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# 小型无人涵道飞行器飞行动力学特性

# Flight dynamics characteristics of miniature unmanned ducted vehicle

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**中文关键词:** 无人涵道飞行器 飞行动力学 配平 稳定性 操纵性

**英文关键词:** unmanned ducted vehicle flight dynamics trimming stability maneuverability

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**中文摘要:**

为了研究无人涵道飞行器的配平特性与稳定性，首先进行了全尺寸涵道螺旋桨风洞吹风试验，分析了涵道螺旋桨的气动特性并建立了涵道螺旋桨的气动模型，在此基础上建立了无人涵道飞行器的飞行动力学数学模型，对无人涵道飞行器进行了配平特性与稳定性分析.结果表明：前飞速度与迎角对涵道螺旋桨气动特性影响很大，导致无人涵道飞行器在不同前飞速度下稳定性与操纵性变化较大.在悬停及小前飞速度下，无人涵道飞行器是一种类似倒立摆的不稳定体，而且气动阻尼较小，无人涵道飞行器的速度与姿态角发散很快，倍幅时间约为0.5 s；在大前飞速度下，无人涵道飞行器的气动阻尼增加，飞行稳定性改善，但出现了纵向反操纵现象，增加了无人涵道飞行器的飞行控制难度.

**英文摘要:**

To investigate the flight characteristics of unmanned ducted vehicle, a full-scale ducted propeller wind tunnel test was conducted to build the aerodynamic model and analyze the aerodynamic characteristics of ducted propeller. On these foundations, the flight dynamic mathematical model of the vehicle was established to investigate the characteristics trimming and stability of unmanned ducted vehicle.The results indicate that the aerodynamic characteristics of the ducted-propeller are strongly influenced by the forward speed and attitude angle, leading to significant variations in stability and maneuverability of the unmanned ducted vehicle at different forward speeds. This unmanned ducted vehicle is an unstable body similar to inverted pendulum in hover and low forward speed. The aerodynamic damping is small, while the speed and attitude angle diverge quickly, with double amplitude in 0.5 s. The flight stability is improved due to the increase of aerodynamic damping at high forward speed. The reverse control brings difficulties to flight control the unmanned ducted vehicle.

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