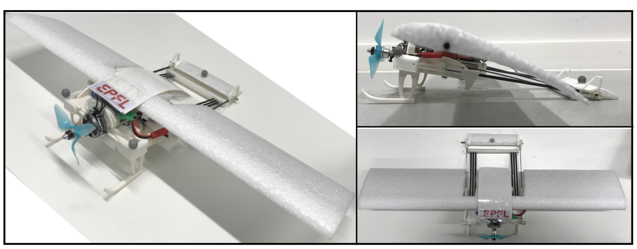
Conceptual design of a bio-inspired jumping-assisted takeoff mechanism for a fixed-wing drone

Tristan Bonato
Laboratory of Intelligent Systems (LIS), EPFL
Master Project, January 21 2022

ABSTRACT

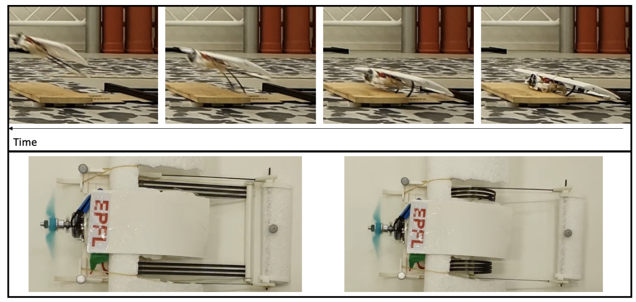
Fixed-wing drone has many advantages from long endurance to high speed flight. However, its take-off is complex because it must reach sufficient initial speed to produce enough lift to enter into the air. Currently, there are typically three takes-off approaches: by hand, catapult or runway. This report presents an alternative take-off methods for fixed-wing drones using integrated jumping legs without external supports. It reveals the simulation and the design of the drone that can reach sufficient initial speed for the takeoff using only one actuator to drive both the jumping mechanism and the propeller without adding extra electrical components for lightweight. This system expands drone application by letting long-endurance fixed-wing drones to land and take off in complex environments, where human supervision and clear runway are unavailable.



Final prototype

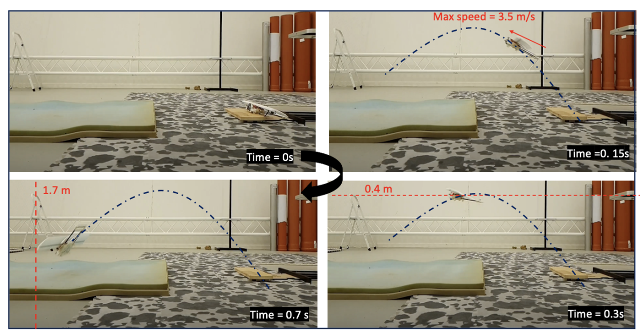
The jumping system is based on six curved carbon beams to store energy and act as springs. The carbon beams are connected to the drone with the help of a pivot to avoid instability on the body when compressing.

The compressive system is our main contribution. The performance of a drone is directly correlated to its weight. To avoid adding extra electrical components, we use the motor that drives the propeller to compress the springs of the jumping mechanism. We design an ingenious mechanism with a freewheel to decompose the engine in two modes: generating thrust for flight and compressing the spring to store energy. Furthermore, the compression mechanism automatically releases the springs when at desired position without extra electronics.



Detail of the drone during jumping phase

The drone performance tests show promising results. These tests were conducted using the OptiTrack, to obtain the position, speed, and body attitude of the drone. The jump gives almost enough speed to fly, even without activating the propeller to generate thrust. Furthermore, the jump is well controlled with very low body rotation.



Trajectory and main values of the jump

This study shows that the proposed concept works well. The drone can compress, jump, and show the ability for flying. To expand these initial promising results and to fully explore the potential of this jumping drone, some improvements can be made in the future. We could modify the design to save weight and improve performance. Furthermore, we can add more springs to offer more jumping power. And finally, some analysis on the friction between the foot and the floor can be relevant.