EXPERIMENTAL INVESTIGATION AND MODELING OF TIME RESOLVED THRUST OF A FLAPPING WING AIRCRAFT

Abstract

by

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This work presents a novel method of measuring the unsteady thrust of a hovering flapping wing vehicle and the development of phenomenological models to simulate it. The measurements were taken using a balance beam with the flapping wings mounted at one end and a counterweight plus an accelerometer mounted at the other. The thrust axis of the flapping wings was mounted vertically, and the counterweight was adjusted to balance the weight and average thrust of the flapping wings. An accelerometer mounted above the counterweight measured the unsteady thrust. This method decoupled the force sensing element from the mass of the flapping wings, as opposed to standard force sensors that use a linear spring. This study showed that the spectral content of the flapping wings extended to 15 times the flapping frequency, well above the resonant frequency of the mass-spring-damper system formed by a load cell and flapping mechanism. High speed video of the wings was used to determine the motion of the flexible structure. This motion was used to develop phenomenological linear models of flapping wing thrust generation. The results show that this approach to linear modeling produces a system of equations that can be used for flight dynamics simulation and controller design.