

disadvantages and advantages as the author described above. Other interesting results can be noted by the author in other models that the author can investigate them.

References

- [1] Abdo, M., Vali, A.R., Toloei, A.R., and Arvan, M.R. (2014). Modeling control and simulation of two axes gimbal seeker using fuzzy PID controller. In 2014 22nd Iranian Conference on Electrical engineering (ICEE), 1342–1347. doi: 10.1109/Iranian CEE. 2014. 6999742.
- [2] Abdo, M.M., Vali, A.R., Toloei, A.R., and Arvan, M.R. (2014). Stabilization loop of a two axes gimbal system using self-tuning PID type fuzzy controller. *ISA Transactions*, 53(2), 591–602. doi: <https://doi.org/10.1016/j.isatra.2013.12.008>.
- [3] Abdo, M.M., Vali, A.R., Toloei, A.R., and Arvan, M.R. (2015). Improving two axes gimbal seeker performance using cascade control approach. *Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering*, 229 (1), 38–55. doi: 10.1177/0954410014525130
- [4] Ahi, B. and Nobakhti, A. (2018). Hardware implementation of an ADRC controller on a gimbal mechanism. *IEEE Transactions on Control Systems Technology*, 26(6), 2268–2275. doi:10.1109/TCST. 2017. 2746059.
- [5] Caponetto, R. and Xibilia, M.G. (2017). Fractional order PI control of a gimbal platform. In 2017 European Conference on Circuit Theory and Design (ECCTD), 1–4. doi:10.1109/ECCTD. 2017. 8093271. 32 Jitendra Sharma et al. / *IFAC PapersOnLine* 53-1 (2020) 27–32.
- [6] Chen, X., Cai, Y., Ren, Y., Yang, X., and Peng, C. (2019). Spacecraft angular rates and angular acceleration estimation using single-gimbal magnetically suspended control moment gyros. *IEEE Transactions on Industrial Electronics*, 66(1), 440–450. doi:10.1109/TIE.2018.2826468.
- [7] Cui, P., Zhang, D., Yang, S., and Li, H. (2017). Friction compensation based on time-delay control and internal model control for a gimbal system in magnetically suspended CMG. *IEEE Transactions on Industrial Electronics*, 64(5), 3798–3807. doi: 10.1109/TIE.2016.2644620.
- [8] Ding, Z., Zhao, F., Lang, Y., Jiang, Z., and Zhu, J. (2019). Anti-disturbance neural-sliding mode control for inertially stabilized platform with actuator saturation. *IEEE Access*, 7, 92220–92231. doi: 10.1109/ACCESS. 2019. 2927427.
- [9] Fang, J. and Ren, Y. (2011). High-precision control for a single-gimbal magnetically suspended control moment gyro based on inverse system method. *IEEE Transactions on Industrial Electronics*, 58 (9), 4331–4342. doi: 10.1109/TIE. 2010. 2095394.
- [10] Guo, Q., Liu, G., Xiang, B., Wen, T., and Liu, H. (2016). Robust control of magnetically suspended gimbals in inertial stabilized platform with wide load range. *Mechatronics*, 39, 127–135. doi: <https://doi.org/10.1016/j.mechatronics.2016.08.003>.
- [11] Huang, L., Wu, Z., and Wang, K. (2018). High-precision anti-disturbance gimbal servo control for control moment gyroscopes via an extended harmonic disturbance observer. *IEEE Access*, 6, 66336–66349. doi: 10.1109/ACCESS. 2018. 2878623.
- [12] Jia, R., Nandikolla, V.K., Haggart, G., Volk, C., and Tazartes, D. (2017). System performance of an inertially stabilized gimbal platform with friction, resonance, and vibration effects. *Journal of Nonlinear Dynamics*, 2017.
- [13] Kim, S.B., Kim, S.H., and Kwak, Y.K. (2010). Robust control for a two-axis gimbale sensor system with multivariable feedback systems. *IET Control Theory Applications*, 4(4),539–551. doi:10.1049/iet-cta.2008.0195.
- [14] Lee, H.P. (2019). Robust control of a two-axis gimbale seeker using loop shaping design procedure. In 2019 20th International Carpathian Control Conference (ICCC), 1–6. doi: 10.1109/Carpathian CC. 2019. 8766056.
- [15] Li, H., Ning, X., and Han, B. (2017a). Composite decoupling control of gimbal servo system in doublegimbale variable speed CMG via disturbance observer. *IEEE/ASME Transactions on Mechatronics*, 22(1), 312–320. doi: 10.1109/TMECH. 2016.2601340.
- [16] Li, H., Zheng, S., and Ning, X. (2017b). Precise control for gimbal system of double gimbal control moment gyro based on cascade extended state observer. *IEEE Transactions on Industrial Electronics*, 64(6), 4653–4661. doi: 10.1109/TIE. 2017. 2674585.
- [17] Li, H., Ning, X., and Han, B. (2017). Speed tracking control for the gimbal system with harmonic drive. *Control Engineering Practice*, 58, 204 – 213. doi: <https://doi.org/10.1016/j.conengprac. 2016. 11. 001>.
- [18] Li, H., Yang, S., and Ren, H. (2016). Dynamic decoupling control of DGCMG gimbal system via state feedback linearization. *Mechatronics*, 36, 127 – 135. doi: <https://doi.org/10.1016/j.mechatronics. 2016. 04. 004>.
- [19] Majumder, C.G., Kumar, K.A., Siva, M.S., and Philip, N. (2018). Integrated gimbal dynamics model for precise gimbal rate control in single gimbal-CMG to achieve high accuracy pointing. *IFAC-Papers On Line*, 51(1), 713 – 718. doi: <https://doi.org/10.1016/j.ifacol. 2018. 05. 120>. 5th IFAC Conference on Advances in Control and Optimization of Dynamical Systems ACODS 2018.
- [20] Obiora, V. and Achumba, I.E. (2017). Adaptive control of aerial vehicle gimbal using fuzzy- PID compensator. In 2017 IEEE 3rd International Conference on ElectroTechnology for National Development (NIGERCON), 451–456. doi: 10.1109/NIGERCON. 2017. 8281914.
- [21] Rajesh, R.J. and Ananda, C.M. (2015). PSO tuned PID controller for controlling camera position in UAV using 2-axis gimbal. In 2015 International Conference on Power and Advanced Control Engineering (ICPACE), 128–133. doi: 10.1109/ICPACE. 2015. 7274930.
- [22] An Enhanced GRU Model With Application to Manipulator Trajectory Tracking, *EAI Endorsed Trans AI Robotics*, vol. 1, no. 1, p. e1, 2022.
- [23] Briefly Revisit Kinematic Control of Redundant Manipulators via Constrained Optimization, *EAI Endorsed Trans AI Robotics*, vol. 1, no. 1, p. e4, 2022.
- [24] Incorporation of efficient second-order solvers into latent factor models for accurate prediction of missing QoS data, *IEEE Trans. on Cybernetics*, vol. 48, no. 4, pp. 1216-1228, 2018.
- [25] An Overview of Calibration Technology of Industrial Robots, *IEEE/CAA J. Autom. Sinica*, vol. 8, no. 1, pp. 23-36, Jan. 2021.
- [26] Diversified Regularization Enhanced Training for Effective Manipulator Calibration, *IEEE Transactions on Neural Networks and Learning Systems*, doi: 10.1109/TNNLS.2022.3153039.