QUADCOPTERS

MODULE 5

QUADCOPTERS INTRO

WHAT IS A QUADCOPTER?

- **Quadcopter (AKA Drone):**
  - An unmanned helicopter whose lift is generated by its four rotors

Figure 1. Tello Drone

COMMON USES

- **Used for a Variety of Functions:**
  - Film industry
  - Package delivery
  - RC hobby
  - Toys for kids
  - Artistic photography
  - Wedding/event venues
  - Search and rescue
  - Wildlife surveillance
  - And much more!

Figure 2. Photography Drone

COMMON USES

Figure 3. Search & Rescue

Figure 4. Wedding Photography

Figure 5. Wildlife Surveillance

Figure 6. Artistic Photography

HOW DO QUADCOPTERS FLY?

FORCES OF FLIGHT

- **Four main forces:**
  - Lift and Weight (up and down)
    - Steady Flight: Lift = weight
  - Thrust and Drag (forwards and backwards)
    - Forward Motion: Thrust > Drag

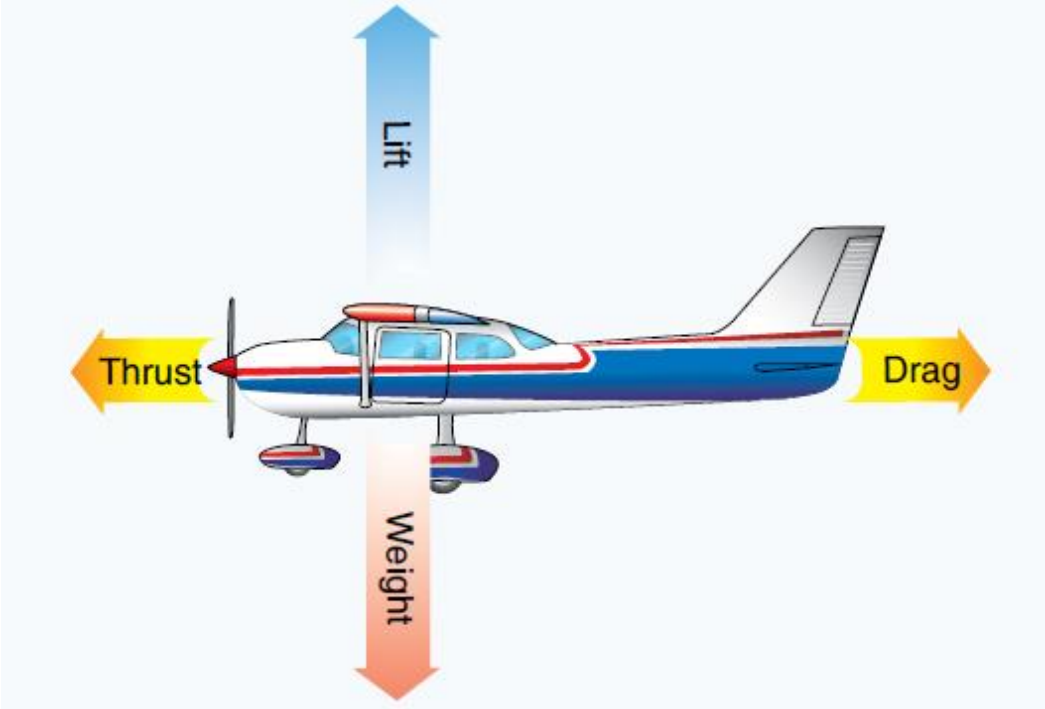

Figure 7. Forces of Flight

LIFT

- **Lift:**
  - The upward acting force that is applied to a body
  - Counteracts gravity
  - Heavier objects need more lift to counteract weight
- **Directly Proportional To:**
  - Size of the blades
  - Number of blades
  - Rotational speed of spinning blades

Figure 8.

