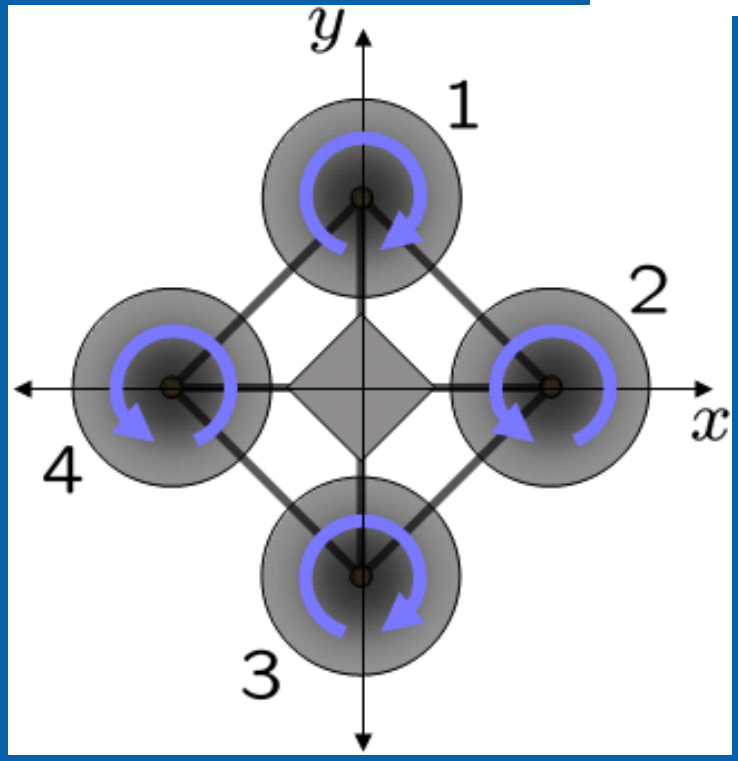
Flight Basics

QuadCopter



Robotics Week Instructor

Joy Shetler, PhD

I never liked riding in helicopters because there's a fair probability that the bottom part will get going around as fast as the top part.

~Lt. Col. John Wittenborn, USAFR

Overview

Physics of Flight

Helicopter Flight

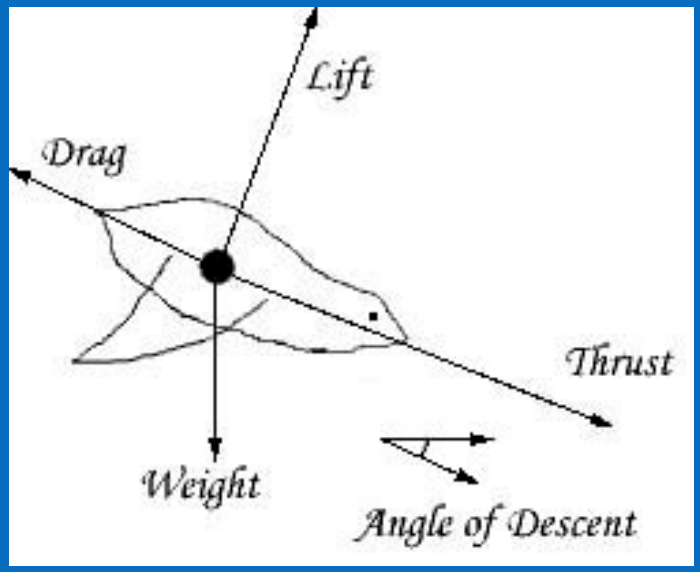
Quadcopter

Summary

Physics of Flight

To understand flight, you must have a basic knowledge of the principles of physics, in this case categorized as biomechanics.

Air is a fluid, just like water.



Drag, lift and thrust are used to propel an object through the air!

