
Entropy Approach to the Investigation of Information Capabilities of Adaptive Radio Engineering System in Conditions of Intrasystem Uncertainty

V. V. Skachkov, V. V. Chepyki, H. D. Bratchenko,* and A. N. Efymchikov

Odessa State Academy of Technical Regulation and Quality, Odessa, Ukraine

*e-mail: gd_bratchenko@mail.ru

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Abstract—The Shannon entropy metric modified for solving the problem of estimating the information capabilities of adaptive radio engineering system in conditions of intrasystem uncertainty has been considered. The application of entropy approach was shown as a tool of the generalized representation of known criteria of adaptive signal processing during the intrasystem perturbations of system parametric vector.

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PROBLEM STATEMENT. ANALYSIS OF INVESTIGATIONS AND PUBLICATIONS

The problem of investigation of information capabilities of adaptive radio engineering systems (RES) performing functions on the basis of using the information about events, situations and processes occurring outside the systems under consideration or within the systems, can be referred to the class of problems with a priori uncertainty. The a priori uncertainty of radio engineering system [1–4] is caused by the condition of its external environment (extrasystem uncertainty) and by the existence of sources of random intrasystem perturbations (intrasystem uncertainty).

The classical representation implies that the character of extrasystem uncertainty depends on the class of problems in hand, dynamics of the variation of external conditions, the form of a priori information about measured and unmeasured parameters of the environment. In this context one can assume that the level of overcoming the extrasystem uncertainty is determined by capabilities of the adaptive RES selected in the target task as a subject of investigation [1, 2].

Prerequisites of intrasystem uncertainty in adaptive RES are the resource restrictions related to the existence of internal system noises, limited accuracy of performed computations, inadequacy of direct and inverse transformations of observed realizations, the lack of isomorphism in real system, etc. [4–7]. Such resource restrictions are intrinsic to any real system and at the physical level they show up in the form of random intrasystem perturbations that in principle can be eliminated. The specified circumstances actualize the problem of quantitative estimation of the degree of impact of irremovable intrasystem perturbations on information capabilities of adaptive RES.

The sensitivity of multidimensional adaptive RES to the intrasystem perturbations with nonwhite Gaussian noise applied to their input, in the general case, does not guarantee the consistency of adaptive processing algorithms due to the possible degeneration of correlation matrix of observed processes. Situations where the correlation matrix of observations has a poor causality and possesses a big defect are considered in [2, 4, 8–12]. The mechanisms of applying the regularization methods for signal processing in adaptive system with antenna array are presented in [8, 11, 12]. The direct method of parametric adaptation of system using the iteration procedure of element correction of correlation matrix inverse estimate that was computed with round-off errors is presented in [8]. The issues of joint optimization of signals and filters under conditions of restrictions occurring during their practical implementation are discussed in [6, 9, 10]. These papers consider the setting errors of the weighting factor vector of adaptive filter and the degree of their impact on the value of the output signal-to-noise ratio in joint optimization algorithms and also present the models of antenna arrays making it possible to determine the impact of intrasystem distortions of amplitude-phase field distribution on the parameters of antenna directional pattern.