WEIGHT

- **Weight:**
  - The force acting on an object due to gravity
  - In air vehicles, weight is counteracted by lift

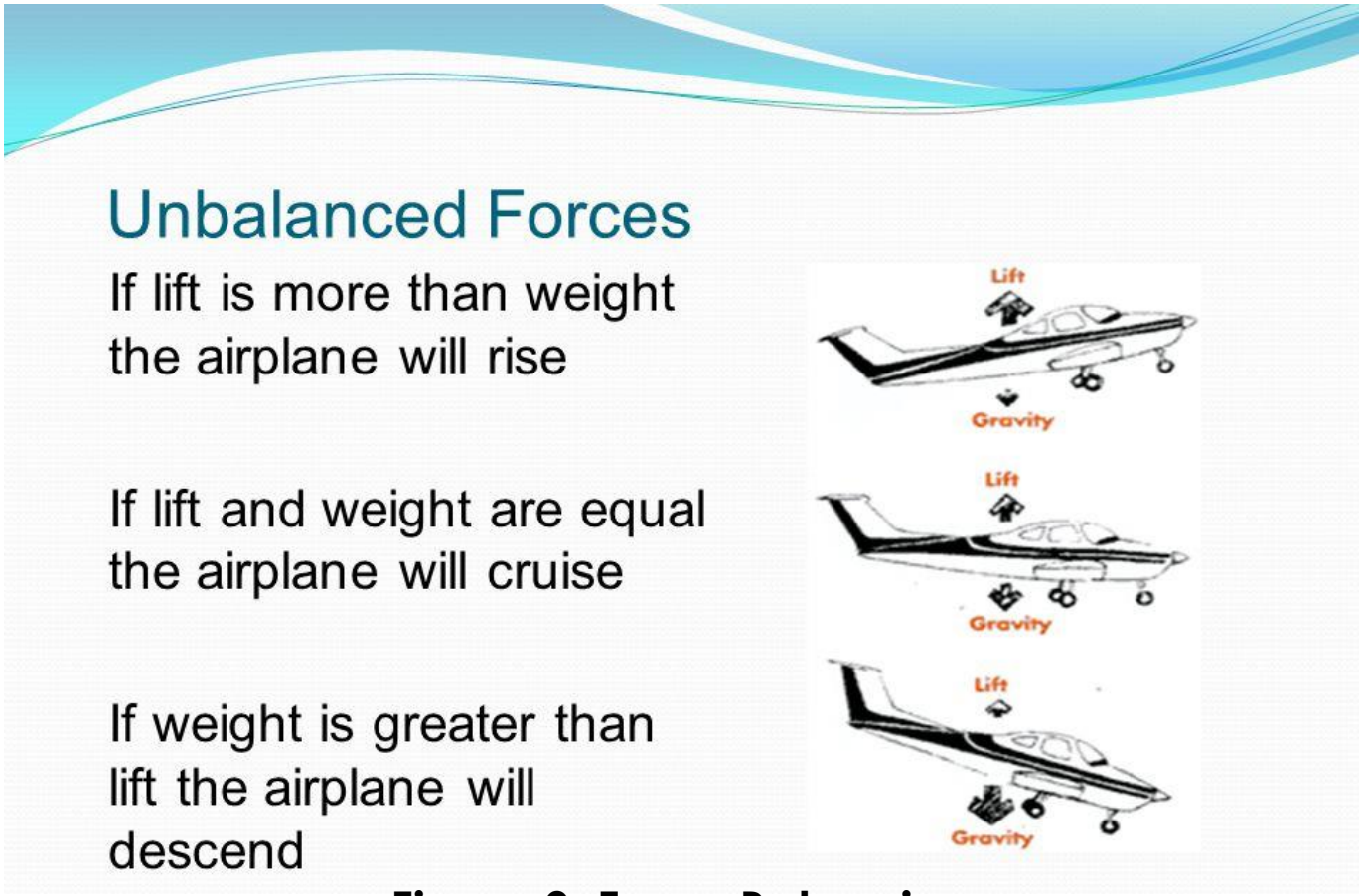

Figure 9. Force Balancing

THRUST

- **Thrust:**
  - The force that moves the vehicle forward
  - In drones, thrust is generated by differential power of the propellers
  - Propels the vehicle forward