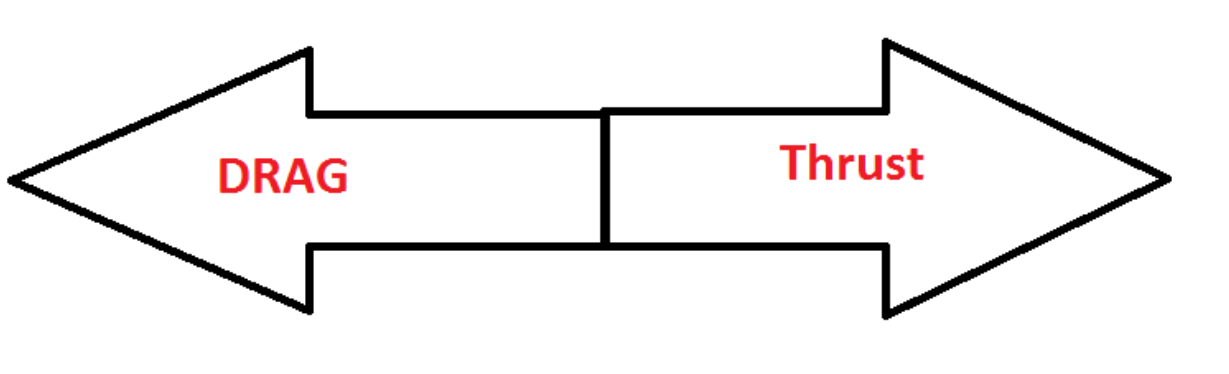
Weight is also an important component in getting air born!

Physics of Flight

Drag, lift, thrust and weight.

Drag is friction between the moving object and the air (also referred to as air resistance). The more streamlined, or aerodynamic, an object is the less air resistance the object generates. The opposite force of drag is thrust.

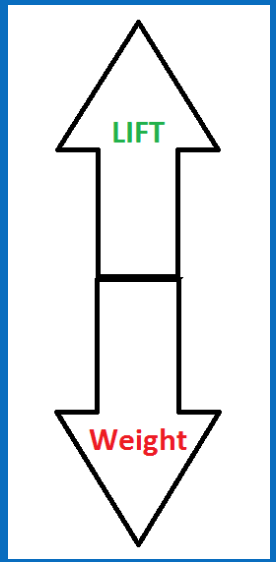
Thrust is the force that moves the object forward. This is generated by a jet engine, propeller or the backward push of a bird wing. To move forward the flying object must overcome drag. To help reduce drag, airplanes are streamlined and most bird shapes have evolved to be streamlined. The opposing force to thrust is drag.



Physics of Flight

Drag, lift, thrust and weight.

Lift - an object must be able to generate enough lift to overcome its weight. To accomplish this, air must be moving across the wing. This can be done by pushing the wing through the air such as with a jet engine or by moving the air across the wing such as with wind. The opposing force of lift is gravity.



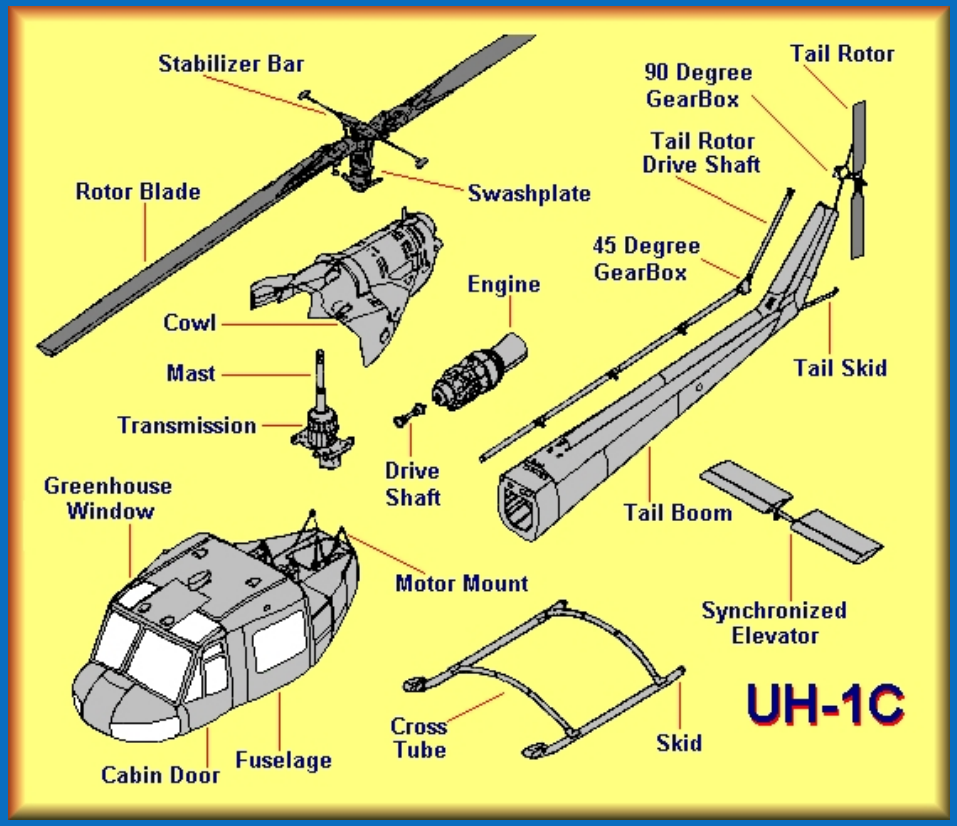
Weight is the force of gravity. It is a continuous downward force that flying objects must constantly overcome to stay aloft. Objects can glide for a very long period of time but will eventually fall back to earth if they are don't generate enough lift to overcome gravity. The opposing force of gravity is lift.

