



INTRO TO STRUCTURAL DESIGN

MODULE 12

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MECHANISMS



- **Mechanism:**
 - A system of parts that we add to our drones to increase/enhance their abilities
- **Goals:**
 - Able to pick up tennis balls
 - Able to drop egg container
 - Quick
 - Easy for operator to control
 - Strong
 - Reliable

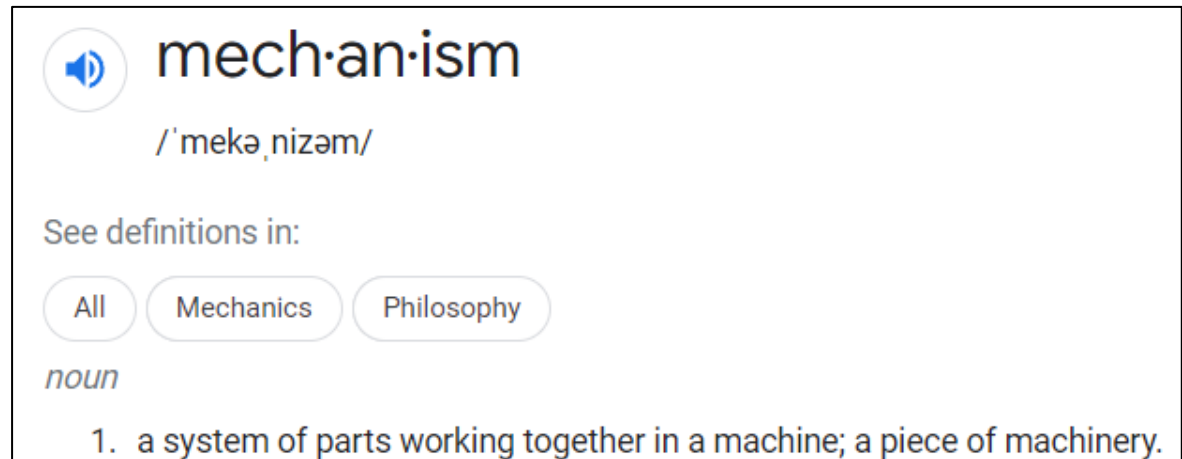


Figure 1. Definition of Mechanism

- **Servo Motors:**
 - Used to move our mechanisms
- **How Do They Work?**
 - Motorcontrollers convert the signal between the drone computer and the servo
 - Servos can either move 180 degrees (standard servo) or 360 degrees (continuous servo)

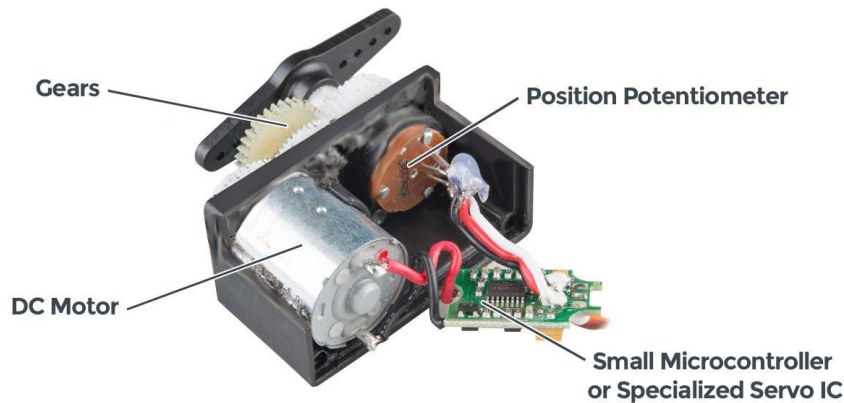
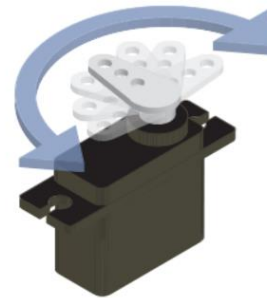


Figure 2. Internals of a Servo

Standard Hobby Servos



Continuous Rotation

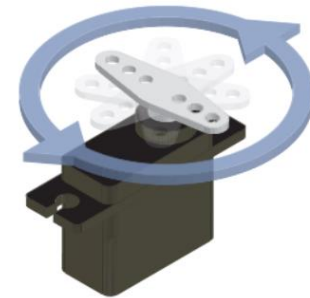


Figure 3. Standard vs Continuous Servos

- **Many Options:**
 - There are many types of mechanisms for grabbing objects – get creative!
 - Can you see the pros/cons to the following designs?
 - Can you think of any more design ideas?

