NOVATEUR PUBLICATIONS
JournalNX- A Multidisciplinary Peer Reviewed Journal
ISSN No: 2581 - 4230
VOLUME 6, ISSUE 10, Oct. -2020

BUILD AN ADAPTIVE CONTROL SYSTEM WITH FLEXIBLE FUNCTIONS

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ABSTRACT:

This article is based on the determination (or assessment) of the current values of parameters or properties of an object, the construction of control systems that perform flexible functions, and the corresponding reconfiguration of the parameters of system regulators. The main thing here is to carry out identification in the shortest possible time, at a speed close to the speed of real dynamic processes.

INTRODUCTION:

The construction of control systems performing adaptive functions is based on the identification (or estimation) of the current values of the parameters or characteristics of the object and, in accordance with this, on the subsequent restructuring of the parameters of the system regulators. The main problem here is the implementation of identification in the shortest possible time, preferably at a rate close to the rate of real dynamic processes. In the simplest control systems, it is possible to control the characteristics or parameters of the system. Identification in adaptive systems of this level is limited to one or two controlled parameters and is carried out on the basis of direct and indirect measurements of the necessary variables (using sensors or computing units). Later, the identification approach began to develop based on the use of adjustable models in adaptive systems that identify the current parameters and variables that are inaccessible to measurement. A measure of the quality of identification is associated with the extremization (most often minimization) of a certain evaluation function - the quality function (QF). The process of minimizing the KF is associated with a change in the parameters of the model (parametric tuning) or the introduction of additional adaptive signals from some adaptive block (signal tuning).

The computational process of KF minimization is an integral part of the adaptive identification algorithm. Another computational process relates to control, as a result of which the parameters of the system regulator are calculated and changed or an additional adaptive signal is generated at the input of the system based on the information obtained from the adaptive identification. Thus, there are two adaptation processes in identification adaptive systems: identification and control. A configurable model as a block can be consistent with the identified object in different ways, namely: parallel connection, serial and mixed. In addition, it is possible to connect the model to parts of the object [3]. With a parallel connection, it is not required, as in other cases, the introduction of additional dynamic blocks (differentials) to implement operator’s inverse to the operator of the identified part of the system or object. This connection option provides the greatest simplicity of the control system, therefore, we will accept it for the construction of an

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VOLUME 6, ISSUE 10, Oct. -2020

adaptive TO control system with delay, as the most rational.

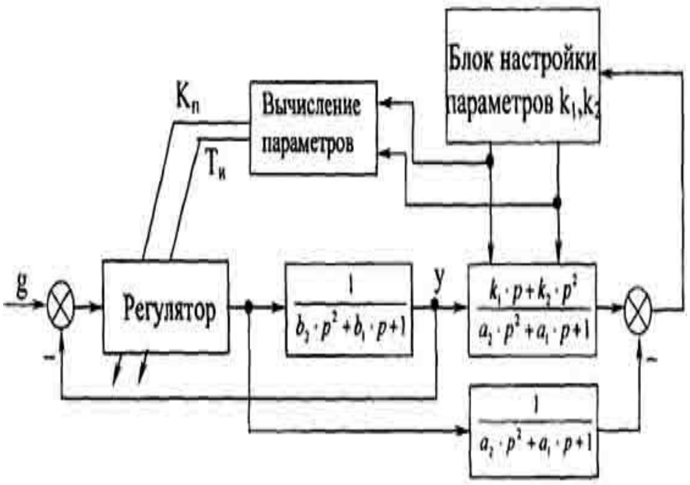

Figure: 1. Adaptive system with sequential tunable model.

Figure: 2. An adaptive system with a parallel tunable model.

A serial connection option is shown in Fig. 1, parallel connection - in fig. 2. Thus, many practical developments of adaptive systems can be combined into the structure of an adaptive system with a tunable model (ASNM).

Another approach to the construction of adaptive control systems for technological objects is associated with the use of a block of the reference model, which "obeys" the movement of the entire control system or its part. In the early development of adaptive systems with a reference model, systems with a preliminary filter (Fig. 3) are distinguished, as well as adaptive systems with parallel inclusion of a reference model relative to the adaptable system [5], shown in Fig. 3. 4. In a system with a preliminary filter, the main task is to achieve "almost" inertia-free behavior of the system, against the background of which the dynamics of the reference model, included in front of the system, is "dominant" [1]. The use of an adaptive system with a parallel inclusion of a reference model has removed the restrictions on the use of this model, consisting in the complexity of the description (order) of the object, which took place in the development of systems with a preliminary filter.

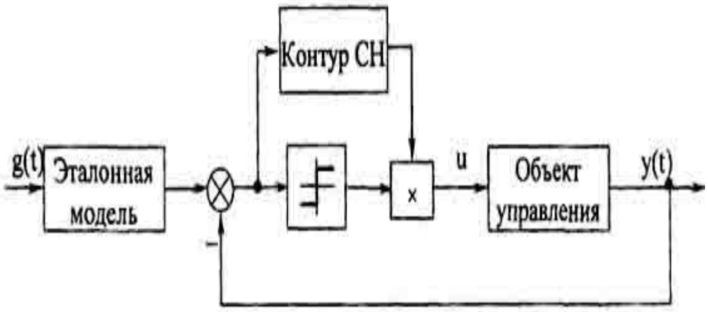

Figure: 3. Adaptive system with pre-filter.

