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INTELLIGENCE MEASURING SYSTEMS OF FUNCTIONAL STEADY CONTROL IN THE FUTURE, APPLICATION AND TIMELINESS

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Анотація

Метою даної роботи є визначення актуальності й необхідності проведення досліджень у напрямку розробки комплексних системних заходів, які б гарантували цілісність об'єкта контролю і його функціональну стійкість до можливих порушень працездатності. Аналіз основних наукових напрямків, що розвиваються в цій області, визначення доцільності подальшого розвитку теоретичних основ узагальнених діагностичних спостерігачів як джерел формування інформаційних вимірювальних сигналів, що характеризують стан складних динамічних систем з урахуванням їх інваріантності до виникаючих дестабілізуючих факторів.

Ключові слова: Динамічна система, функціонально-стійке керування, діагностичний спостерігач, інформаційно-вимірювальні сигнали.

Abstract

The purpose of the submitted paper is definition of the main directions in research and development of a system measure complex which would guarantee integrity of a subject control and its functional resistance to possible loss of function, studying of the main scientific directions developing in this area. Possibilities of further development of the diagnostic observer's theoretical bases as form sources of the complex dynamic system information signals characterizing states taking into account their invariance to the arising destabilizing factors.

Keywords: Dynamic system, functional and steady control, diagnostic observer, information measuring signals.

Introduction

At the end of last century, the leading industrial powers, first of all the USA and USSR which politically and economically competed among themselves, at implementation of large-scale engineering designs to be confronted by a problem of ensuring due level of reliability and guaranteeing global safety. As a rule it concerned such priority fields of the industry as aerospace, defense, nuclear and power, oil and gas processing, metallurgical, and chemical and technology, transportations, etc. [1, 2]. Characteristic feature of independent technical means and systems, the specified group, their high cost, availability of extreme service conditions and potential danger of application is.

The key part of the problem consisted that the traditional methods of reliability assurance based on repeated hardware reservation, introduction of the built-in control systems, use of reserve elements provide to performance degradation in technical and economic indicators of projected systems and didn't give the expected effect for that simple reason that became malfunction sources and refusals under certain conditions. Thus, the concept of additional redundancy introduction at the physical control layer became a restraining factor on the way of highly reliable technical means creation and somewhat even deadlock under certain conditions. At the same time the attention of many researchers was drawn to the fact that evolution in wildlife at rather low level of physical reservation (as a rule no more than two) managed to create due to integration of information and functional redundancy, impressively durable forms of live organisms at the relevant organization. Further researches in this area led to the fact that the emergency conditions of technical systems caused by the various destabilizing factors, including malfunctions, failures or refusals began to be considered as admissible. In these conditions there was necessary forming of the properly control influence directed to compensation of malfunction effects to the purpose of trial functions maintenance for the main task performance of the technical system determined by its assignment [3]. Such type of control began to call functionally steady control. It had to be carried out due to redistribution of internal system resources for the solution of the main task even in the conditions of possible malfunctions and refusals.

Results and discussion

The main materials for achievement of a goal is the analysis of the foreign scientific sources, reports and publications made at special sessions, authoritative international conferences of the last decades regarding determination of relevance and prospects of the chosen scientific direction. In this respect the regular sessions of the safety industrial process congresses IFAC SAFE PROCESS which are carried out every three years are indicative: Munich (1987), Tallinn (1990), Sydney (1993), San Francisco (1996), Beijing (1999, 2006), an extraordinary session in Budapest ((2000), Barcelona (2009), Mexico City (2012), Paris (2015), Toulouse (2017). Besides, in this sphere growth of activity and at other, not less important conferences, such as IEEE (Conference on Decision and Control), ACC (American Conference Control) and neural networks conferences, rough sets and artificial intelligence is observed also.

Redistribution of difficult system dynamic complexes internal resources for the purpose of functioning and reliability, assumes a little other than traditional their organizational structure. In traditional automatic systems resources (information, power, computing) are usually rigidly assigned to separate nodes, channels, subsystems that excludes their redistribution and limits possibilities of forming of functionally steady control.