Helicopter Flight

A helicopter (informally known as a "chopper" or a "helo") is a type of rotorcraft in which lift and thrust are supplied by one or more engine-driven rotors. This allows the helicopter to take off and land vertically, to hover, and to fly forwards, backwards, and laterally.

Anti-Torque Control –Most helicopters have a single main rotor, but torque created as the engine turns the rotor against its air drag causes the body of the helicopter to turn in the opposite direction to the rotor. To eliminate this effect, some sort of anti-torque control must be used.

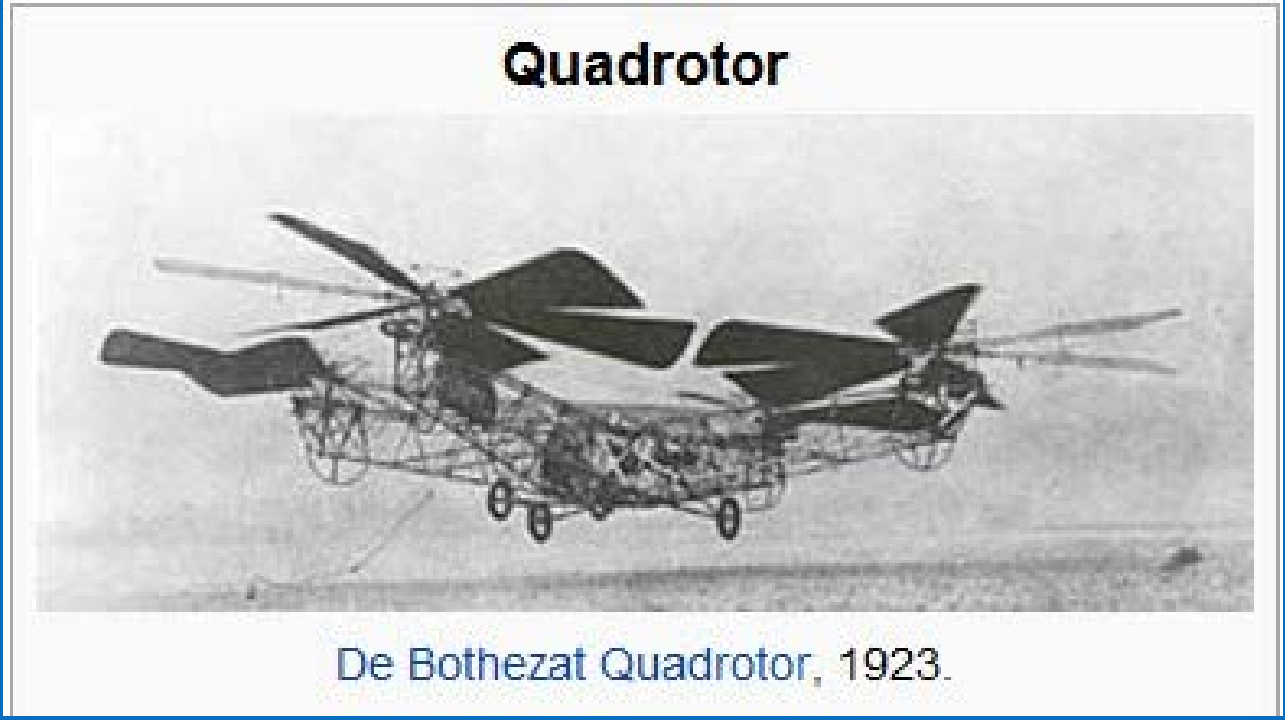
Tailrotor: Provides anti-torque and in-flight trim for the helicopter.



