3rd European Congress of Mathematics
Poster sessions

Section 08: Ordinary Differential Equations and Dynamical Systems | Poster number 624

Stabilization of integrals of rigid body velocity dynamics

I. V. Burkov*, St. Petersburg Technical University.
A. L. Fradkov, Institute of Mechanical Engineering, Russian Academy of Sciences.

ABSTRACT

The dynamics of the velocities of rigid body with fixed point is described by Euler equations

$$A\dot{p} + (C - B)qr = M_x, \quad B\dot{q} + (A - C)pr = M_y, \quad C\dot{r} + (B - A)pq = M_z, \tag{1}$$

where (p, q, r) is the vector of angular velocity of the body, A, B, $C > 0$ are principal moments of inertia, M_x, M_y, M_z are the projections of the controlling forces. It is assumed that the ellipsoid of inertia does not degenerate to a ball.

We consider the following case of controlling inputs: $M_x = u$, $M_y = v$, $M_z = 0$. This case corresponds to the situation when the satellite is controlled by only two reactive jets acting along the principal axis of inertia. The system with zero inputs has the classical first integrals:

$$K = (Ap^2 + Bq^2 + Cr^2)/2, \quad M = (A^2p^2 + B^2q^2 + C^2r^2)/2 \tag{2}$$

Let K_* and M_* denote the desired levels of the first integrals. Choosing these integral levels we define a program trajectory, which is a inertial (free) motion of the system with zero inputs $u = 0$ and $v = 0$. The goal of control if to find a feedback $u = u(p, q, r)$ and $v = v(p, q, r)$ such, that the integrals (2) should converge to the desired levels for all initial velocities. It is easy to show that the motion should converge to the program trajectory.

To solve this goal we propose, f.e., the following control

$$u = -\alpha[(K - K_*)Ap + (M - M_*)A^2p], \quad v = -\beta[(K - K_*)Bq + (M - M_*)B^2q]$$

where α and β are positive gain coefficients.

The synthesis of control and the proof have been carried out by applying Lyapunov-like technique from the paper by Fradkov (Autom. Remote Control, 1999, no.4).

The method may be generalized to other acting of control inputs.

Keywords: *asymptotic stabilization of manifolds, Lyapunov methods, rigid body*

Mathematics Subject Classification: *93*

Contact Address: `burkov@osipenko.stu.neva.ru`