Control of Object with Feedback Loop Using Imperfect Position and Acceleration Sensors

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Abstract. The paper discusses the problem of balancing robot control loop with negative feedback. The controller (regulator) can be calculated by numerical optimization. Sensors of the controlled value are imperfect. Orientation angle sensor (gyroscope) has a limited speed, as well as binary quantization noise. An acceleration sensor (accelerometer) has the average drift value and Gaussian noise. None of these sensors is not sufficient to stabilize balancing robot effectively, but using of them both in a single control loop can achieve the required accuracy of control in static and dynamic. Method of sharing the two sensors to determine more accurately the single value, previously developed in theory, has been tested with simulation. Furthermore, the results are confirmed with their practical use with good effect.

Key words: automation, control, transient process, stability, quality of control, closed-loop system, the accuracy of the sensors, balancing robot, gyroscope, accelerometer

REFERENCES

- Zhmud V. A. Modelirovanie, issledovanie i optimizacija zamknutyh sistem avtomaticheskogo upravlenija. Monografija. Novosibirsk, Izd-vo NGTU, 2012. – 335 s. (Zhmud V.A. Simulation study and optimization of locked systems of automatic control. Monograph. Novosibirsk, Publishing House of the NSTU, 2012. - 335 p.)
- [2] Zhmud V.A., Zavorin A.N. Struktura modeli dlja optimizacii sistemy s obratnoj svjaz'ju. Patent RF RU 2554291 C1. Opubl. 27.06.2015. Bjull. № 18.
- [3] V. A. Zhmud. The Use of the Feedback Control Systems in Laser Physics Researching Experiments. // Proceedings of RFBR and DST Sponsored "The 2-nd Russian-Indian Joint Workshop on Computational Intelligence and Modern Heuristics in Automation and Robotics", 10–13 September, 2011, Additional volume, pp.40–43.
- [4] Zhmud V.A., Zavorin A.N. Method of designing energy-efficient regulators for complex objects with partially unknown model. Proc.: The control and modeling in complex systems. Proceedings of the XVI International Conference June 30-July 3, 2014, Samara. Russia. p. 557-567.
- [5] The modeling tests of the new PID-regulators structures. Voevoda, A.A., Zhmud, V.A., Ishimtsev, R.Y., Semibalamut, V.M. 2009. Proceedings of the IASTED International Conference on Applied Simulation and Modelling, ASM 2009. P.165 168.
- [6] Modern key technologies in automatics: Structures and numerical optimization of regulators. Zhmud, V., Yadrishnikov, O., Poloshchuk, A., Zavorin, A. 2012. Proceedings - 2012 7th International Forum on Strategic Technology, IFOST 2012.
- [7] The design of the feedback systems by means of the modeling and optimization in the program VisSim 5.0/6. Zhmud, V., Liapidevskiy, A., Prokhorenko, E. 2010. Proceedings of the IASTED International Conference on Modelling, Identification and Control. PP. 27–32.
- [8] V. Zhmud, O. Yadrishnikov. Numerical optimization of PID-regulators using the improper moving detector in cost function. Proceedings of the 8-th International Forum on Strategic Technology 2013 (IFOST-2013), vol. II, 28 June – 1 July. Mongolian University of Science and Technology, Ulaanbaator, Mongolia. IEEE organized. 2013. P. 265 – 270. http://www.must.edu.mn/IFOST2013/
- [9] V. Zhmud, A. Polishchuk, A. Voevoda, R. V. Rao. The Tuning of the PID-Regulator for Automatic Control System of Thermo Energetic Equipment // Proceedings of the Fifth International Conference on Advances in Mechanical Engineering (ICAME-2011), June 06-08, 2011. Surat – 395 007, Gujarat, India. pp. 254-263.
- [10] Zhmud V.A., Zavorin A.N. Metodi di ottimizzazione del controllo numerico su una modelli troncati. Italian Science Review. 2014; 4(13). PP. 686-689. Available at URL: <u>http://www.ias-journal.org/archive/2014/april/Zhmud.pdf</u> and <u>http://www.ias-journal.org/archive/2014/april/Zhmud.pdf</u>



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