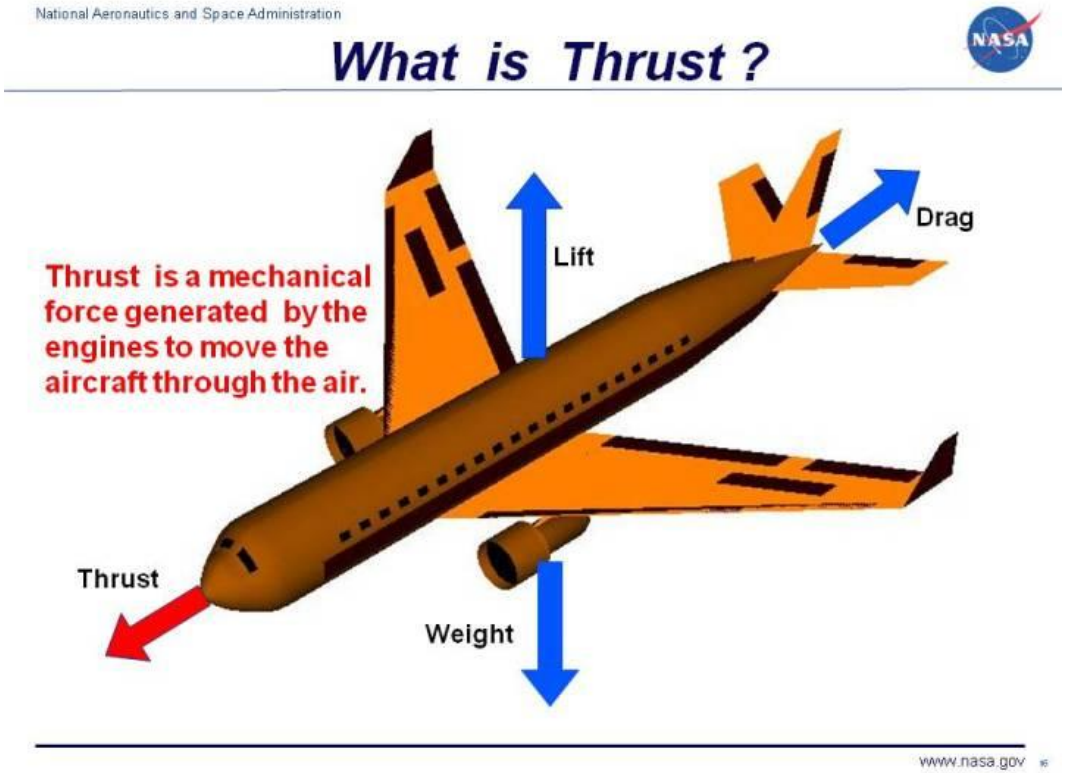

Figure 10. What is Thrust?

DRAG

- **Drag:**
  - The force acting opposite to the drone's motion
  - This applies to any object moving with respect to a surrounding fluid
- **Effects:**
  - In drones, drag can be created by air resistance against the shape of the drone
  - In high winds, it takes more energy to offset the drag
  - Aerodynamics are important to reduce drag (this is why airplanes have their specific shapes)

Figure 11. Wind Effects

aer·o·dy·nam·ics

/ˌerōˌdīˈnamiks/

noun

the study of the properties of moving air and the interaction between the air and solid bodies moving through it.

