Abstract

The problems of control systems intellectualization are observed. The necessity of intellectualization of a wide range of systems and control methods is grounded. The hierarchy of intellectual control levels is observed and different artificial intelligence means are comparatively analyzed.

Keywords: intellectualization; intellectual control levels; fuzzy logic.

Introduction

Artificial intelligence (AI) as a field of research and development emerged and developed in parallel with the development of the theory of automatic control, starting around 50-th years, with the first major applications in computing and information science, and later in automatic control. The first commercial and industrial applications of AI belong to the 80-th years of the last century. During this period, AI has reached some level of stability and maturity.

An important factor that can lead to a rethinking of today's achievements and make new ups of the theory and practice of AI is the sharp increase in possibilities of computer technology, including hardware implementation of logical and other means of AI.

The term "intellectual control system" refers to any combination of hardware and software, which is joined by general information process, operating autonomously or in man-machine mode, and capable to synthesize the control goal and to find rational ways to achieve the control goal (in the presence of motivation and knowledge

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including information about the environment and its internal status)\textsuperscript{1,3}. Today the capacity to synthesize the control goal is realised by human-machine interaction, and the autonomous control systems capable only to find rational ways to achieve the control goal are called as "intelligent control systems".

Currently, the science and practice of control retains a keen interest in the integration of classical methods of automatic control with methods of AI and in AI applications in the field of control for complex weakly-formalized objects and processes. In particular, when the information, system status, control criteria, and control goals change over time and are fuzzy and sometimes contradictory.

The report considers a hierarchy of levels of intellectual control and a comparative analysis of different means of AI. Due to the fact that the past decade has seen a rapid increase in the number of theoretical and applied research in the field of fuzzy controllers, the main focus of the report is to review the major achievements in this area. Though, unfortunately, even this field doesn't allow to make a complete review free from the authors' predilections.

1. General problems of control systems intellectualization

The successful solving of the problems to ensure the technological independence of the state in the field of civil and military purpose complex technical objects development and application significantly depends on the effectiveness of control systems and technologies being developed. Adequate theory and control technologies are necessary, taking into account possible deficiency of certain (depending on application) required resources: information, timing, energy, financial, material, personnel, etc.

Known accidents and disasters in transport, industry, energy etc., are often associated with the so-called "human factor" (HF), including the overwork of operators. HF often occurs as a result of quality problems with design of control system, in particular as emergency situations in controllability. Human errors, as well as the exhaustion of the technical resource of objects and control systems are common for present Russian circumstances. They urgently require guaranteed reliability and quality of control, including upgrades of project, operational and modernization control capacities.

One needs methods and technologies for evaluation of control systems and to ensure their optimality, functional and operational reliability, efficiency, fault tolerance and survivability are necessary under the following conditions:

- lack of a priori information about the control object and external environment of its functioning, including in opposition conditions;
- A big number of unstationarity factors to be difficult to take into account and their subjective character;
- degradation (from failures, accidents) or necessity of targeted reconfiguration (revitalizing or developmental control).

With expansion of the functional loading the control systems substantially become complicated. Among the numbers of complexity factors of modern and advanced control systems appear:

- multilevel controls, heterogeneity of description of subsystems by quantitative and qualitative models, different scales of processes in space and time, multimodality, multilink, decentralization and ramified nature and general structural complexity of modern control systems and their control objects,
- presence of uncontrolled coordinate-parametrical, structural, regular and singular impacts, including active counteraction in a conflict environment,
- the use of the determininistic and probabilistic models for description of uncertainties of information about the vector of the state and parameters of the system, about properties of errors of measuring and environment,
- non-linearity, distributed parameters, delay in control or object dynamics and impulsive impacts, high dimension of models and others.

The large-sized structure of control science and technologies is presented in Fig.1.
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