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微纳技术与精密机械

Hex-Rotor无人飞行器及其飞行控制系统设计

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摘要： 提出了一种Hex-Rotor无人飞行器以克服现有多旋翼飞行器的欠驱动和强耦合特性对其飞行控制效果的影响,利用6个旋翼独特的结构配置来保证飞行器独立控制空间六自由度的能力。介绍了这种新型飞行器的结构特点并建立其动力学模型,引入滤波反步法与自抗扰算法设计了具有双环并行结构的飞行控制系统,在数字仿真中实现了飞行器的空间六自由度独立控制并克服了未知外部扰动以及模型不确定性带来的影响。结果显示,原型机试飞实验中,飞行器的水平位移跟踪误差不超过±4 m,高度误差不超过±3 m,姿态角误差不超过±0.05 rad,均保持在传感器的测量误差范围内,飞行器较为准确地跟踪了期望指令。仿真和实验结果证明了该新型Hex-Rotor飞行器具有期望的六自由度独立控制能力,建立的数学模型准确,设计的飞行控制系统能够实现轨迹与姿态跟踪飞行。

关键词： 多旋翼飞行器 滤波反步法 自抗扰技术 双环并行结构

Hex-Rotor aircraft and its autonomous flight control system

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Abstract: A novel Hex-Rotor aircraft was proposed to overcome the effect of under-actuation and strong coupling characteristics on the flight performance of existing multi-rotor aircrafts. Based on the unique configuration of six driving rotors, the Hex-Rotor aircraft has the ability to control the space 6-DOF channels independently. First, the structures and characteristics of the Hex-Rotor aircraft were introduced and its dynamic model was established. Then, an autonomous flight control system with a parallel double-loop structure was designed, in which the command-filter backstepping approach was introduced into the attitude stability augmentation control loop, and the translational controller based on the active disturbance rejection control technique was used in the position loop. Finally, the total independent control of the aircraft on 6-DOF channels was achieved in the numerical simulation and the influences of unknown external disturbances and model uncertainties on the flight control performance were overcome. The prototype experiment results indicate that the horizontal tracking errors, altitude errors and attitude errors for the aircraft are limited in ±4 m, ±3 m, and ±0.05 rad, respectively, which are all according with the precision ranges of measurement units and mean that the prototype has tracked the reference translational and attitude commands accurately. The simulation and experimental results verify that the designed Hex-Rotor aircraft has desired maneuvering capability, and the control system is able to guarantee the autonomous tracking flight of the aircraft.

Keywords: multi-rotor aircraft command-filter backstepping active disturbance rejection control parallel double-loop structure

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本刊中的类似文章

1．宫勋 白越 赵常均 高庆嘉 彭程 田彦涛.新型Hex-Rotor无人飞行器及其飞行控制系统设计[J]. 光学精密工程, ,(): 0-0