Spring-Powered Tether Launching Mechanism for Improving Micro-UAV Air Mobility

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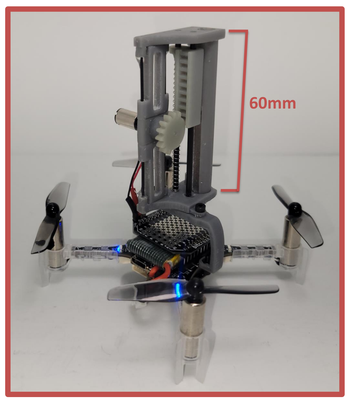
Motivation

Concept art generated with Starry AI.

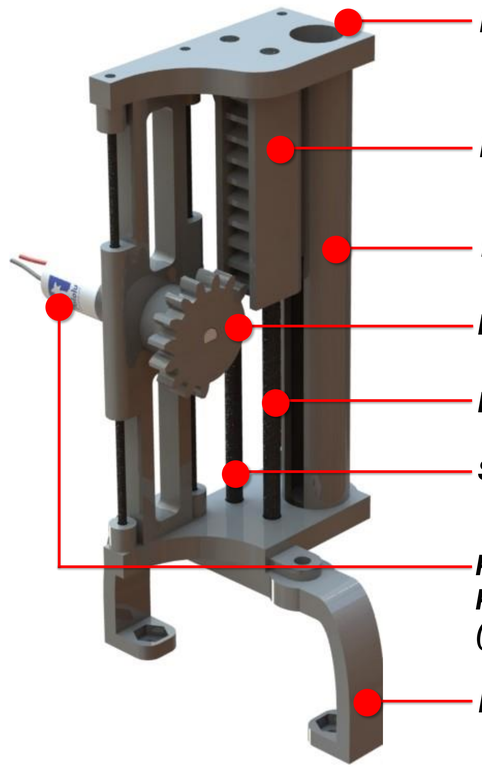
Tethered projectiles grant robots increased mobility options such as climbing, rappelling, and hanging. However, these do not exist at the cm-scale due to power and weight constraints. Small-scale impulsive systems allow miniature robots to **deliver bursts of energy that far exceed the maximum output of similarly-sized conventional actuators**. In this work, we leverage 3D printing and an impulsive, latch-actuated mechanism for the purpose of **launching tethered projectiles from a miniature drone**. This **improves the mobility options available to small robots** and lets them better navigate complex environments.

Proposed Setup

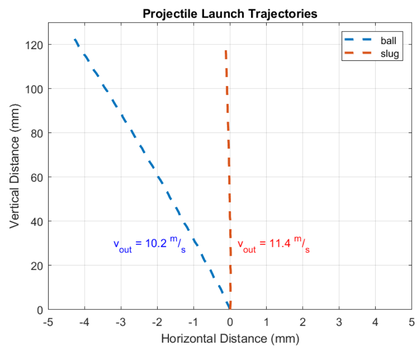


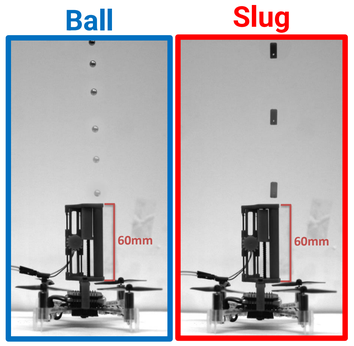
- The selected mini-quadcopter is a ***Bitcraze* CrazyFlie 2.1**, an agile, versatile, and open-source platform.
- The launcher's dimensions are **3cm × 1.4cm × 6cm** (L×W×H) and it has a mass of **16.8 g**..
- The launcher draws **3 V** at **0.1 A** from the drone's battery.
- The design was evolved from a system submitted to an **ICRA 2022 workshop**.

Mechanical Design



Projectile Launches

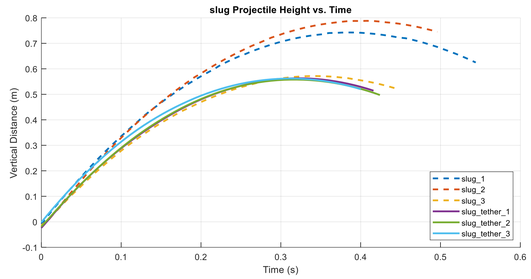


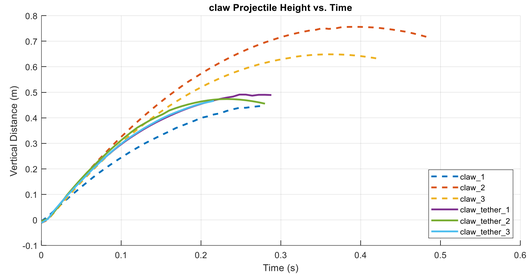


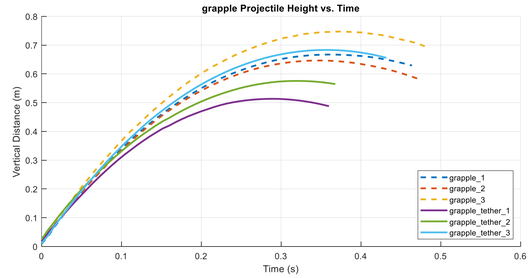
- Initial tests observed the **flight trajectories** of ball bearing projectiles and custom magnetic slugs.
- Both the ball and slug projectiles show **considerable initial velocity**, demonstrating large force output that could translate to long range.
- Small horizontal deviation allows the projectiles to **accurately hit targets** located directly above the launcher.

Tethered Casting

- **Vertical launches** were conducted with **three projectile variants**: a magnetic slug, a claw, and a grappling hook.
- The flight performance of **tethered** and **untethered** projectiles was compared.
- The **grappling hook** had the **best tethered performance**.







Conclusion & Future Work

- **Miniature tether launchers are a compact and feasible aid to micro-UAV mobility.** In this work, a novel cm-scale impulsive launcher was designed, capable of casting projectiles for useful distances with reasonable accuracy.
- **Tether retraction and storage will be explored.** So far, this work has incorporated tethers without considering how to retract them or how to store tethers onboard.
- **Flight testing** will characterize system performance in the air under diverse and complex environmental conditions. All investigations thus far have involved ground testing.

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