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Classical and Fuzzy Approaches to 2–DOF Control Solutions for BLDC–m Drives

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Chapter

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Abstract

This chapter gives two–degree–of–freedom (2–DOF) speed control solutions for brushless Direct Current motor (BLDC–m) drives with focus on design methodologies. A classical 2–DOF structure, 2–DOF proportional-integral (PI) and proportional–integral–derivative (PID) structures and 2–DOF fuzzy control solutions are presented and approaches regarding the methods are highlighted. A case study concerning a BLDC–m drive with variable moment of inertia is presented. Comparative studies based on digital simulation results are included to exemplify the design methods.

Keywords

Speed control 2–DOF control brushless direct current motor PID control

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References

1. Isermann, R.: Mechatronic systems: Fundamentals. Springer, Heidelberg (2005)
   Google Scholar
2. Akpolat, Z.H., Asher, G.M., Clare, J.C.: A practical approach to the design of robust speed controllers for machine drives. IEEE Trans. Ind. Electron 47, 315–324 (2000)
   CrossRef
   Google Scholar
3. Miklosovic, R., Gao, Z.: A robust two–degree–of–freedom control design technique and its practical application. In: Proceedings of 39th IAS Annual Meeting Conference, Seattle, WA, USA, vol. 3, pp. 1495–1502 (2004)
   Google Scholar
4. Landau, I.D., Zito, G.: Digital control systems: Design, identification and implementation. Springer, London (2006)
   Google Scholar
5. Preitl, S., Precup, R.E., Preitl, Z.: Control structures and algorithms. Editura Orizonturi Universitare, Timisoara (2009) (in Romanian)
   Google Scholar
6. Araki, M., Taguchi, H.: Two–degree–of–freedom PID controllers. Int. J. Control Automat. Syst. 1, 401–411 (2003)
   Google Scholar
7. Astrom, K.J., Hagglund, T.: PID controllers theory: Design and tuning. Instrument Society of America, Research Triangle Park (1995)
   Google Scholar
8. Leva, A., Bascetta, L.: On the design of the feed-forward compensator in two-degree-of-freedom controllers. Mechatronics 16, 533–546 (2006)
   CrossRef
   Google Scholar
9. Alfaro, V.M., Vilanova, R., Arrieta, O.: Robust tuning of Two-Degree-of-Freedom (2–DoF) PI/PID based cascade control system. J. Process Control 19, 1658–1670 (2009)

CrossRef
Google Scholar

10. Cheng, Z., Yamada, K., Sakanushi, T., Murakami, I., Ando, Y., Nguyen, L.T., Yamamoto, S.: A design method for two–degree–of–freedom multi–period repetitive controllers for multiple–input/multiple–output systems. In: Preprints of 18th IFAC World Congress, Milano, Italy, pp. 5753–5758 (2011)
Google Scholar
11. Preitl, S., Precup, R.E.: An extension of tuning relations after symmetrical optimum method for PI and PID controllers. Automatica 35, 1731–1736 (1999)
MATH
CrossRef
Google Scholar
12. Preitl, Z.: Model-based design methods for speed control applications. Editura Politehnica, Timisoara (2008)
Google Scholar
13. Peng, Y.Q., Luo, J., Zhuang, J.F., Wu, C.Q.: Model reference fuzzy adaptive PID control and its applications in typical industrial processes. In: Proceedings of IEEE International Conference on Automation and Logistics (ICAL 2008), Qingdao, China, pp. 896–901 (2008)
Google Scholar
14. Preitl, Z., Levendovszky, T.: Computer aided design of two–degree–of–freedom (2DF) controllers. Scientific Bulletin of "Politehnica" University of Timisoara Romania. Transactions on Automatic Control and Computer Science 48(62), 70–75 (2003)
Google Scholar
15. Visioli, A.: Fuzzy logic based set–point weight tuning of PID controllers. IEEE Trans. Syst. Man. Cybern. A Syst. Humans 29, 587–592 (1999)
CrossRef
Google Scholar
16. Shu, S.Q., Ding, X.Y., Wu, W., Ren, H.Y.: Application of a self–tuning two degree of freedom PID controller based on fuzzy inference for PMSM. In: Proceedings of International Conference on Electrical Machines and Systems (ICEMS 2008), Wuhan, China, pp. 1629–1632 (2008)
Google Scholar
17. Precup, R.E., Preitl, S., Petriu, E.M., Tar, J.K., Tomescu, M.L., Pozna, C.: Generic two–degree–of–freedom linear and fuzzy controllers for integral processes. J. Franklin Inst. 346, 980–1003 (2009)
MathSciNet
MATH
CrossRef
Google Scholar
18. Preitl, S., Precup, R.E., Preitl, Z.: Aspects concerning the tuning of

2–DOF fuzzy controllers. In: Proceedings of Xth Triennial International SAUM Conference on Systems, Automatic Control and Measurements (SAUM 2010), Nis, Serbia, pp. 210–219 (2010)
Google Scholar

