Preliminary Design of a 3D-Printed Airframe for an Intelligent Radiation Awareness Drone (iRAD)

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Introduction and Motivation

- Unmanned aerial vehicles (UAVS) can be used for autonomous radiation detection
- Commercially available UAVs are easily damaged and cost of purchase and repair is expensive
- 3D printing can reduce costs, increase customization and iteration

Technical Approach

- CAD models created with Fusion 360
- Topology optimization used for maximized stiffness-to-weight ratio
- Finite Element Analysis (FEA) performed with ANSYS to ensure parts tolerate flight loads with 1.5 safety factor
- Bambu Lab X-1 3D printer with PLA filament

Mission Relevance

- Safer and more efficient radiation monitoring
- Modular and reproducible design for educational outreach and further mission relevant customization
- Speed of production ensures rapid prototyping and testing for many needs

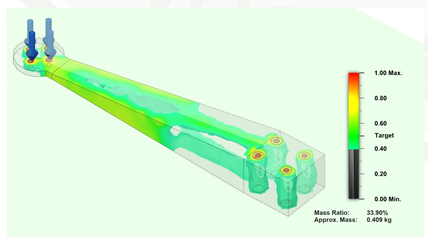
Results

- Drone performance comparable to similar commercial off the shelf (COTS) drone, Holybro X500 V2
- 3D printed drone is more affordable and rapidly produced, parts printed in ~20h
- Topology optimization reduces mass of arms by 30%, FEA indicates maximum stress of 14.9 MPa

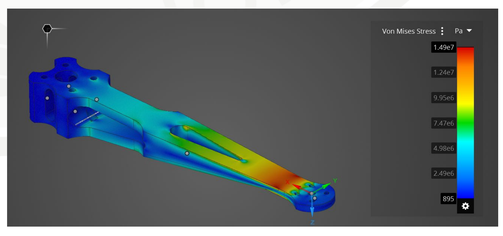
Metric	iRAD Performance	COTS Drone Performance
Cost of Frame	$50	$140
Frame Mass	513 g	610 g
Maximum Payload	2 kg	1.5 kg
Flight Time	10 min	15 min
Flight Range	5.75 km	7.5 km

▲ Drone Frame CAD Assembly

▲ 3D Printed Drone Frame



▲ Topology Optimization of Arm



▲ FEA of Arm

Expected Impact

- iRAD deployed widely to collect radiation background and mapping data
- iRAD swarms used to assess large areas, reducing collection time
- Build-your-own drone and sensor packages for educational purposes

MTV Impact

- Research and presentation experience
- Student funding and supplies
- Workshop participation and networking

Conclusion

- 3D printing methods allow faster and cheaper production of UAVs
- 3D printing offers customization suitable for radiation detection and mapping missions
- iRAD expected to be durable and rapidly repairable

Next Steps

- Manufacture with specialized filament materials (Carbon Fiber Nylon, Aero PLA, Thermoplastic Polyurethane Filament)
- Extensive flight testing with multiple drones
- Data collection with non-ionizing sources

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