UDC 681.5.07

EVALUATION STABILITY REGION PARAMETRIC SYSTEMS WITH VARIABLE STRUCTURE

L.A.PANTALIYENKO, Candidate of Physical and Mathematical Sciences

The results of numerical calculation of areas of practical stability of parametric linear systems with variable structure. The problem of stability for a finite period of time for structurally given set of initial conditions and parameters

Parameters, practical stability, linear systems with variable structure, disturbance.

In many problems of applied nature, including accelerating technology, phase trajectories of a dynamical system can have gaps on some surfaces at a time. Thus, during the motion of a particle in the accelerating electric field rectangular inlet and outlet of the tube changes the direction of the drift velocity of the particle [1]. This means that the projection of the particle velocity have some gaps. Tasks analysis of discontinuous dynamical systems [[illegible]] include evaluation of areas of stability, tolerance parameters, guaranteed sensitivity [[illegible],3,4]. This kind of problem on the basis of general theorems practical stability for systems with variable structure [[illegible]], it is proposed to consider at the same position, and obtain the corresponding estimates in analytical form.

The aim of research ─ development of constructive algorithms areas of stability for linear systems with parametric variable structure in the presence of permanent disturbances.

Materials and methods research. The paper used mathematical methods of practical and parametric stability on the part of variables. As parameters, in particular, can be seen and initial conditions in the given structure.

Explore the practical problem of stability for linear nonstationary parametric systems with variable structure

$$\frac{dx}{dt} = A(t)x + G(t)\alpha + f(t), \; t \in [t_{i-1}, t_i), \; i = 1,2,\dots,N. \qquad (1)$$

Here $A(t)$, $G(t)$, $t \in [t_{i-1}, t_i)$, $i = 1,2,\dots,N$ — integrated matrix elements of dimension $n \times n$ and $n \times m$ respectively, and permanent disturbance $f(t)$, $t \in [t_{i-1}, t_i)$, $i = 1,2,\dots,N$ assumed known or unknown, but limited.

Let Φ_t — set allowable state vector x at time $t \in [t_0, T]$ ($0 \in \Phi_t$, $t \in [t_0, T]$), and G_0^x, $G_0^\alpha \subset G_\alpha$ — the set of admissible initial conditions and system parameters (1) respectively.

Definition 1. Unperturbed solution $x(t,0) = 0$ of system (1) will be called $(G_0^x, G_0^\alpha, \Phi_t, t_0, T)$ — stable if $x(t,\alpha) \in \Phi_t$, $t \in [t_0, T]$ for any initial conditions $x(t_0,\alpha) \in G_0^x$ and arbitrary $\alpha \in G_0^\alpha \subset G_\alpha$.

If restrictions on the parameters of the state vector and compatible type: x, $\alpha \in \Phi_{t,\alpha}$, $t \in [t_0, T]$, and evaluation of the initial area defined set $G_0^{x,\alpha}$, by analogy introduces the concept of $(G_0^{x,\alpha}, \Phi_{t,\alpha}, t_0, T)$ — stability.

To obtain the stability of numerical algorithms considered linear and non-linear constraints [ ] on the phase coordinates.

For the numerical evaluation of areas of stability consider linear and nonlinear constraints on the phase coordinates:

$$G_0^x = \{x \mid x^* B x \le c^2\}, \; G_0^\alpha = \{\alpha \mid \alpha^* B_\alpha \alpha \le c_\alpha^2\}, \; G_0^{x,\alpha} = \{x, \alpha \mid x^* B x + \alpha^* B_\alpha \alpha \le c^2\},$$

where B, B_α — known positively identified square matrix of dimension n and m respectively. Then unperturbed solution $x(t,0) = 0$ of system (1) in the sense of definition 1 stability will be called $(B, c_\alpha, B_\alpha, \Phi_t, t_0, T)$ — stable, and with compatible restriction — study $(B, B_\alpha, \Phi_{t,\alpha}, t_0, T)$ - stability [ ].

The relevant stability criteria given. To obtain the necessary and sufficient conditions of stability in the case of nonlinear dynamical constraints need to set Ψ_t ($\Psi_{t,\alpha}$) approximate hyperplane and use the results (stability criteria).

The algorithms can also be used to calculate the areas of practical stability of nonlinear systems with variable structure by their previous linearization linearly independent functions [2].

Results. For parametric linear systems with variable structure proved necessary and sufficient conditions for stability practical, applicable to nonlinear systems by their previous linearization.

Conclusions

On the basis of general theorems practical stability for parametric systems estimation algorithms developed regions of initial conditions and parameters associated with designing real dynamic objects.

References

1. Бублик Б.Н. Структурно-параметрическая оптимизация и устойчивость динамики пучков / Бублик Б.Н., Гаращенко Ф.Г., Кириченко Н.Ф.– К.: Наук. думка, 1985. – 304 с.

2. Панталієнко Л.А. Дослідження практичної стійкості нелінійних систем, залежних від параметрів / Л.А. Панталієнко // Науковий вісник НАУ. ─ 2005. ─ №90 ─ С. 185−191.

3. Панталієнко Л.А. Дослідження практичної стійкості параметричних моделей зі змінною структурою / Л.А. Панталієнко // Науковий вісник НУБіП України. Серія «Техніка та енергетика АПК». ─ 2012. ─ Вип. 174, ч.1. ─ С. 152−156.

4. Розенвассер Е.Н. Чувствительность систем управления / Е.Н. Розенвассер, Р.М. Юсупов.– М.: Наука , 1981. – 464 с.

5. Самойленко А.М. Дифференциальные уравнения с импульсным воздействием /А.М. Самойленко, Н.А. Перестюк – К.: Вища шк., 1987. – 287 с.

Приведены результаты численного расчета областей практической устойчивости линейных параметрических систем с переменной структурой.

Рассмотрены постановки задач устойчивости на конечном промежутке времени для структурно заданных множеств начальных условий и параметров.

Параметры, практическая устойчивость, линейные системы с переменной структурой, возмущения.

Наведено результати чисельного розрахунку областей практичної стійкості лінійних параметричних систем зі змінною структурою. Розглянуто постановки задач стійкості на скінченному проміжку часу для структурно заданих множин початкових умов і параметрів.

Параметри, практична стійкість, лінійні системи зі змінною структурою, збурення.