

# Enhancing Transformable Drone Through Redesigned Self-Locking Joint

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## Engineering Problem & Objectives

Limitations:

1. Conventional drone with rigid structural design is unable to adapt to surroundings with limited clearance, tangled string/wires.
2. M4's joint design with servos directly connected to joints can be easily broken through bending forces from accidents due to the highly compact design within a servo for high control precision

Engineering Goal: Support post-disaster search and rescue operations through entering regions that human rescuers are unable to reach with a transformable drone featuring an improved joint design to enhance the drone's durability while operating in hazardous areas.



## Results & Analysis

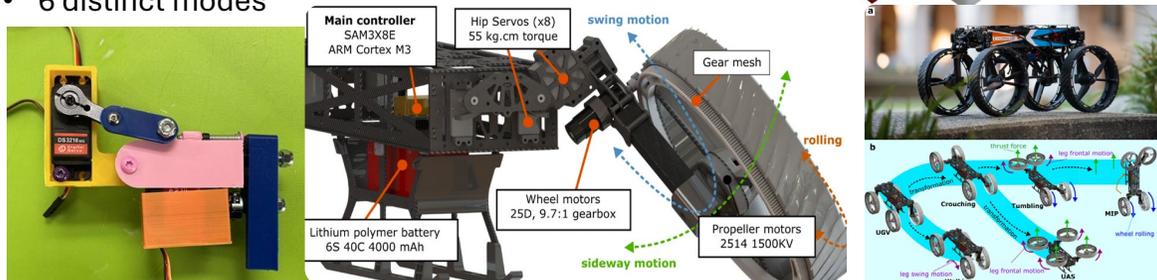
There are three main tests: Transformability Test, Stability Test, and Instantaneous Force Test, each focused on one specific part of the system that must be functional and effective in actual operations and applications.

Angles (deg)	Device Max Force	Control Group Max Force
0	45.8	5.4
45	74.5	21.6
90	111.1	9.7
135	67.4	19.7



## Project Design

- 2 independent joint systems
- Multiple sub-joints with self-locking capability
- Powered through Servo and Arduino UNO R3
- Joint system 3D printed
- 6 distinct modes



## Conclusions

The test result shows significant improvement in the amount of force the device can withstand without servo actively resisting. The device entered a self-locked state with only structural components to transmit force to rigid structures, fulfilling the main purpose of the redesigned structure—protect servo through removing them from the process of withstanding external forces and unexpected arm movements. Future works to this self-locked multi-link joint system includes using more rigid material and manufacturing process rather than PLA with 3D printing. The strength of each individual structural component is the current limitation to the amount of force the device is able to withstand. Other improvements include minimizing sub-joint size to further shrink space requirements for each joint system. Current design proves the functionality of self-locking joint structure in transformable drone; an improved self-locking joint can further redirect force from servo to other device structures.