DIRECT LIAPUNOV’S MATRIX FUNCTIONS
METHOD AND OVERLAPPING DECOMPOSITION
OF LARGE SCALE SYSTEMS

A.A. Martynyuk
Institute of Mechanics
National Academy of Sciences of Ukraine, Kiev, Ukraine
To the 70th birthday of Professor D.D.Šiljak

Abstract. In the framework of the method of matrix-valued Liapunov functions stability problems are considered for the dynamical system extended (reduction) in terms of a linear transformation. The examples are presented which show how generalized decomposition together with matrix-valued function extend the possibilities of application of the second Liapunov method in stability investigation of dynamical system.

Keywords. Large scale systems; overlapping decomposition; Liapunov’s matrix function; stability; asymptotic stability.

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1 Preliminary results

Let the system of perturbed motion equations

\[ S_x: \quad \frac{dx}{dt} = f(t, x), \quad x(t_0) = x_0, \quad (1.1) \]

be given, where \( x \in \mathbb{R}^n \) and \( f \in C(\mathbb{R}_+ \times \mathbb{R}^n, \mathbb{R}^n) \), which possesses under initial conditions \((t_0, x_0) \in \text{int} (\mathbb{R}_+ \times \mathbb{R}^n)\) a unique solution \( x(t) = x(t; t_0, x_0) \) determined for all \( t \geq t_0, \ t_0 \geq 0 \).

Together with system (1.1) we consider a nonlinear continuously differentiable transformation [1, 2]

\[ y = \Phi(t, x), \quad \Phi \in C^{(1,1)}(\mathbb{R}_+ \times \mathbb{R}^n, \mathbb{R}^m) \quad (1.2) \]

for which a reverse one exists and is determined by the formula

\[ x = \Pi(t, y), \quad \Pi \in C^{(1,1)}(\mathbb{R}_+ \times \mathbb{R}^m, \mathbb{R}^n). \quad (1.3) \]

Using (1.2), and (1.3) we reduce system (1.1) to the form

\[ S_y: \quad \frac{dy}{dt} = \tilde{f}(t, y), \quad y(t_0) = \Phi(t_0, x_0), \quad (1.4) \]