressure sensor
  - Visual odometry sensor (60fps)
  - Front camera (720p, 30fps)



<http://ardrone2.parrot.com/ardrone-2/specifications/>

# Example: Parrot Ardrone 2.0

- Embedded Linux system
  - ARM Cortex A8, 1GHz
  - Linux 2.6.32
  - USB 2.0 host
  - WiFi b,g,n
  - Open-source API



<http://ardrone2.parrot.com/ardrone-2/specifications/>

# Available Platforms

- Commercial platforms
  - Parrot Ardrone
  - AscTec Hummingbird, Pelican, Firefly
  - Bitcraze Crazyflie
  - ...
- Community/open-source projects
  - Mikrokopter
  - ...



<http://www.seeedstudio.com/depot/Crazyflie-Nano-Quadcopter-Kit-6DOF-with-Crazyradio-BCCFK01B-p-1364.html>



<https://www.mikrocontroller.com/>

- Test your understanding of the flight principle
- Web-based quadrotor simulator
- Programmable in Python
- For the moment, assume we have no noise
- Specify a sequence of motor commands to
  - Ascend, descend, fly forward, fly left, ...
  - Fly 1m forward, 1m left, ...
  - Fly (blindly) through the parcours!