FEATURES OF PROVISION OF FUNCTIONAL STABILITY OF AIRCRAFT ONBOARD EQUIPMENT COMPLEX

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Abstract. The authors have presented the features of the formation and maintenance of the functional stability properties of aircraft onboard equipment complex under the influence of destabilizing factors.

Let's consider the complex of onboard equipment of the aircraft as a distributed intelligent system of the form:

$$G(V,L), V = \{ v_i \}, L = \{ l_{ij} \}, \; i, j = 1,2, \ldots, n, \qquad (1)$$

where the set of vertices V of the graph $G(V,L)$ corresponds to the set of information (intelligent) modules of the complex of on-board equipment with dimension n, the set of edges L corresponds to the set of connections l_{ij} between information modules (i, j).

We present a graph of the model of the onboard equipment complex in the form of an adjacency matrix [1]:

$$A = \{ a_{ij} \}, \quad i, j = 1,2, \ldots, N, \qquad (2)$$

where a_{ij} – elements of the adjacency matrix of the diagnostic graph, which have a value of 1, if there is an edge:

$$l_{ij} = \{ v_i, v_j \}, \in L, \qquad (3)$$

and 0 – if the edge does not exist; v_i, v_j – modules of the distributed system of the onboard equipment complex, connected by information communication lines l_{ij}.

The space of parameters P of the onboard equipment complex is represented as $\langle V, L, F \rangle$, where the set of vertices V of the graph $G(V, L)$ corresponds to the set of information (intelligent) modules of the on-board equipment complex, the set of edges L corresponds to the set of connections l_{ij} between information modules (i, j), F – the set of functions of information (intelligent) modules of the onboard equipment complex and connections between them.

We will assume that the functioning of the on-board equipment complex is determined by a set of parameters $p\langle v, l, f\rangle$, where the subset $v \subseteq V$, $|v| \le |V|$, the subset $l \subseteq L$, $|l| \le |L|$, and the subset $f \subseteq F$, $|f| \le |F|$. Accordingly, the parameter $p\langle v, l, f\rangle$ – is an element of the set of parameter spaces $P\langle V, L, F\rangle$. The change in the internal state of the on-board equipment complex over time $w(t, p)$ depends on p. Thus, $t \in T$, where T – a time interval of functioning of aircraft onboard equipment.

The strategy for implementing the principles of functional stability of the onboard equipment complex is as follows. At the construction stage, the provision of functional stability is carried out by introducing structural, hardware, software and time redundancy. For this purpose, the optimal (according to the criterion of maximum of functional stability) structure of the aircraft on-board equipment complex, characterized by structural and hardware redundancy, is determined. The main failures and errors in the operation of the onboard equipment complex are parried by software. To do this, software and temporal redundancy are introduced into the software to control, diagnose and decrypt diagnostic information. Then for the functional stability of the on-board equipment complex, as the property of a complex system will be fair:

$$\forall\, v \subseteq V\ \exists\, v_{max},\ v_{min},\ \Delta v \neq \varnothing,$$

$$\forall\, l \subseteq L\ \exists\, l_{max},\ l_{min},\ \Delta l \neq \varnothing,$$

$$\forall\, f \subseteq F\ \exists\, f_{max},\ f_{min},\ \Delta f \neq \varnothing,$$

where

$$v = v_{max} \cup v_{min},\ \Delta v = v_{max} \cap v_{min},$$

$$l = l_{max} \cup l_{min},\ \Delta l = l_{max} \cap l_{min},$$

$$f = f_{max} \cup f_{min},\ \Delta f = f_{max} \cap f_{min},$$

where v_{max}, , l_{max} , f_{max} – maximum subsets in terms of capacities, respectively, of elements, lines of communication, functions of elements of the

aircraft on-board equipment complex, for which the conditions are fair: $|v_{max}| = |V|$, $|l_{max}| = |L|$, $|f_{max}| = |F|$,

v_{min}, l_{min}, f_{min} – minimum subsets in terms of capacities, respectively, of elements, lines of communication, functions of elements of the aircraft on-board equipment complex, for which the conditions are fair: $|v_{min}| < |V|$, $|l_{min}| < |L|$, $|f_{min}| < |F|$,

$\Delta v, \Delta l, \Delta f$ – formal description of redundancies, respectively, of elements, lines of communication, functions of elements of the aircraft on-board equipment complex.

Provision of the functional stability of the on-board equipment complex includes stages of self-diagnosis, failure prediction by verification of the distributed knowledge base, failure parrying, restoration of the structure of the on-board equipment complex without significant restructuring of verification means [2, 3, 4].

But to provide the functional stability of the on-board equipment complex, it is necessary to take into account the rapid parrying of failures, or the resumption of work in a minimum of time. Therefore, the functional stability of the on-board equipment complex describes a family of probabilities of many probable indicators that ensure operation under the influence of disturbance, perhaps with some estimates of characteristics, but the ability to resume work in a given minimum time:

$$P(F_{avionics\tau}) = P\left\{ F_{avionics\tau}\left[w(t, \langle v, l, f \rangle), t \le \tau \right] \in G_{A_1}^{\tau} \right\}, \quad (4)$$

where $P(F_{avionics\ \tau})$ – the set of probabilistic indicators of functional stability;

$w(t, \langle v, l, f \rangle)$ – the internal state of the system, which is an element of the phase space P;

p – a parameter that determines the duration of the effects of destabilizing factors and the moments of their effects;

v – the set of elements of the system model;

l – the set of model connections;

f – the set of functions of elements and connections of the system;

A – the set of system model resources $a = \langle v, l, f \rangle$;

$G_{A_1}^{\tau}$ – the set of values of all functions of the complex of onboard equipment for the model of its operation under the influence of destabilizing factors over time τ.

In this case, the functional stability of the aircraft on-board equipment complex is provided using the principle of synergistic regenerative control in some minimum of time.

References

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