Dyno-Snatcher

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Executive Summary

The Dyno-Snatcher is a robotic claw designed for search and rescue missions, mounted on a quadruped robot. It enables remote-controlled debris removal in hazardous environments, reducing risk to human responders. The design features a lightweight 4-degree-of-freedom (DOF) system, optimized weight distribution, and reinforced structural elements for durability. Through iterative prototyping, the team achieved a 26% weight reduction, improved load capacity, and enhanced servo motor efficiency. Testing confirmed the claw's ability to lift 2 lbs and grasp objects up to 3 inches in diameter. Ongoing refinements focus on improving motor control and power efficiency for real-world deployment.

Introduction & Objectives

The Dyno-Snatcher is a robotic claw designed to assist search and rescue teams by remotely removing debris and obstacles in hazardous environments using a quadruped robot. The key objectives include:

- Develop a 4 DOF arm that is lightweight (<8 lbs) and portable
- Claw must lift at least 2 lbs and grasp and object up to 3 inches in diameter
- Validate structural integrity through stress analysis and load testing
- Test remote controlled operation for precise object manipulation (up to +/- 6.35 mm)

Design & Features

The robotic arm is designed in SolidWorks and is composed of:

- 4-DOF articulation
- High-torque servos; 70 kg and 25 kg
- Printed using PLA
- 2 finger taper claw mechanism for gripping objects up to 3 inches in diameter and lifting of 2 lbs
- GT2 timing belt system
- Remote control operation through Python GUI

This specific configuration ensures there's a balance between strength, precision and adaptability is various use cases.

