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Abstract

Quadrotors are coming up as an attractive platform for unmanned aerial vehicle (UAV) research, due to the simplicity of their structure and maintenance, their ability to hover, and their vertical take-off and landing (VTOL) capability. With the vast advancements in small-size sensors, actuators and processors, researches are now focusing on developing mini UAV's to be used in both research and commercial applications. This work presents a detailed mathematical nonlinear dynamic model of the quadrotor which is formulated using the Newton-Euler method. Although the quadrotor is a 6 DOF under-actuated system, the derived rotational subsystem is fully actuated, while the translational subsystem is under-actuated. The derivation of the mathematical model was followed by the development of the controller to control the altitude, attitude, heading and position of the quadrotor in space, which is, based on the linear Proportional-Derivative- Integral (PID) controller; thus, a simplified version of the model is obtained. The gains of the controllers will be tuned using optimization techniques to improve the system's dynamic response. The standard Gravitational Search Algorithm (GSA) was applied to tune the PID parameters and then it was compared to Hybrid Memory Based

Gravitational Search Algorithm – Particle Swarm Optimization tuning, and the results shows improvement in the new algorithm, which produced enhancements by (40.126%) compared to the standard algorithm.

References

1. Rashedi, E., Nezamabadi-pour, H., Saryazdi, S., 2009, GSA: A Gravitational Search Algorithm, Information Sciences Vol. 179, pp. 2232–2248, Kerman, Iran.
2. Beard, R.W., 2008, Quadrotor Dynamics and Control, Report, BYU ScholarsArchive, Brigham Young University, Provo.
3. Benić, Z., Piljek, P., and Kotarski, D., 2016, Mathematical modelling of unmanned aerial vehicles with four rotors. Interdisciplinary Description of Complex Systems Vol.14, No.1, pp. 88-100.
4. Bresciano, T., 2008, Modelling, Identification and Control of a Quadrotor Helicopter, M.Sc. Thesis. Lund University – Department of Automatic Control, Lund, Sweden.
5. Bouabdallah, S., 2004, PID vs LQ Control Techniques Applied to an Indoor Micro Quadrotor, IEEE/RSJ International Conference on Intelligent Robots and Systems, Sendal, Japan, pp. 2451–2456.
6. Bouabdallah, S., 2006, Design and Control of Quadrotors with Application to Autonomous Flying,
7. Ph.D. Thesis, Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland.
8. ElKholy, M., N., 2014, Dynamic Modeling and Control of a Quadrotor Using Linear and Nonlinear Approaches, Master Thesis, School of Sciences and Engineering, American University in Cairo, Egypt.
9. Kotarski, D., Benić, Z., and Krznar, M., 2016, Control Design For Unmanned Aerial Vehicles With Four Rotors, Interdisciplinary Description of Complex Systems Vol. 14, No. 2, pp. 236-245.
10. Li, J., Li, Y., 2011, Dynamic Analysis and PID Control for a Quadrotor, IEEE International Conference on Mechatronics and Automation, Beijing, China.
11. Oscar A., 2015, Get Longer Flight Time On Multicopter, website article https://oscarliang.com/maximize-flight-time-quadcopter/
12. Pipatpaibul, P., and Ouyang P. R., 2011, Quadrotor UAV control : online learning approach, Proceedings of the ASME 2011 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference IDETC/CIE 2011 August 28-31, 2011, Washington, DC, USA.
13. Salih A. L., Moghavvemi M., Haider, Mohamed A. F., and Gaeid K. S., 2010, Flight PID controller design for a UAV quadrotor, Scientific Research and Essays Vol. 5, No. 23, pp. 3660-3667.
14. Mirjalili, S., Hashim, S. Z. M., 2010, A New Hybrid PSOGSA Algorithm for Function Optimization, International Conference on Computer and Information Application, Tianjin, China.
15. Darzia, S., Kiongb T. S., Islamc M. T., Soleymanpourd, H. R., Kibriaca S., 2016, A memory-based gravitational search algorithm for enhancing minimum variance distortionless response beamforming, Applied Soft Computing Vol. 47, pp.103–118.
16. Talbi E. G, 2002, A Taxonomy of Hybrid Metaheuristic, Journal of Heuristics, vol. 8, no. 5, pp. 541-546.

Index Terms

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Keywords

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