

THE ELLIPSOIDAL ESTIMATION OF THE STATE OF DISCRETE CONTROL SYSTEMS WITH THE HELP OF MATRIX COMPARISON SYSTEMS

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Introduction

Last years we can observe the considerable progress in the area of discrete and digital control systems [1], [2]. The popularity of these systems in various industries is caused by the development of microprocessor and computer engineering, as well as by the advantages of using the digital systems.

We consider the discrete systems of automatic control which are presented by difference equations with indefinite nonlinearities from sector. The initial state of system is indefinite. It is known only that it is contained in the given ellipsoid. We take into account indefinite disturbances. The method of matrix comparison systems (MCS), which was proposed in [3] and developed in [4]–[7] for the analyses of dynamics and the estimation of state of continuous nonlinear controlled systems, is extended to the mentioned above class of systems. Note that the systematic investigation of discrete systems with the help of the Lyapunov functions method was implemented in [8]. The first theorem about difference equations was obtained in [9] and its generalizations were done in [10]. In [11], developed was the method of vector comparison systems in the analysis of dynamics of discrete processes. The vector difference comparison systems were investigated in [12]. In [13], developed were the methods for constructing the Lyapunov vector-functions with components consisting of modules of linear forms and vector comparison systems for nonlinear discrete controllable systems.

In this paper, we propose the justification of the method of matrix comparison systems for the discrete models of control systems and prove the theorem about matrix difference inequalities. We investigate the properties of matrix difference equations with the right-hand side which is monotone with regard to the cone of nonnegative definite symmetrical matrices. We propose the methods for constructing the matrix difference comparison systems, the procedures for generating the ellipsoidal estimates for the set of discrete processes. It is shown that the positive defined solutions of MCS define the quadratic Lyapunov functions which extract invariant sets in the phase space of the initial system. For the linear non-autonomous difference equations we prove the connection between the matrix comparison systems and the evolutionary equations of the ellipsoids method [14].

The methods and algorithms of constructing MCS and ellipsoidal estimates of discrete processes for nonlinear controllable systems are realized in MATLAB. The results are illustrated by several examples.

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