19. Horowitz, I.M.: Synthesis of feedback systems. Academic Press, New York (1963)
MATH
Google Scholar
20. Baranyi, P., Gedeon, T.D.: Rule interpolation by spatial geometric representation. In: Proceedings of 6th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems (IPMU 1996), Granada, Spain, pp. 483–488 (1996)
Google Scholar
21. Baranyi, P., Yam, Y., Varkonyi–Koczy, A.R., Patton, R.J., Michelberger, P., Sugiyama, M.: SVD based complexity reduction to TS fuzzy models. IEEE Trans. Ind. Electron 49, 433–443 (2002)
CrossRef
Google Scholar
22. Skrjanc, I., Blazic, S., Matko, D.: Direct fuzzy model–reference adaptive control. Int. J. Intell. Syst. 17, 943–963 (2002)
MATH
CrossRef
Google Scholar
23. Johanyak, Z.C.: A brief survey and comparison on various interpolation based fuzzy reasoning methods. Acta Polytechnica Hungarica 3, 91–105 (2006)
Google Scholar
24. Fodor, J., Rudas, I.J.: On continuous triangular norms that are migrative. Fuzzy Sets Systems 158, 1692–1697 (2007)
MathSciNet
MATH
CrossRef
Google Scholar
25. Blazic, S., Skrjanc, I., Matko, D.: Globally stable direct fuzzy model reference adaptive control. Fuzzy Sets Systems 139, 3–33 (2003)
MathSciNet
MATH
CrossRef
Google Scholar
26. Mihailovic, B., Pap, E.: Asymmetric general Choquet integrals. Acta Polytechnica Hungarica 6, 161–173 (2009)
Google Scholar
27. Vascak, J., Madarasz, L.: Adaptation of fuzzy cognitive maps – a comparison study. Acta Polytechnica Hungarica 7, 109–122 (2010)
Google Scholar

28. Johanyak, Z.C.: Student evaluation based on fuzzy rule interpolation. Int. J. Artif. Intell. 5, 37–55 (2010)
Google Scholar

29. Linda, O., Manic, M.: Uncertainty-robust design of interval type–2 fuzzy logic controller for delta parallel robot. IEEE Trans. Ind. Informat. 7, 661–670 (2011)
CrossRef
Google Scholar

30. Stinean, A.I., Preitl, S., Precup, R.E., Pozna, C., Dragos, C.A., Radac, M.B.: Speed and position control of BLDC servo systems with low inertia. In: Proceedings of 2nd International Conference on Cognitive Infocomunications (CogInfoCom 2011), Budapest, Hungary, p. 8 (2011)
Google Scholar

31. Stinean, A.I., Preitl, S., Precup, R.E., Dragos, C.A., Radac, M.B.: 2–DOF control solutions for BLDC–m drives. In: Proceedings of IEEE 9th International Symposium on Intelligent Systems and Informatics (SISY 2011), Subotica, Serbia, pp. 29–34 (2011)
Google Scholar

32. Baldursson, S.: BLDC motor modelling and control – A Matlab/Simulink implementation. M.Sc. Thesis, Institutionen for Energi och Miljo, Goteborg, Sweden (2005)
Google Scholar

33. Nasar, S.A., Boldea, I.: Electric drives, 2nd edn. CRC Press, Taylor and Francis, New York (2005)
Google Scholar

34. Boldea, I.: Advanced electric drives. PhD courses (2010-2011), ”Politehnica” University of Timisoara, Timisoara, Romania (2011)
Google Scholar

35. Mink, F., Bahr, A.: Adaptive speed control for drives with variable moments of inertia and natural drequencies, LTi DRIVES GmbH Entwicklung Software, Lahnau, Germany. (2011)
Google Scholar

36. ECP: Industrial emulator/servo trainer model 220 system, testbed for practical control training, Bell Canyon, CA, USA. Educational Control Products (2010)
Google Scholar

37. Preitl, S., Precup, R.E., Dragos, C.A., Radac, M.B.: Tuning of 2–DOF fuzzy PI (D) controllers laboratory applications. In: Proceedings of 11th International Conference on Computational Intelligence and Informatics (CINTI 2010), Budapest, Hungary, pp. 237–242 (2010)
Google Scholar

38. Horvath, L., Rudas, I.J.: Modelling and solving methods for engineers. Academic Press, Burlington (2004)
Google Scholar

39. Vascak, J.: Navigation of mobile robots using potential fields and computational intelligence means. Acta Polytechnica Hungarica 4, 63–74 (2007)
Google Scholar

40. Dankovic, B., Nikolic, S., Milojkovic, M., Jovanovic, Z.: A class of almost orthogonal filters. J. Circ. Syst. Comp. 18, 923–931 (2009)
CrossRef
Google Scholar

41. Iglesias, J.A., Angelov, P., Ledezma, A., Sanchis, A.: Evolving classification of agents' behaviors: a general approach. Evolving Syst. 1, 161–171 (2010)
CrossRef
Google Scholar

42. Garcia, A., Luviano-Juarez, A., Chairez, I., Poznyak, A., Poznyak, T.: Projectional dynamic neural network identifier for chaotic systems: Application to Chua's circuit. Int. J. Artif. Intell. 6, 1–18 (2011)
Google Scholar

43. Linda, O., Manic, M.: Self-organizing fuzzy haptic teleoperation of mobile robot using sparse sonar data. IEEE Trans. Ind. Electron. 58, 3187–3195 (2011)
CrossRef
Google Scholar

44. Kasabov, N., Abdull Hamed, N.H.: Quantum–inspired particle swarm optimisation for integrated feature and parameter optimisation of evolving spiking neural networks. Int. J. Artif. Intell. 7, 114–124 (2011)
Google Scholar

45. Peng, C., Han, Q.L.: Delay–range–dependent robust stabilization for uncertain T–S fuzzy control systems with interval time–varying delays. Inf. Sci. 181, 4287–4299 (2011)
MathSciNet
MATH
CrossRef
Google Scholar

46. Obradovic, D., Konjovic, Z., Pap, E., Rudas, I.J.: Linear fuzzy space based road lane model and detection. Know. Based Syst. (2012), doi:10.1016/j.knosys.2012.01.002
Google Scholar

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