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題目
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摘要

本文介紹了

關鍵字： 無人機動態建模，向量推力控制，同軸雙槳系統，最佳化方法，線性矩陣不等式

Abstract

This paper presents

Keywords: UAV dynamics modeling, thrust vector control, coaxial rotor, optimization, linear matrix inequality

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Reference

- [1] G. J. Ducard and M. Allenspach, “Review of designs and flight control techniques of hybrid and convertible VTOL UAVs,” Aerospace Science and Technology, vol. 118, p. 107035, Nov. 2021.
- [2] P. Baiocco, “Overview of reusable space systems with a look to technology aspects,” Acta Astronautica, vol. 189, pp. 10–25, Dec. 2021.
- [3] J. Rubio Hervas and M. Reyhanoglu, “Thrust-vector control of a three-axis stabilized upper-stage rocket with fuel slosh dynamics,” Acta Astronautica, vol. 98, pp. 120–127, May 2014.
- [4] J. Wang, N. Cui, and C. Wei, “Optimal rocket landing guidance using convex optimization and model predictive control,” Journal of guidance, control, and dynamics, vol. 42, no. 5, pp. 1078–1092, 2019.
- [5] T. Henderson, R. Favour, B. Hamlen, I. Mitha, E. Bowe, and N. Papanikolopoulos, “Hovering Locomotion for UAVs With Thrust-Vectoring Control Surfaces,” IEEE Robotics and Automation Letters, vol. 7, pp. 5214–5221, Apr. 2022.
- [6] X. He and Y. Wang, “Design and Trajectory Tracking Control of a New Bi-Copter UAV,” IEEE Robotics and Automation Letters, vol. 7, pp. 9191–9198, Oct. 2022.
- [7] M. R. Mokhtari, B. Cherki, and A. C. Braham, “Disturbance observer based hierarchical control of coaxial-rotor UAV,” ISA Transactions, vol. 67, pp. 466–475, Mar. 2017.
- [8] N. Zhao, H. Deng, C. Wang, K. Li, and S. Jia, “Design and dynamic modelling of a coaxial-rotor system,” in 2016 8th International Conference on Modelling, Identification and Control (ICMIC), (Algiers, Algeria), pp. 989–994, IEEE, Nov. 2016.
- [9] Y. Wei, H. Chen, K. Li, H. Deng, and D. Li, “Research on the Control Algorithm of Coaxial Rotor Aircraft based on Sliding Mode and PID,” Electronics, vol. 8, p. 1428, Nov. 2019.

- [10] K. Li, Y. Wei, C. Wang, and H. Deng, “Longitudinal Attitude Control Decoupling Algorithm Based on the Fuzzy Sliding Mode of a Coaxial-Rotor UAV,” Electronics, vol. 8, p. 107, Jan. 2019.
- [11] O. Garcia, A. Sanchez, K. Wong, and R. Lozano, “Modeling and control of a vectored-thrust coaxial UAV,” in 2009 European Control Conference (ECC), (Budapest), pp. 695–700, IEEE, Aug. 2009.
- [12] J. Fan and ,Department of Mathematics, and MOE-LSC, Shanghai Jiao Tong University, Shanghai 200240, “On the levenberg-marquardt methods for convex constrained nonlinear equations,” Journal of Industrial & Management Optimization, vol. 9, no. 1, pp. 227–241, 2013.
- [13] C. Kanzow, N. Yamashita, and M. Fukushima, “Levenberg–marquardt methods with strong local convergence properties for solving nonlinear equations with convex constraints,” Journal of Computational and Applied Mathematics, vol. 172, pp. 375–397, Dec. 2004.
- [14] D. N. Kozakevich and S. A. Santos, “Solving nonlinear systems of equations with simple constraints,” p. 23.
- [15] A. Levant, “Sliding order and sliding accuracy in sliding mode control,” International journal of control, vol. 58, no. 6, pp. 1247–1263, 1993.
- [16] J. A. Moreno and M. Osorio, “A lyapunov approach to second-order sliding mode controllers and observers,” in 2008 47th IEEE conference on decision and control, pp. 2856–2861, IEEE, 2008.
- [17] F. Nan, S. Sun, P. Foehn, and D. Scaramuzza, “Nonlinear mpc for quadrotor fault-tolerant control,” IEEE Robotics and Automation Letters, vol. 7, pp. 5047–5054, Apr. 2022.
- [18] A. Patel, A. Banerjee, B. Lindqvist, C. Kanellakis, and G. Nikolakopoulos, “Design and model predictive control of a mars coaxial quadrotor,” in 2022 IEEE Aerospace Conference (AERO), (Big Sky, MT, USA), pp. 1–11, IEEE, Mar. 2022.
- [19] C.-C. Peng and C.-L. Chen, “Dynamic controller design for a class of nonlinear uncertain systems subjected to time-varying disturbance,” Nonlinear Dynamics, vol. 57, pp. 411–423, Aug. 2009.
- [20] C.-C. Peng, “Nonlinear Integral Type Observer Design for State Estimation and Unknown Input Reconstruction,” Applied Sciences, vol. 7, p. 67, Jan. 2017.