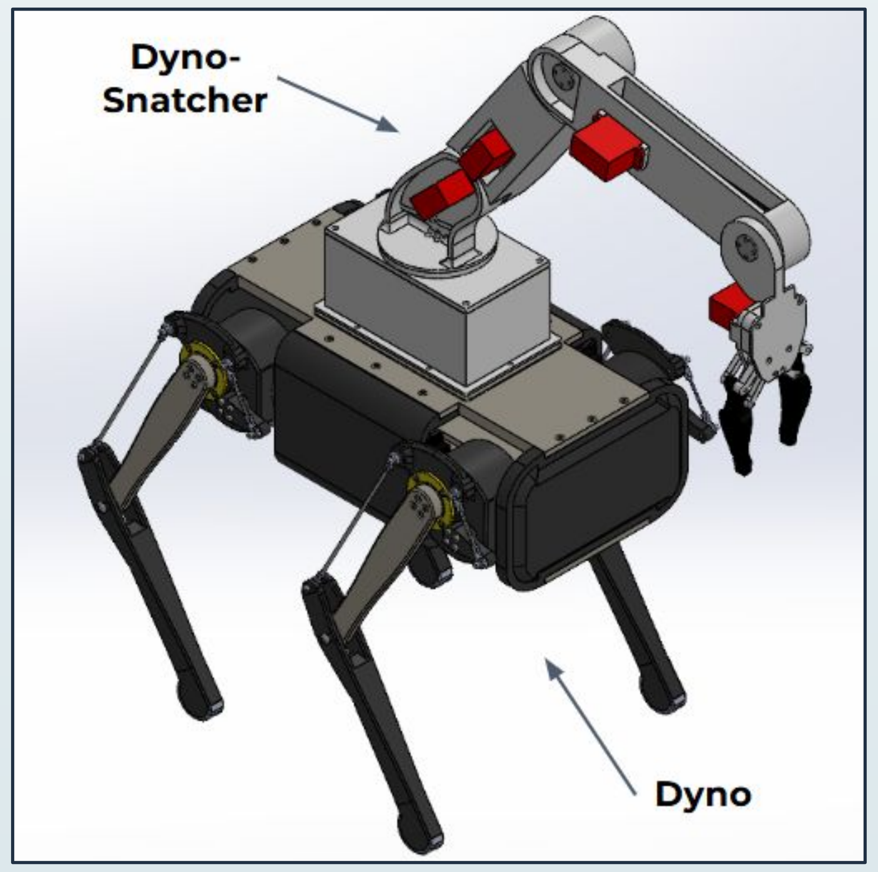

Figure 1: Full CAD Assembly of Dyno and Dyno-Snatcher

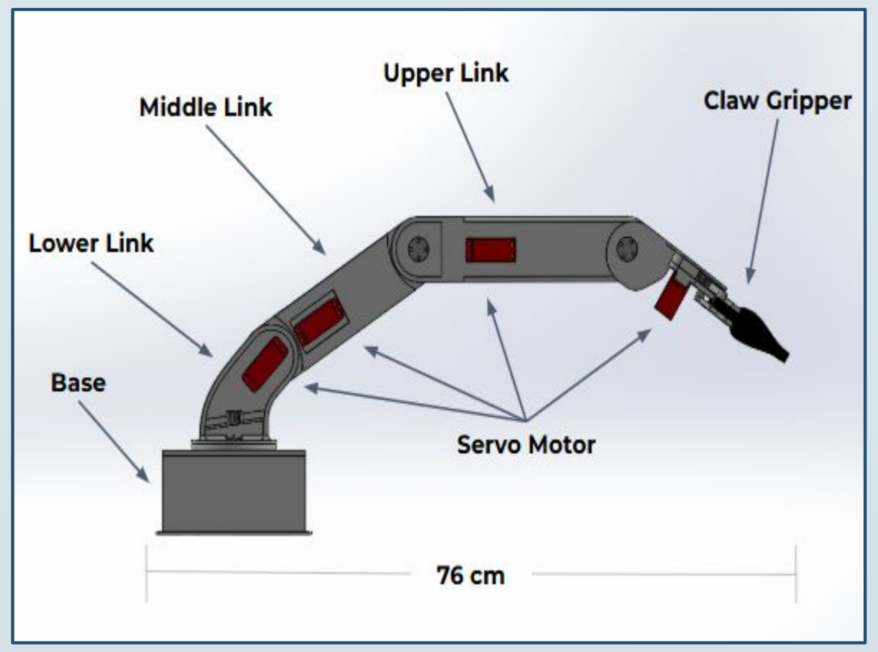

Figure 2: CAD of Dyno-Snatcher

Results

FEA Simulation:

- Boundary Conditions:
  - Fixed geometry at servo horn mounting point
  - Force: 3 lbf in the negative y-direction
- Max stress: 3.909 MPa, significantly lower than the yield strength of PLA (60 MPa)
- Max displacement: 0.222 mm

Note: Simulation was performed with solid bodies but claw components were printed with 6 walls and 20% infill

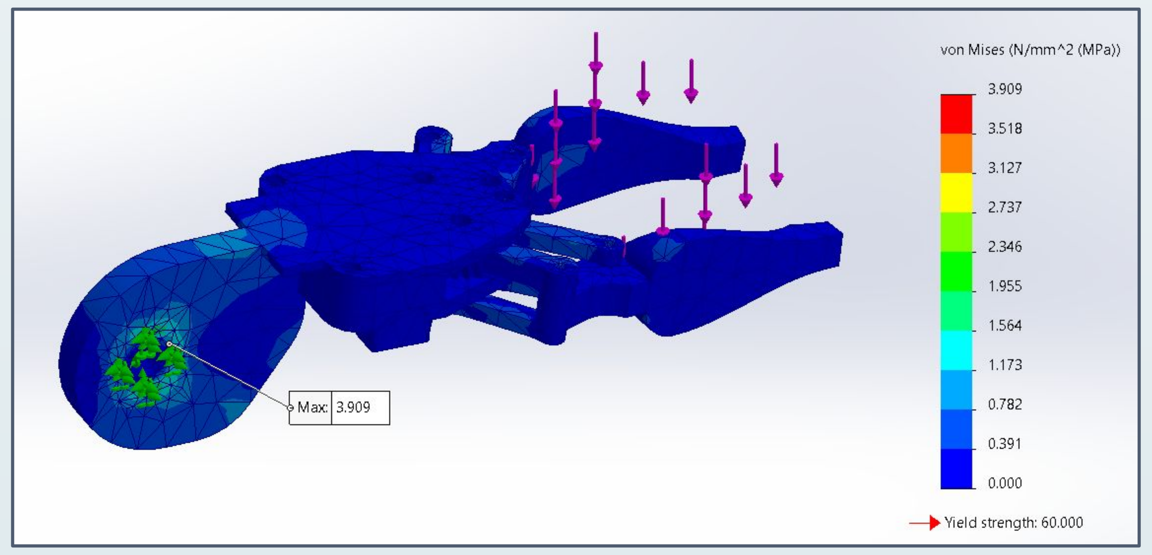

Figure 3: FEA SImulation on claw assembly 100% PLA infill

Verification:

- Load Capacity Test - **PASS**
  - Lift 2 lb and 3 in diameter object
- Stability/Durability Test - **PASS**
  - Repeated operation and loading to test for structural integrity and observe any instabilities
- Precision Test - **PASS**
  - Verify claw places objects with +/- 6.35 mm accuracy
- Duration Test - **PASS**
  - Complete full 20 minute mission operation and observe servo stalling or overheating

Conclusion

Future Improvements:

- Enhance claw strength for improved gripping performance
- Incorporate sensor feedback for potential autonomous functionality
- Optimize weight distribution for better balance on the quadruped
- Refine servo control algorithms to increase motion precision

Team Contribution & Project Scope:

- MAE 151A:
  - Developed "Prototype A"
    - Developed project scope, system outlines, and manufacturing plans
    - Developed structural prototype
- MAE 151B:
  - Developed "Prototype B"
    - Reduced weight by 26%
    - Relocated C.O.G. towards the base (77% weight decrease at arm end)
    - Developed electronics housing, routed wiring, and RC code
    - Strengthened structured

The robotic arm integrates with a quadruped, demonstrating reliable remote-controlled functionality. While the system meets baseline operational requirements, structural reinforcements and software optimizations can further improve performance. Future iterations may incorporate appropriate structural analysis, sensor feedback, and advanced control algorithms to expand its use cases.

Acknowledgements

Special thanks to Professor Sherif Hassaan, Professor David Copp, Professor Mark Walter and Mohamed Shorbagy