Figure 12. Definition of Aerodynamics

DRONE CONTROLS

ROLL, PITCH, & YAW

- **Motions:**
  - Roll: tip left/right
  - Pitch: tip forward/backward
  - Yaw: twist left/right

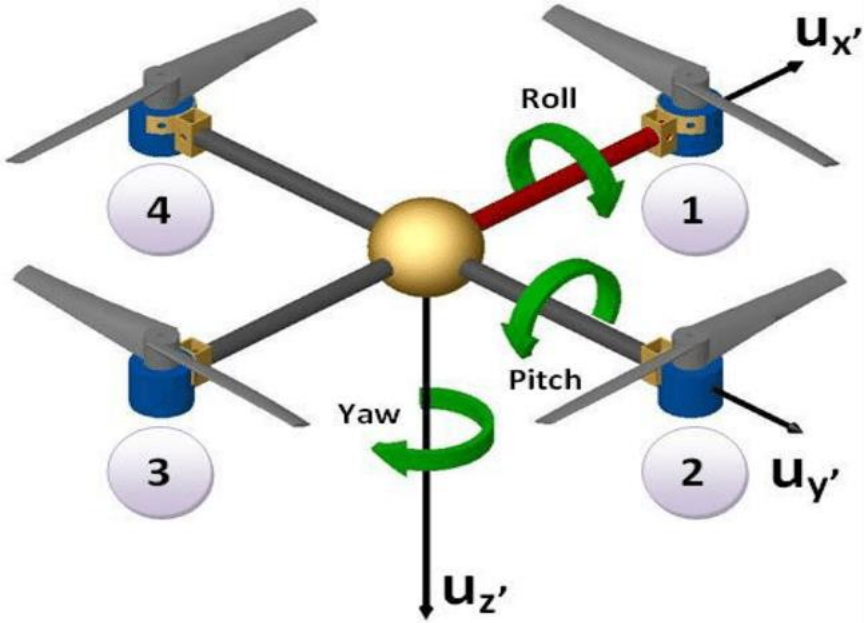

Figure 13. Quadcopter Axes

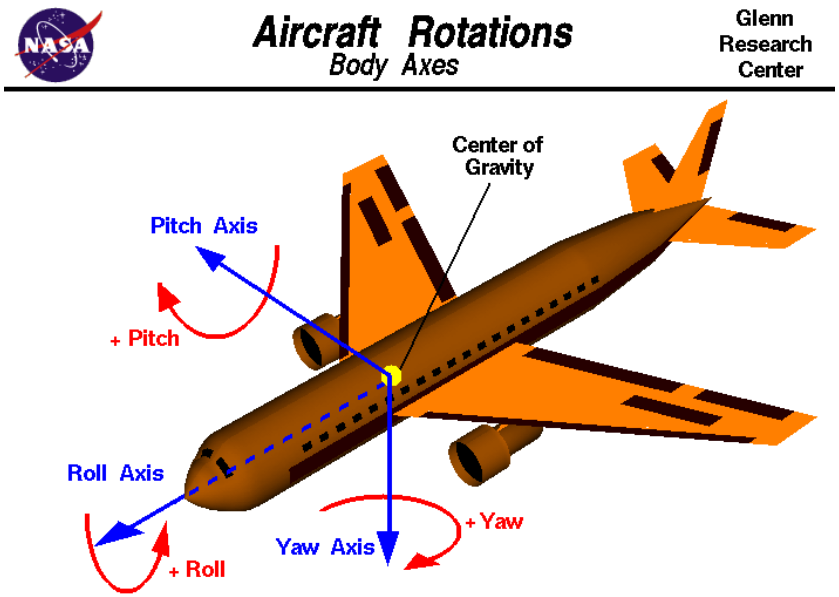

Figure 14. Airplane Axes

HOW TO MANEUVER

- **Drones:**
  - Throttle individual propellers
- **Airplanes:**
  - Tilt control surfaces to divert air