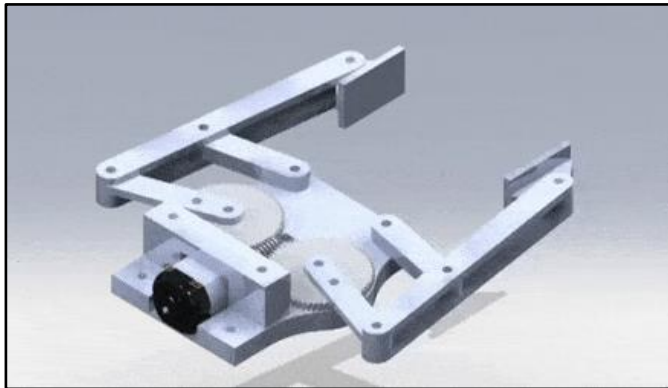


Figure 4.
Gripper

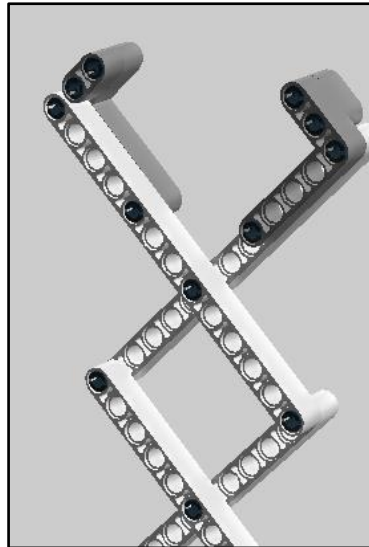
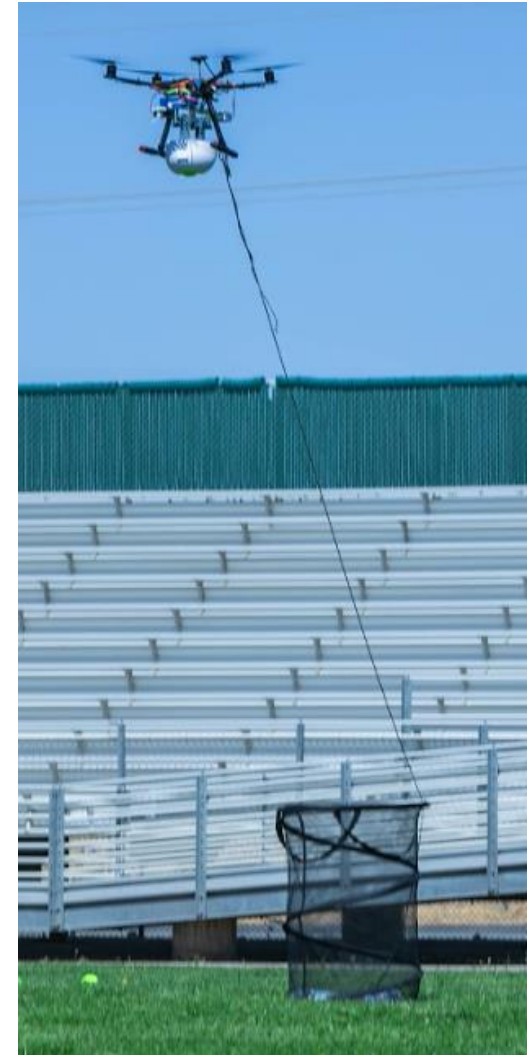


