Project 6: Airdrop Solutions

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Overview: The AUVSI SUAS competition involves developing a unmanned aerial vehicle (UAV) and a ground vehicle (UGV) capable of delivering a payload to a certain locations and navigate around imaginary obstacles autonomously.

Introduction: Airdrop Solutions' is centered around the design and implementation of subsystems relevant to the Airdrop task highlighted by the competition rulebook. The subsystems would be subject to the following circumstances:

- An autonomous UGV capable of navigating relatively flat terrain and dropping a package
- *Safe* and *accurate* landing of the UGV from an altitude of ~100 ft
- UAV can be in motion

Other constraints for the subsystems were determined by UAV Forge Senior Design Project team leadership:

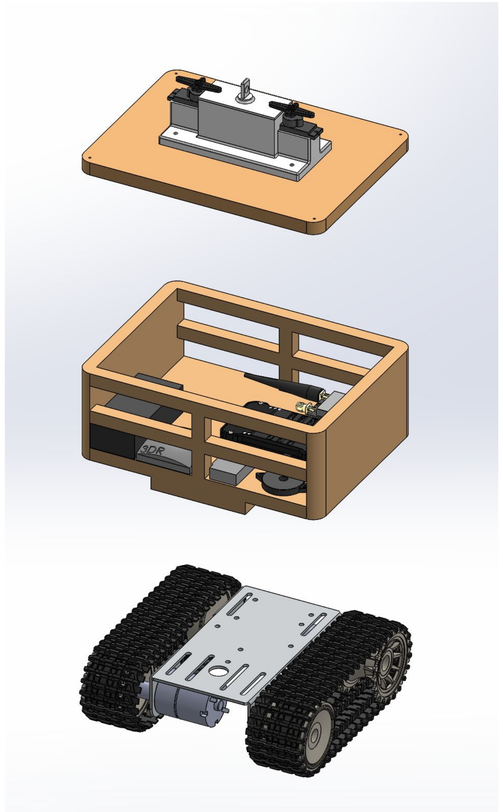
- Weight, size, and cost
- 4 wheel drive
- Guided descent drop mechanism:
  - Active Guidance: an active hybrid/closed loop control system to ensure accurate landing
  - Passive Guidance: an open loop control system based on analytical models

Objective: Design a system that will allow our UAV and UGV to execute the Air Drop task.

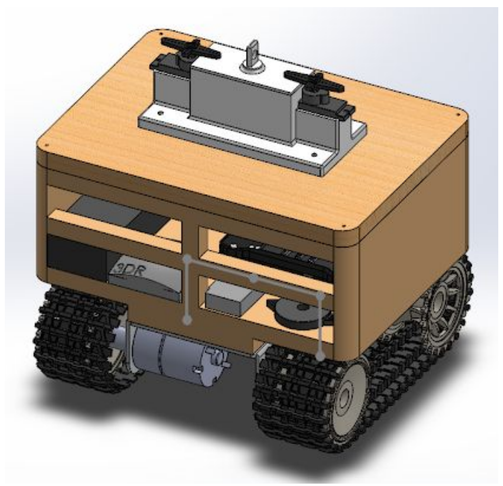
Challenge: When the UAV position is first passing the Air Drop location during the waypoint navigation task that will not require our UAV to (1) deviate from our flight path between waypoints and (2) navigate to the Air Drop location a second time.

Final Design Model

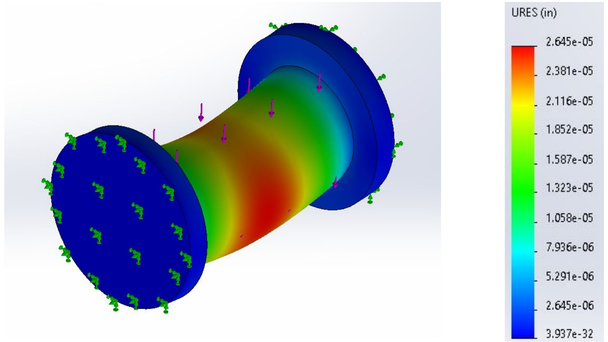
- Assembly of the UGV and Decoupler (Winch not included, attached to UAV)
- Specifications
  - Decoupling system will be screwed on top of the UAV
  - (Height, Width, Length):
    - 7.66 x 7.48 x 6.66 inches (with decoupler)
    - 5.13 x 7.48 x 6.66 inches (without decoupler)
  - Weight: ~3 lbs
- Cost:
  - Winch: ~$45
  - Decoupler: ~$35
  - Body + Components: ~$333
  - Total: ~$413