- [21] Y.-R. Li and C.-C. Peng, “Super-Twisting Sliding Mode Control Law Design for Attitude Tracking Task of a Spacecraft via Reaction Wheels,” Mathematical Problems in Engineering, vol. 2021, pp. 1–13, Mar. 2021.
- [22] C.-C. Peng and C.-Y. Su, “Modeling and Parameter Identification of a Cooling Fan for Online Monitoring,” IEEE Transactions on Instrumentation and Measurement, vol. 70, pp. 1–14, 2021.
- [23] C.-C. Peng and T.-Y. Chen, “A recursive low-pass filtering method for a commercial cooling fan tray parameter online estimation with measurement noise,” Measurement, vol. 205, p. 112193, Dec. 2022.
- [24] E. Tetreault, D. Rancourt, and A. Lussier Desbiens, “Active Vertical Takeoff of an Aquatic UAV,” IEEE Robotics and Automation Letters, pp. 1–1, 2020.
- [25] R. Gill and R. D’ Andrea, “Computationally Efficient Force and Moment Models for Propellers in UAV Forward Flight Applications,” Drones, vol. 3, p. 77, Oct. 2019.
- [26] L.-H. Chen and C.-C. Peng, “Extended Backstepping Sliding Controller Design for Chattering Attenuation and Its Application for Servo Motor Control,” Applied Sciences, vol. 7, p. 220, Feb. 2017.
- [27] Chung-Shi Tseng and Bor-Sen Chen, “Multiobjective PID control design in uncertain robotic systems using neural network elimination scheme,” IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans, vol. 31, pp. 632–644, Nov. 2001.
- [28] D. Sanalidro, H. J. Savino, M. Tognon, J. Cortes, and A. Franchi, “Full-Pose Manipulation Control of a Cable-Suspended Load With Multiple UAVs Under Uncertainties,” IEEE Robotics and Automation Letters, vol. 5, pp. 2185–2191, Apr. 2020.
- [29] C.-L. Chen and C.-C. Peng, “Control of a perturbed chaotic system by using a trajectory trapping strategy,” Nonlinear Dynamics, vol. 69, pp. 2105–2115, Sept. 2012.
- [30] R. S. McKay, M. J. Kingan, S. T. Go, and R. Jung, “Experimental and analytical investigation of contra-rotating multi-rotor uav propeller noise,” Applied Acoustics, vol. 177, p. 107850, June 2021.
- [31] S. D. Prior, “Reviewing and investigating the use of co-axial rotor systems in small uavs,” International Journal of Micro Air Vehicles, vol. 2, pp. 1–16, Mar. 2010.

- [32] A. Koehl, H. Rafaralahy, M. Boutayeb, and B. Martinez, “Aerodynamic modelling and experimental identification of a coaxial-rotor uav,” Journal of Intelligent & Robotic Systems, vol. 68, pp. 53–68, Sept. 2012.
- [33] A. J. Torija, P. Chaitanya, and Z. Li, “Psychoacoustic analysis of contra-rotating propeller noise for unmanned aerial vehicles,” The Journal of the Acoustical Society of America, vol. 149, pp. 835–846, Feb. 2021.
- [34] B. Theys, G. Dimitriadis, P. Hendrick, J. D. Schutter, and KU. Leuven, “Influence of propeller configuration on propulsion system efficiency of multi-rotor unmanned aerial vehicles,”