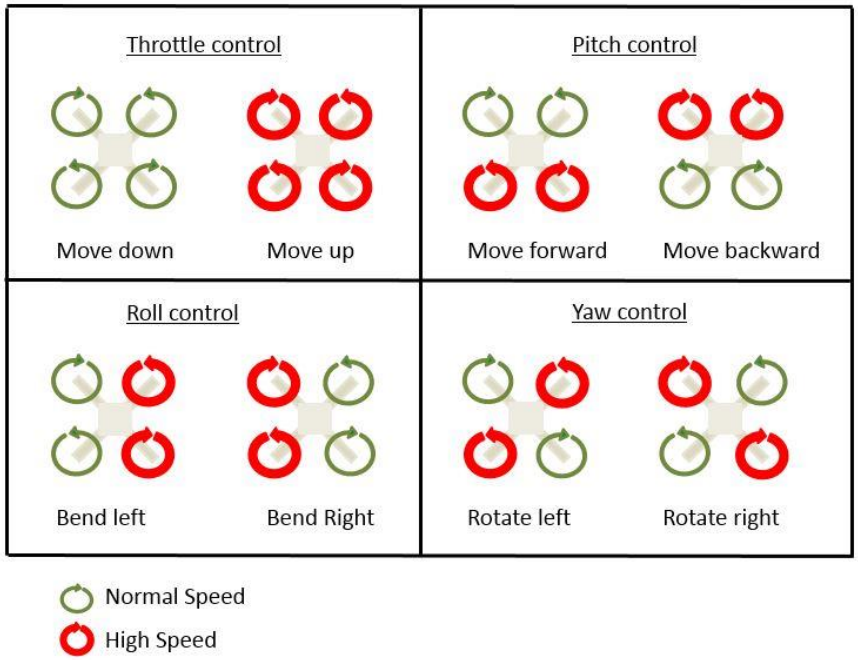

Figure 15. Quadcopter Axes

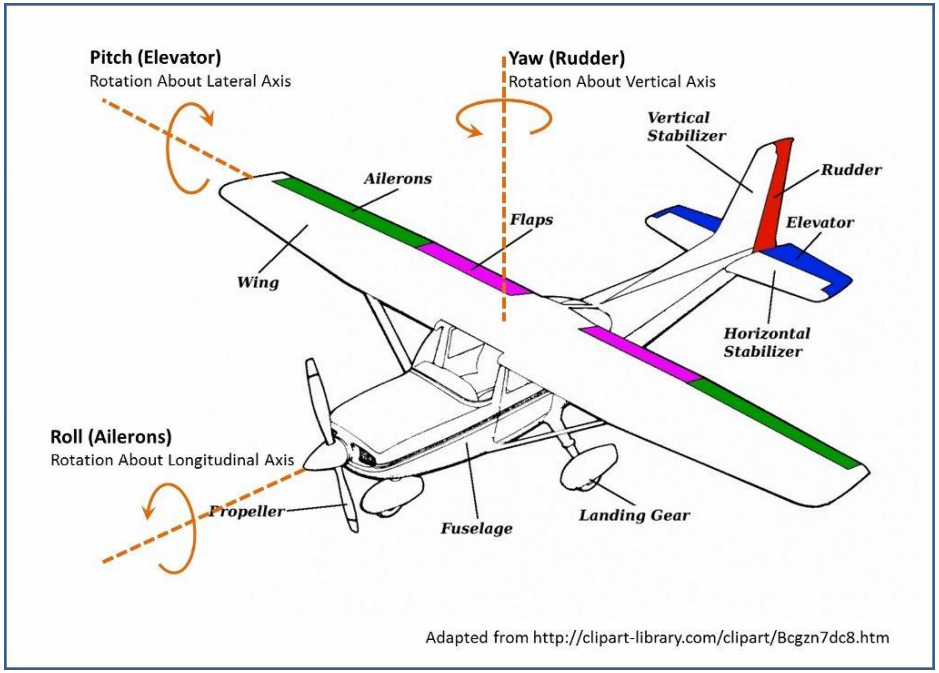

Figure 16. Airplane Axes

ARC DRONES

TELLO

- **Programming Languages:**
  - DroneBlocks, JavaScript, & Python
- **Building:**
  - No skills required!
  - Comes premade
- **Capabilities:**
  - Basic remotely-controlled flight
  - Basic autonomous flight
  - Video/picture capturing