Quadcopter (also called a quadrotor helicopter or quadcopter)

is a multicopter that is lifted and propelled by four rotors.

There are several advantages to quadrocopters over comparably-scaled helicopters. First, quadrotors do not require mechanical linkages to vary the rotor blade pitch angle as they spin. This simplifies the design and maintenance of the copter.



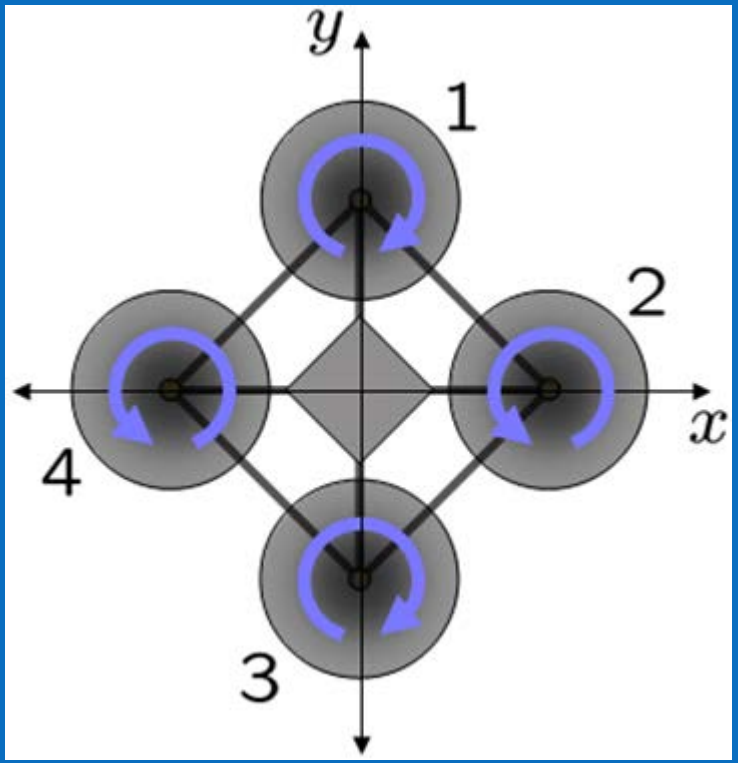
De Bothezat Quadrotor, 1923.

A number of manned designs appeared in the 1920s and 1930s.

Quadcopter Flight

Each rotor produces both a thrust and torque about its center of rotation, as well as a drag force opposite to the vehicle's direction of flight.

If all rotors are spinning at the same angular velocity, with rotors one and three rotating clockwise and rotors two and four counterclockwise, the net aerodynamic torque, and hence the angular acceleration about the yaw axis is exactly zero, which implies that the yaw stabilizing rotor of conventional helicopters is not needed.



myQuad Operation

Basic Flight operations

All four rotors contribute to a uniform lift, creating a vertical lift vector

Thrust (Moving Forward or Backward)

By slightly accelerating the rear motor, the vertical lift vector tips forward creating a small force vector in the forward direction

Banking (Turning Left or Right)

The same effect can cause the myQuad to bank left or right via small accelerations from the opposite motor

