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BIOLOGICALY INSPIRED PROPULSION OF MICRO-AIR VEHICLES

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Summary: Small unmanned aerial vehicles (UAVs) have been receiving an increasingly interest in the last decades. This interest was fostered by the need of vehicles able to perform surveillance, communications relay links, ship decoys, and detection of biological, chemical, or nuclear materials. Smaller and handy vehicles (micro air vehicles or MAVs) fit in the general sizes, weights, and locomotion performance of natural flying or swimming animals. Nevertheless, biomimetic engineered devices are still far from the living organisms and more research is needed.

There is a general agreement that an unsteady dynamics approach is required to capture the physical phenomena at this scale. Additionally, propulsion and lift should not be considered independently. Flapping wing systems appeared in animals such as insects, birds, and fishes, which are known to exhibit remarkable aerodynamic and propulsive efficiencies. So, there have been several experimental and numerical studies of the bio-mimetic propulsive flapping. Most of these studies addressed the role of kinematic parameters such as flapping frequency, amplitude and phase difference on thrust generation and propulsive efficiency. At the same time, the effect of airfoil configuration has been considered far less and the published work is not always in agreement. Some authors attribute the superior efficiency of natural systems of thrust generation and propulsive efficiency to wing flexibility and focused their research on flexible wings with chord and span flexibilities. Recent results suggest that swimming and flying animals could control de predictability of vortex-wake interactions, and the corresponding propulsive forces with their fins and wings.

So, successful biology-inspired or biomimetic concepts will depend on the understanding of the natural mechanisms especially when they do not agree with the present engineering design principles.

The present work focus on mechanisms involved with natural locomotion (propulsion or propulsion and lift). Commonalities between natural flying and swimming are analyzed together with flow control issues. The study has been driven by the ability of living organisms to fit an ecological system in terms of their locomotion.