Figure 17. Tello Drone

SPRING KIT

- **Programming Languages:**
  - Python, C++, Java, and more
- **Building:**
  - Skills required:
    - Soldering
    - Basic tools
  - Structure assembled with bolts

- **Capabilities:**
  - Semi-autonomous flight
  - Autonomous flight
  - Video/picture capturing
  - GPS
  - Ground station feedback
  - Mechanism attachment

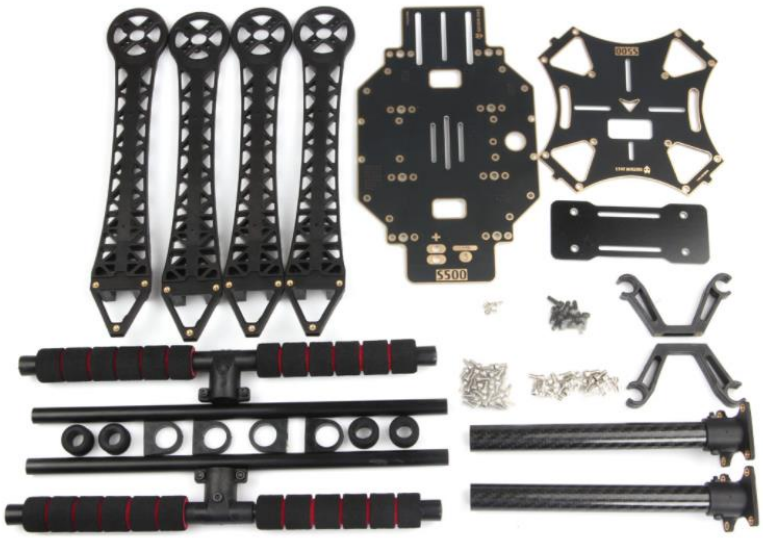

Figure 18. Kit Components

Figure 19. Assembled Drone

RESOURCES

MORE RESOURCES

- **Kit Site:** https://shop.holybro.com/s500-v2-kitmotor2216-880kv-propeller1045_p1153.html
- **Tello Site:** https://www.ryzerobotics.com/tello
- **Deeper Look into Quadcopter Dynamics:** https://towardsdatascience.com/demystifying-drone-dynamics-ee98b1ba882f
- **Drone Uses:** https://www.mydronelab.com/blog/drone-uses.html

SOURCES

SOURCES

- **Figure 2:** https://bhgrecareer.com/bebetterblog/how-drones-are-transforming-the-real-estate-industry/
- **Figure 7:** https://www.cfinotebook.net/notebook/aerodynamics-and-performance/aircraft-stability
- **Figure 8:** https://www.reddit.com/r/aviation/comments/19tlzl/bro_do_you_even_generate_lift_from_my_facebook/
- **Figures 9-10, 14:** https://slideplayer.com/slide/4645965/
- **Figure 11:** https://hobbyhenry.com/can-a-drone-fly-in-the-wind/
- **Figure 12:** https://languages.oup.com/google-dictionary-en
- **Figure 13:** https://www.researchgate.net/figure/Figure-3-yaw-pitch-and-roll-movements-of-quadcopter_fig3_319456278
- **Figure 15:** https://www.researchgate.net/figure/Dynamic-movement-of-a-quadcopter_fig3_329303380
- **Figure 16:** https://www.researchgate.net/figure/Various-parts-of-Radio-Controlled-plane_fig2_313204903

SOURCES, CONT.

- **Figure 17:** https://www.wezshop.com/?product_id=282221290_51
- **Figure 18:** https://www.newegg.com/p/382-008E-0DMR3?item=9SIARYZCNR0284&source=region
- **Figure 19:** http://www.holybro.com/product/pixhawk4-s500-v2-k it/