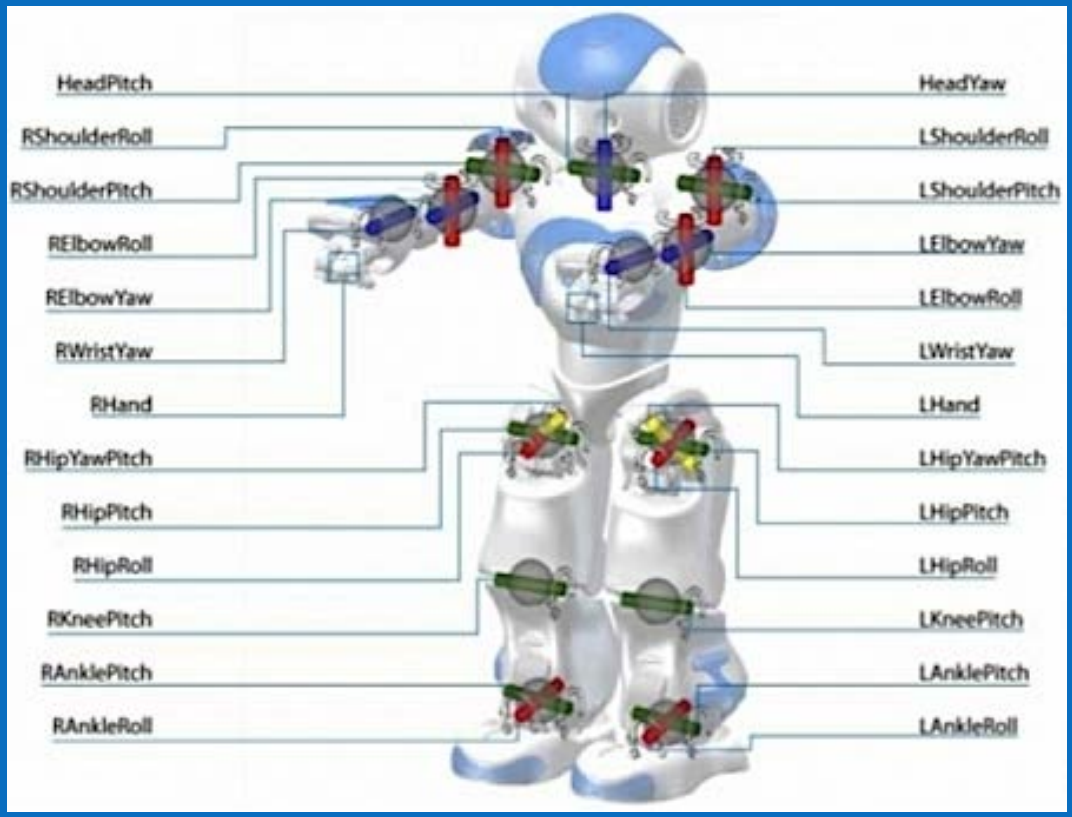
Humanoid robots

Nao (pronounced now) is an autonomous, programmable humanoid robot developed by Aldebaran Robotics, a French startup company headquartered in Paris. The robot's development began with the launch of Project Nao in 2004. On August 15, 2007, Nao replaced Sony's robot dog Aibo as the robot used in the Robot Soccer World Cup (Robocup) Standard Platform League (SPL), an international robotics competition.[1] The Nao was used in RoboCup 2008 and 2009, and the NaoV3R was chosen as the platform for the SPL at RoboCup 2010

Humanoid robots

Aldebaran Robotics designs, produces and markets a wide range of sophisticated, fully programmable humanoid robots, with a view to contribute to the good of mankind, through solutions for assistance to the person, health and assistance for children with autism.

The various versions of the Nao robotics platform feature either 14, 21 or 25 degrees of freedom (DoF). All Nao Academics versions feature an inertial measurement unit with accelerometer, gyrometer and four ultrasonic sensors that provide Nao with stability and positioning within space. The legged versions included eight force-sensing resistors and two bumpers.



Questions?

References and Videos!!

There's a LOT of references used for the myQuad presentations and projects. The list is included in the document myQuadReferences.

This also includes a number of youtube videos and other resources available for inquiring minds!

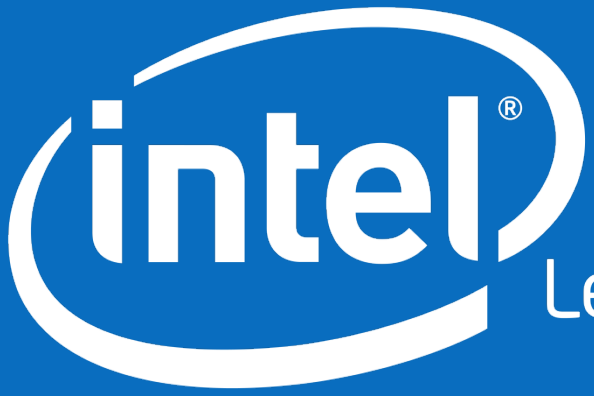
Project 5
myQuad

(build a QuadCopter)

Follow the instructions for Project 5.

Remember, you may need to use code from the previous projects for this project!

Your team will also be required to generate a final report for this project. So, take notes, keep good records, and make sure that you have the material that you need for your final report!



Leap ahead™