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Tasks and Principles of Complex Objects Coordination Resources Control

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Abstract

It is noted in the work that for complex objects control there is required the efficient use of control systems resources: computational, informational, monitoring. In that connection there is given resources control task formulation in the form of optimization problem. The given problem is named as the coordination task and there is offered the methodology of its solution. It implements the problem solution based on assumed model reflecting the states and interrelations of factors in the control problem environment.

Keywords: Complex objects, resources control, cordination, optimization problems;

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1. Introduction

Problem of coordination, hereinafter referred to as a C-problem. Let set initial prerequisites for setting and statement of the problem.

Coordination process is possible to be initiated provided there are known:

control process state in the current and preceding time points (t_n, t_{n+1});

control system (CS) monitoring resources states at current time point;

operating control problem solution states (O-control) of cycle control (CC).

Let denote control system resources and their characteristics as:

$PY = \{PY_i : i = \overline{1,n}\}$,

Let control resources at the current time point to be:

$PY_{tek} = \{PY_{teki} : i = \overline{1,n}\}$,

Thereupon based on performance of current C-state $Sor(t)$ and on the basis of resources coordination (C-resources) PY_{tek} shall take such a coordinating solution (C-solution) UR_i out of possible multiplicity UR which obey

$F(W_y(N_н) - W_y(N_{tek})) \rightarrow min$,

and at that meet the conditions and requirements to introduce C-processes

$Wo(UR_i) \rightarrow max$,

where $W_y(N_н)$- predicted values of control quality indices reached upon initial malfunction of cycle control;

$W_y(N_{tek})$- magnitude of quality control indicators subsequent to current malfunction occurrence (pathology) reaching of which is provided with accepted C-solution UR_i; $Wo(.)$- criteria of C-control.

Indicators $Wo(.)$ consist of a partially indicators series

$Wo = (W_i : i = \overline{1,m})$,

where the partially criteria are: W_1- maximum fast operation (minimum time consumption for C-processes); W_2- minimum computing operations outlay, i.e. minimum processor time consumption, etc;

The core of the given problem comes to reducing the losses due to half-integral malfunctions occurrence to minimum and to restore the control quality to its level at initial malfunction. C-processes problem solution at O-control is not an end in itself it is the auxiliary task, i.e. its successful solution promotes and brings to successful solving the task of CC operational control.

Basic features and principles of solving the problem of coordinating the resources of complex task control problem solving. Coordination task solving can be implemented similarly as the cycle control task solution. The whole coordination process can be represented as the succession of coordination cycles, i.e. within the cycle control duration

$$PC = \{CC_i : i = \overline{1,n}\},$$

where CC_i - coordination cycle.

Therefore its solving can be performed with the method consisting of

$MC = (MCSR, MCPS)$,

where MCSR- method of coordination state representation;

MCPS- method of coordination problem solving.

Proceeding from the results of conducted analysis of malfunction and pathological processes as well conditions and requirements of formulation of above mentioned coordination problem arise the provisions the methods and means of the posed problem solution shall be based on. Out of them the principal, important points for successful diagnosing problem solving at the conceptual level are:

Necessity in C-control (in solving the C-task) appears solely at the moment when during cycle control there occurs such a change of operational control initial state which results in adequacy of decision making process continuation as per initial state (i.e. there occurs C-situation). Therefore it is clear that C-process shall start from control medium state comparison process (and/or C-state) in two instants of time. Therefore the model of state for the states differentiation is necessary from the point of view of C-decisions making.

C-control processes organization (or C-problem solving) shall be performed based on the assumed model reflecting the states and interrelations of factors in C-control problem medium. The given model shall define following factors:

I. Cycle control multiplicity and spectral composition. Cycle control multiplicity and spectral composition consist of:

the scale of malfunction and pathologic processes measurement;

ratio of parameters $\delta t_{цу}$ and $(\delta\delta t \bigcup \delta\delta\delta t)$ among which there is monitoring and selected repetition period of cycle control $\delta t_{цу}$.

Therefore dependent on $\delta t_{цу}$ and on ratio the C-control model defines the multiplicity of coordination process malfunction: 0-multiple, 1-multiple, 2-multiple, etc.

II. Control cycle duration has the lower boundary which shall not go into though the hardware and software capacity allow it. The reason is that upon implementation of control decisions U stimulus controlling agents shall be kept through time proceeding from operational control response rate. Exceptions are represented with control decisions complying with emergency situations. It shows that if for phases of cycle control CC, DG diagnosing and RCT (resource control time) there is spent 0 time, i.e. $\delta T_1 = 0$, $\delta T_2 = 0$, then $\delta T_3 > 0$, where $\delta T_1, \delta T_2, \delta T_3$ - length of phases of CC: DG, RCT, DCR (decision control of a resource) performance. Besides δT_3 for various malfunction groups is different, i.e. $\delta T_{3j} \neq \delta T_{3i}$.