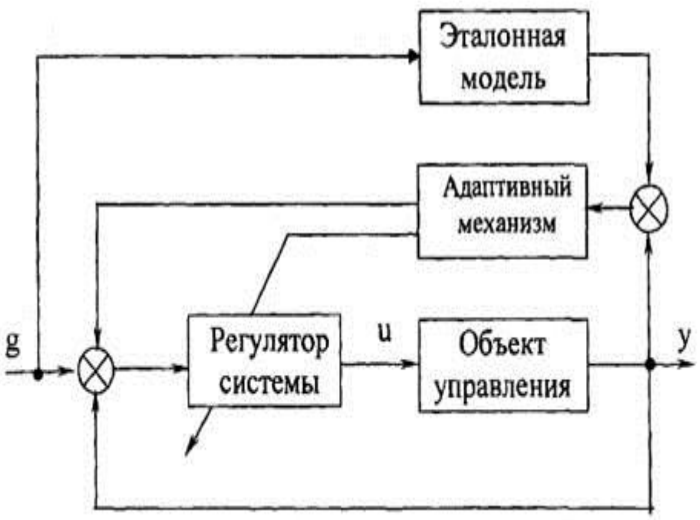

Figure: 4. Adaptive system with parallel reference model.

However, the issue of the stability of adaptive processes has not been fully

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investigated. In addition, when developing adaptive systems with a reference model, the problem of choosing a reference model arises. It is very important that in these systems, in comparison with ASNM, tuning is carried out without prior identification. The measure of the "closeness" of the movement of the system to the reference model is also estimated by the corresponding KF, minimized during adaptation by adjusting the parameters of the controller (parametric adaptation) or by introducing an additional adaptive signal (signal adaptation). Thus, many developments of adaptive systems can be combined into the structure of an adaptive system with a reference model (ASEM) [6], shown in Fig. five.

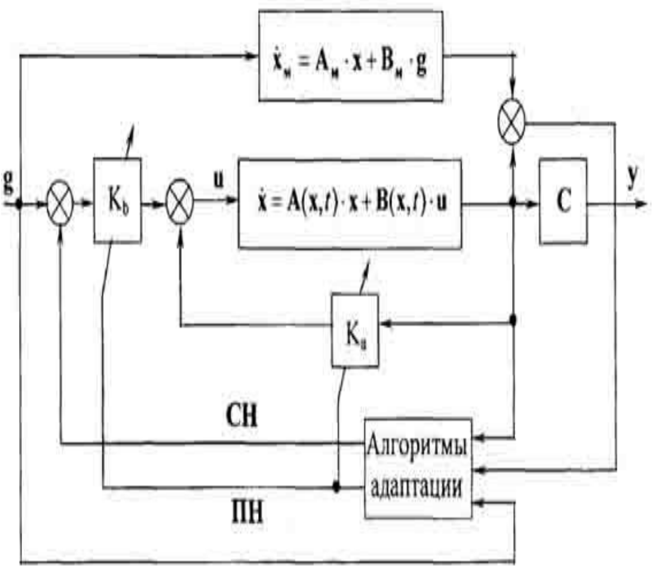

Figure: 5. Block diagram of ASEM with PN and SN.

Adaptive systems differ in the type of adaptation. There are search and searchless types of adaptation [2, 4]. Since the calculation of the change in the KF value, as a rule, is difficult, such a task is facilitated by the introduction of search movements, on which the KF increment is estimated. It is obvious that in search adaptation time is required to estimate the current value of the KF, which it would be desirable to reduce to a minimum. This requirement is met by non-search adaptation, in which the calculation of the current KF is carried out directly, namely, the introduction of a reference (tunable) model gives real time the possibility of the current assessment of the KF of adaptive processes. The performance of ASEM and ASNM is based on the following obvious assumptions [5].

Ideal case:

1) ОУ - linear;
2) Reference model - linear and stationary system (for ASEM);
3) Model and system (object) of the same order;
4) On the adaptation interval, the parameters change only under the influence of the adaptive mechanism (quasi-stationary condition);
5) There is such a number of adjustable parameters of the controller (model), according to which the adaptive control is closed;
6) From external signals only input control signals act on the adaptive system;
7) The initial values of the tuned parameters before the moment of functioning of the adaptive system are unknown;
8) The state vector of the system (object) is measurable for all components.

Real life situations correspond to the general case where the assumptions for the ideal case either fail or are violated.

General case:

1) The reference model is a non-linear and non-stationary system;
2) The tunable (identifying) system contains nonlinearities;
3) The orders of the model and the object do not match;
4) The adaptive system can be open for all adjustable parameters;
5) During adaptation, the parameters of the object change (the condition of quasi-stationarity is not met);
6) External disturbances act in the system;

7) Measurements of the components of the state vector of the object are made with additive noise.

The assumptions for the general case, however, can differ for ASEM and ASNM, in contrast to the ideal case: for example. The reference model is chosen of a smaller order than the object. The assumption on the fourth point for the general case applies practically only to ASEM. Based on the analysis of available adaptive systems, it is possible to single out the structures of adaptive control systems that are most suitable for constructing adaptive control systems for technological objects with delay, as well as to single out the principle of adaptation that is effective in terms of the rate of flow of adaptive processes.

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