

---

# Application of quaternions to the problems of space vehicles attitude control

© N.E. Zubov<sup>1,2</sup>, A.V. Lapin<sup>1</sup>, E.A. Mikrin<sup>1,2</sup>

<sup>1</sup> S.P. Korolev Rocket and Space Corp. “Energia”,  
Korolev, Moscow region, 141070, Russia

<sup>2</sup> Bauman Moscow State Technical University, Moscow, 105005, Russia

*The problem of space vehicle specified attitude constructing with quaternion elements used for describing angular motions is solved by means of the most universal modal control method, i.e. the exact pole placement method. The problem of landing module angular motion control in the landing phase is discussed as an example.*

**Keywords:** space vehicle, modal control, quaternions, exact pole placement method.

## REFERENCES

- [1] Zubov N.E. Optimal control of spacecraft terminal orientation on the basis of an algorithm with a predicting model. *Cosmic Research*, 1991. int. 29, vol. 3, pp. 340–351 [in Russian].
- [2] Zubov N.E., Mikrin E.A., Misrikhanov M.Sh., Ryabchenko V.N. Synthesis of decoupling laws for attitude stabilization of a spacecraft. *J. Comput. Syst. Sci.*, 2012, int. 51, pp. 80–96.
- [3] *Theoretical Foundations of Designing Information Control Systems for Space Vehicles*, E.A. Mikrin (ed.) Moscow, Nauka, 2006 [in Russian].
- [4] Raushenbakh B.V. and Tokar’E.N. *Spacecraft Attitude Control*. Moscow, Nauka, 1974) [in Russian].
- [5] Martynov N.N. *Introduction to Matlab 6*. Moscow, Kudits obraz, 2002 [in Russian].
- [6] Misrikhanov M.Sh. and Ryabchenko V.N. Algebraic and Matrix Methods in the Theory of Linear MIMO Systems. *Vestn. IGEU*, 2005, No. 5, pp. 196–240.
- [7] Zubov N.E., Mikrin E.A., Misrikhanov M.Sh. and Ryabchenko V.N. Modification of the Exact Pole Placement Method and Its Application for the Control of Spacecraft Motion. *J. Comput. Syst. Sci.*, 2013, int. 52, vol. 2, pp. 279–292.
- [8] Gantmacher F.R. *The Theory of Matrices*. Moscow, Nauka, 1988 [in Russian].
- [9] Zubov N.E., Lapin A.V., Mikrin E.A. Synthesis of decoupling laws for controlling the angular motion of landing module with solid-fuel landing engine minimizing the transient time. *J. Comput. Syst. Sci.*, 2013, int. 52, pp. 480–490.

**Zubov N.E.**, Dr. Sci. (Eng.), Deputy and Scientific Director of the Research and Development Centre of S.P. Korolev Rocket and Space Corp. “Energia”, Professor of the Automatic Control System Department of Bauman Moscow State Technical University. Author of over 70 scientific articles in the field of spacecraft dynamical systems control. e-mail: Nikolay.Zubov@rscce.ru

**Lapin A.V.**, Post-graduate of S.P. Korolev Rocket and Space Corp. “Energia”. Author of three articles on space vehicles control problems.

---

---

**Mikrin E.A.**, Dr. Sci. (Eng.), Member of the Russian Academy of Sciences, First Deputy General Designer of the S.P. Korolev Rocket and Space Corp. “Energia”, Head of the Automatic Control System Department of Bauman Moscow State Technical University. Author of over 100 scientific articles in the field of spacecraft dynamical systems control.  
e-mail: [Eugeny.Mikrin@rsce.ru](mailto:Eugeny.Mikrin@rsce.ru)

---