Creation of a uniform information complex capable to analyze base characteristics of separate subsystems in the conditions of possible malfunctions, failures, refusals and other destabilizing factors could become a technology on the basis of all channel integration, nodes and subsystems and also to redistribute cash resources. According to the theorem of division which mathematically is strictly proved only for linear systems, optimum functionally steady control is synthesized in two stages [4]:

- at the first stage optimum assessment of a dynamic system condition taking into account possible malfunctions, perturbations, errors of modeling and measuring noise by means of special devices, so-called diagnostic observers forms;

- at the second stage on the basis of the derived condition system estimate the optimum determined control which creates the special control influence parrying influence of the arisen malfunctions is synthesized. Considering the principle of divisibility, both phases can be completed independently of each other, and for each of stages there is the relevant theoretical base.

Following this concept, the problem of further improvement of already present-day generalized diagnostic observers and development of new theoretical provisions in this direction is put in the forefront. A basis of this statement is the following assumptions [4, 5]:

1. Diagnostic observers are intended for real-time processing.

2. The control system of a dynamic node condition is called the functional diagnostic system. The typical procedure of diagnostics consists of three consistently carried out parts: failure detection, means adoption of the binary decision; localization of fault, means determination of its location (sensor or a managing subsystem, etc.), identification of fault, and means definition of its type;

3. In the majority of practical applications, traditional approach to diagnostics of malfunctions which basis the concept of hardware redundancy is used. Due to availability of contradictions between reliability and cost of the added large number of the same equipment, use of joint measurements of different physical quantities is considered more expedient for the purpose of cross check of each other. Thus we come to a concept of analytical (functional) redundancy;

4. In the systems of functional diagnostics based on the concept of analytical redundancy the check on consistency of data, usually, is carried out by comparison of values of the measured signal and its assessment. Assessment of a signal forms mathematical model of the considered system. Its called model oriented in this case.

5. Lack of additional equipment need installation there is the main advantage of the model oriented concept. Sufficient capacity of the control computer system and the increased memory size is the thing what is required in this case only. Impressive progress in information - computer technologies area allows to implement the specified concept in practice.

Conclusions

Already more than a quarter of the century basic researches on problems of functional resistance to possible losses of dynamic systems operability are in the center of attention both in the academic environment, and in the industry. During this time very separate researches were created in the individual scientific direction which was generally recognized, the new philosophy and methodology arose. This direction develops

thanks to an ever-increasing request of society for highly reliable, in functional sense, the technical systems meeting modern requirements for safety of their operation including ecological. First of all it belongs to objects of nuclear power, the space, petrochemical and gas industry, application of floating platforms at oil and gas production from a bottom of the sea shelf. Critical situation develops also in the system of aircraft safety. For the purpose of prevention of expensive equipment damage, reduction of huge costs of production and prevention of catastrophic effects and accidents of type Chernobyl and Fukushima many private companies and the governments of industrialized countries generously finance scientific research in this direction.

Fundamental difference of method synthesis of intelligence measuring systems of functional steady control is the fact that they are directed not to reduction of amount of malfunctions and refusals in separate subsystems of a controlled object as traditional methods of reliability assurance, survivability, fault tolerance, etc., and on ensuring performance of the main important functions when incidents of system availability was already happened.

REFERENCES

1. Kuchma L. D. Ukrayna – ne Rossyia. M.: Vremia, 2004 h. 558 s.
2. J. Watton. Modelling, Monitoring and Diagnostic Techniques for Fluid Power Systems. Springer, 2007 360 p.
3. Kulik A.S. Kontseptsiya aktivnoi otkazoustoichivosti sputnikovykh sistem orientatsii i stabilizatsii. Radioelektronika i komp'yuterni sistemi. 2009, #2(36) s. 101–108.
4. R. Isermann and P. Balle, “Trends in the application of model-based fault detection and diagnosis of technical processes,” Control Engg. Practice, vol. 5, pp. 709–719, 1997.
5. I. Izadi, S. L. Shah, D. S. Shook, and T. Chen, “An introduction to alarm analysis and design,” in Proc. of IFAC SafeProcess’09, (Barcelona, Spain), June 30- July 3, 2009.

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