Figure 5.
Collapsible Claw



Figure 6.
Scoop Ball Catcher

MECHANISMS IN ACTION





STRUCTURAL INTEGRITY

IMPORTANT QUALITIES

- **A mechanism's structure must be well-designed to be:**
 - Strong
 - Durable
 - Lightweight
- **Keep it Simple:**
 - Keep designs as simple as possible for the task at hand
 - More components = more that can go wrong!
- **Sturdy Joints:**
 - Example: coat racks – 1, 2, 3, or 4 screws
 - Which do you think is most *sturdy*? (See more next slide)

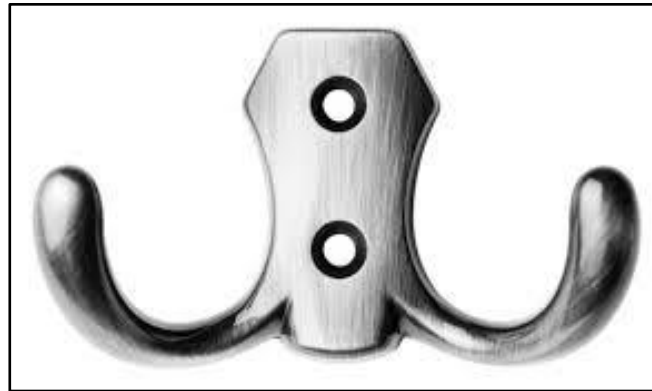


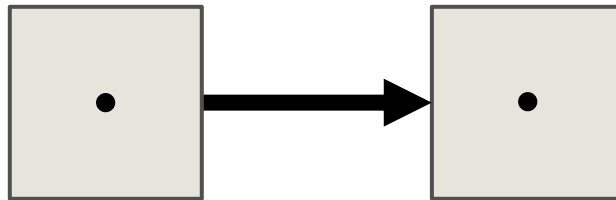
Figure 7. Joint Comparison

STURDY JOINTS

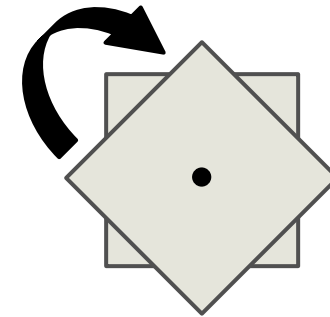


- **Definitions:**

- Translation = sliding to a new location
- Rotation = spinning around a center/axis



Translation



Rotation

- **Reducing Error in Joints:**

- All joints have some imperfection/wiggling
 - Loose-fitting joints will allow translation (sliding)
- Fastener placement can reduce both translation and rotation
 - 1 fastener:
 - Can rotate completely (held in 1 dimension)
 - 2 fasteners:
 - Better, but still loose (held in 2 dimensions)
 - 3-4 fasteners (triangle/rectangle placement):
 - Best (held in 3 dimensions)



COMPUTER AIDED DESIGN (CAD)

CAD SOFTWARE



- **Sketchup (Free):**
 - Popular in classrooms
 - Extremely basic functionality
 - Easiest to learn, but least useful
- **Inventor (Free):**
 - Popular in classrooms
 - Mid-grade functionality
 - Great as free option for learning CAD skills
- **SolidWorks (\$99/year):**
 - Popular in classrooms and mechanical engineering
 - Great for modeling mechanism assemblies
- **Catia (\$60):**
 - Popular in aerospace engineering
 - Great for modeling complex surfaces



Figure 8. Sample SolidWorks Model



SOURCES

SOURCES



- **Figures 2 & 3:** <https://www.sparkfun.com/servos>
- **Figure 4:** <https://youtu.be/HMQ4u9UIPSQ>
- **Figure 5:** <https://bricks.stackexchange.com/questions/1869/how-to-make-a-lego-claw-arm>
- **Figure 6:** <https://www.ebay.com/itm/385302926092>
- **Figure 7:** <https://www.amazon.com/Ambipolar-TriLeg-Triple-Entryway-Hangers-Perfect/dp/B07BSDY6BQ>
- **Figure 8:** <https://learnsolidworks.com/>