Figure(1): UGV + Decoupler Exploded View (Winch attached to UAV baseplate)

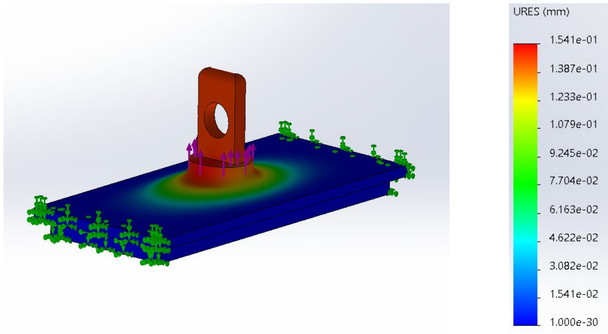


Figure(2): UGV + Decoupler



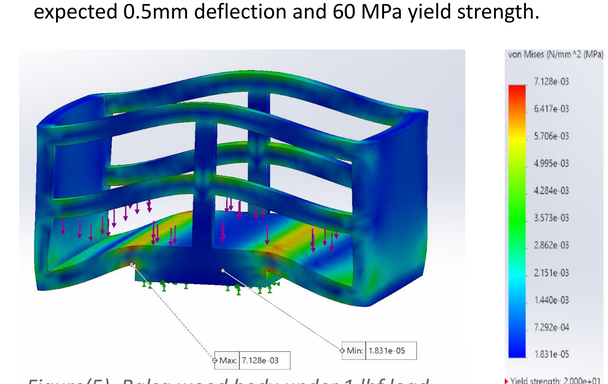
Figure(3): ABS Spool under 4 lbf load

Analysis:
Max deflection at 2.645e-5 in. under uniform solid material conditions which may not apply to 3D printed parts



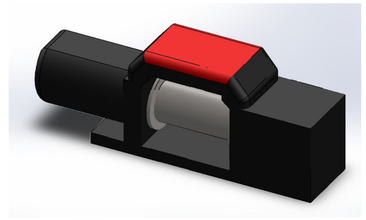
Figure(4): Polycarbonate plate under 4 lbf from payload

Analysis:
Concentrated 4 lbf at center. Based on results, max deflection of 0.154 mm and 3.37 MPa. Results well below expected 0.5mm deflection and 60 MPa yield strength.



Figure(5): Balsa wood body under 1 lbf load

Analysis:
Maximum stress of 0.007128 MPa under the rated 20 MPa based on uniform construction and weight distribution.



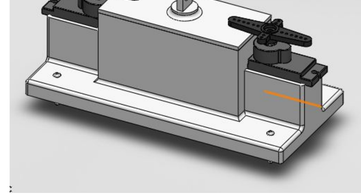
Figure(6): Winch Model

Descent System: Winch

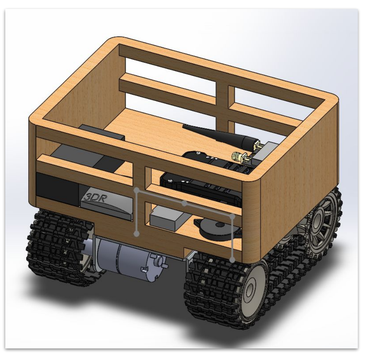
- Attached to the UAV with passive guidance system
- Manufacturable in house
- Parts:
  - Reedy Radon 2 3-Slot 3200Kv Brushed Motor, 19T
  - 3D printed spool: ABS/PLA enabling rapid prototyping
  - Fishing line: lightweight, strong

Decoupling System: Plate Release

- Cam Lock Inspiration from cabinetry construction.
- Provides a simple design for manufacturing, controlled release and lock of UGV, and better distribution of force from the payload.
- Parts
  - 3D Printed Body & Plate
    - Polycarbonate
    - Lightweight
    - Withstands loads
  - MG90S micro servo
  - 18-8 SS Button Head Screw, ½" long
  - Servo Horns (Aluminium 6061-T6): minimal deflection & lightweight



Figure(7): Plate Release Model



Figure(8): UGV Frame (without components)

UGV System: Chassis and Body

- Aluminum tank chassis with rubber treads for traction and landing recovery
- Balsa wood body frame to hold components and payload
- Parts:
  - One DC motor per tread
    - Function: Differential steering and propulsion
    - Two sprocket and idle wheels
  - Aluminum base plate attached to frame by industrial glue
  - Balsa Wood frame: lightweight and resists fracture under loads during drop based on simulations