Therefore for every malfunction group (for instance, BN_h) there exists the lower boundary of cycle control duration (i.e. for B_h conforms δT).

III. Amount of $N_в$ occurred at the stage of O-control can be traced to a definite number M.

Possible $N_в$ amount tracing to one is reached in the following way.

Quantity and variety of N development depends on following factors:

- scale of pathologies and malfunctions measurement;
- spectral characteristics of DTO (difficult technical objects) malfunction;
- CO (cycle operative control) repetition period upon O-control.

It first and foremost depends on spectral characteristics of DTO malfunction and secondly on CO repetition period selection within cycle control (or O-control). Reducing the repetition period to zero is not reasonable even it is allowed with hardware-software means. Its magnitudes shall have definite lower limits. It is connected with inertia development of C-environment (DTO state).

The given reduction version is implemented as follows:

Phase differences are reduced to two. It is from the point of view of coordinating decisions structure. From the angle of states weight comparison in time points $t_{н}$ and t_{i} the account is conducted at procedural level of decision making.

1. In control and coordination cycles there various targets are aimed to. Therefore levels of C-problem representation and solution shall be different.
2. Upon O-control the cycle is the principal one and its performance shall not be delayed in time. Therefore C-problem shall be solved simultaneously with cycle control under the conditions of the principal processes performance - cycle control processes as the second process (computational). That is C-processes shall be performed simultaneously with cycle control processes.

Parallelism of C-process performance is maintained in different ways dependent on realization of machine model.

There exists a large number of various computing machines architecture. Dependent on the selected model the machine-realization systems have different organizational structure. In particular such as SISD, MISD, SIMD, MIMD.

More detailed organizational structure exposure is given further on.

For theoretical development it is assumed that processes complete parallelism has been provided. That is there is no limitation of memory, processor, etc., global resources. Resources limitation is taken into account upon specializing or reducing the coordination processes.

IV. Monitoring decisions of cycle control are formed and realized distended in time, stage-wise. Therefore there is required timely revealing and eliminating the variations in the cycle control results that is it is necessary to correct them within the formation and execution of control decisions.

In other words in the process of formation it is necessary to correct the decision formation process results dependent on the current situation change. (It can be implemented through regular repetition of C-solutions taking and performance (which in whole promote C-decisions aims attainment and of O-control in whole).

Cycle control processes timely correction that is complete C-control problem decision is maintained through C-control problem solution at every time point throughout cycle control or O-control.

But C-control problem solution in such version on the base of modern control of scientific-technical progress and computing machines capacity is impossible. Though for approximation to such problem solution variant it is necessary to perform following conditions: C-control process shall commence simultaneously with cycle control processes at initial cycle control malfunction and complete only when the aim of O- control is reached. Complete organization process shall consist of cycled sites of C-solutions taking and performing, that is C-solutions taking and performing along the whole interval of cycle control shall be repeated with a definite interval.

Thus the whole coordination process (or organization) of O- control consists of separate sites-cycles of decision making and implementing, i.e.

$$PO = < OASC_i : i = 1, n >,$$

where $PO = < OASC_i : i = 1, n >$, - coordination or organization cycle (or cycle of C-solution adoption and performance). Number of $OASC_i$ repetitions is situational and depends on O- control success.

Repetition period (δt_3) depends on a number of factors of O- control problem solution.

At that δt_3 shall be minimal as possible, on the other hand the following shall be accounted.

Duration of cycle control has the lower boundary which shall not go into though hardware/software capacity allows it. The reason is that upon realization of U controlling decisions their impact shall be kept in time proceeding from O- control inertia, except the controlling decisions conforming to emergency situations. It shows that for CC, DG and RCT phases the consumption time is 0, i.e. $\delta T_1 = 0$, $\delta T_2 = 0$, but $\delta T_3 > 0$, where $\delta T_1, \delta T_2, \delta T_3$ - is performance duration of CC, DG, RCT, DCR phases. At that δT_3 for various groups of malfunctions is different, i.e. $\delta T_{3j} \neq \delta T_{3i}$.

Therefore for every group of malfunctions (for instance, BN_h) there exists the lower cycle duration boundary (i.e. to B_h conforms δT).

V. In order to ensure control processes organization quality the coordination processes shall be adapted to peculiarities of control cycle processes. It can be reached through C- control introduction at various GM control cycles into different GM-coordination which ensures the maximum performance of coordination quality requirements.

Subsequent organization quality requirements assurance can be reached through rational use of time intervals along the cycle control or O- control interval. In particular it is attained through correct selection of C-problem solution cycle repetition period (δt) and of duration (length) of the given problem solution time at different phases of cycle control. It is necessary to ensure C-solutions adoption and performance between the repetition periods of C-process.

These principles are the basis for coordination methods and coordination problems solution. Therefore, development of computational algorithms and software of coordination system requires the new principles which will be given in the corresponding stages of development.

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