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Parallel virtual circuits for the integrated power plant control systems with onboard digital computing machine

Considered the methods of distributed simulation of power plant system with onboard computing machine, which allow to reduce the machine time in the study of probabilistic characteristics of large-scale system. The proposed method of modeling allows to use the park of computers in the construction of integrated power plant system.

Introduction. For control algorithms of aviation power plant (PP) (tasks of gas generator, inlet device and jet nozzle control; tasks of optimization of operating modes taking into account the purpose and state of flight of the aircraft) it is expedient to use onboard digital computing machine (OnBDCM).

Possible schemes for the inclusion of OnBDCM in the control system of the power plant are presented in fig. 1.

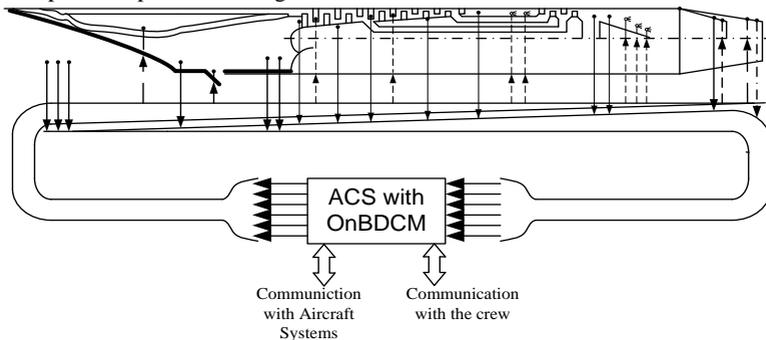


Fig. 1. Scheme of inclusion of OnBDCM in ACS PP.

The main technical characteristics of OnBDCM are: command system; computing speed (average number of operations performed by the machine per second); bit numbers, commands and storage device; memory capacity; the computing speed of the input and output device; requirements for operational reliability; supply voltage range; power consumption, dimensions, weight and operating conditions.

Also, for automatic control system (ACS) with OnBDCM can be find features: it is necessary to convert signals generated by sensors; the execution of any algorithm occurs by its repeated repetition at change of only input data; it is necessary to solve problems in real time.

Depending on the specific control loop, the frequency of the solution is from 20 to 100 Hz.

Possible frequency of operations for digital ACS PP: input-output is 8 percent; addition is 35 percent; multiplication is 12 percent; division is 2 percent; transfer of control is 10 percent; shipments are 16 percent; other operations are 17 percent [1,2].

Creation of electronic ACS gas turbine engine (GTE) with full responsibility and rigid operating conditions impose additional requirements to a design and element base of OnBDCM.

Therefore, to increase the productivity and reliability of OnBDCM it is necessary to use multiprocessor systems with parallel information processing

Parallel virtual circuits. The system of parallel (distributed) modeling of ACS GTE includes three subsystems: subsystem of preparation of computing process, subsystem of distributed modeling and subsystem of analysis of results of modeling.

The training subsystem performs the transformation of the program of a sequential simulation model into a parallel design in accordance with the algorithms of technological stages [1-4].

The distributed simulation subsystem executes the software modules of the simulation model blocks, which are placed on different processors, in a single model time in accordance with the selected synchronization algorithm. The software module of the unit is a sequential simulation model. Interaction of processes is realized by means of the mechanism between processor communications: IPX sockets, TCP sockets.

The subsystem of analysis of simulation results is a standard algorithm of methods for processing and interpretation of simulation results.

For describing the simulation model of the ACS GTE and the virtual channel, the algorithm for processing the states of the processing modules is determined: MESSIN, MNPBEG, MNPEND, MCTBEG, MCTEND [2,4].

The processing module MNPBEG simulates the beginning of message processing on the switching-processing nodes.

In the prologue phase, the network node is identified, which must start processing the message, which occupies the first place in the input buffer drive (IBD) of the node T_0 .

When simulating the start of processing, the duration of message processing on the node is determined, the state of the node is set to 1 and the timer of the node (T_1) is adjusted. If the end time of message processing by the node is less than the moment of occurrence of the third special state (P_1), the system timer of the third state (T_2) is corrected. Otherwise, there is a transition to the epilogue phase, where after the simulation of the beginning of message processing on the node, the system timer of the second state (T_3) is adjusted. The scheme of operation of the node is presented in fig. 2.

The MNPEND processing module simulates the end of message processing on network nodes.

In the prologue phase, the node and the message are identified, and the address in the message array for which the message is registered (T_0) is determined.

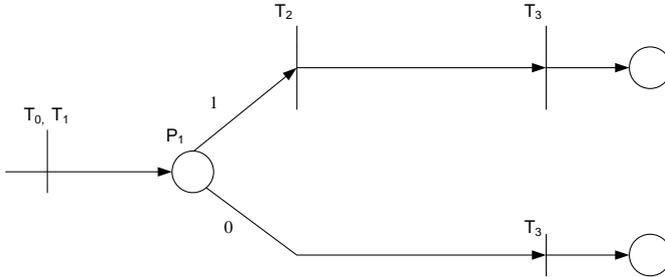


Fig. 2. The scheme of operation of the module MNPBEG.

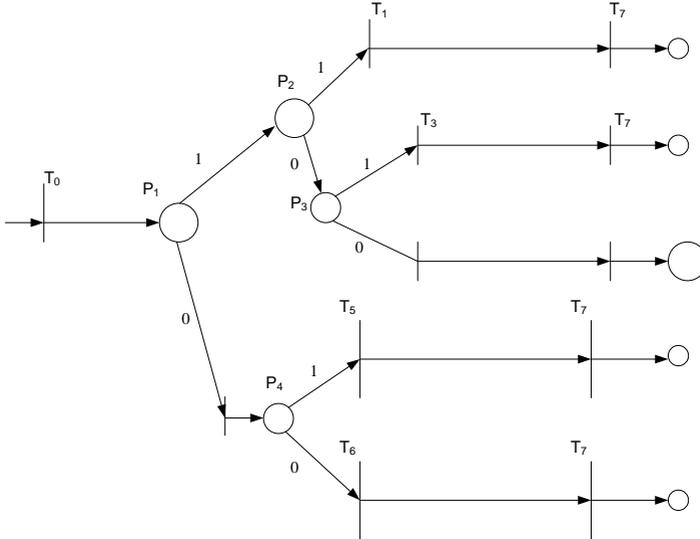


Fig. 3. The scheme of operation of the module MNPEND.

Simulation of the end of service on the node is determined by:

- for the message defined by this node (P_1), it is determined whether the message belongs to the investigated stream (P_2), under the conditions the collection of information about the time of delivery of the message is determined, the message is deleted from the network (T_1);

- if the message does not belong to the studied stream, it is determined the possibility of deleting it from the node (P_3), if so, the message is deleted from the node from the network (T_3), otherwise the timer of the latter is delayed and corrected (T_4).

- for transit messages, the output channel (T_2) is determined, and if the buffer drive of the channel (BDCh) is filled (P_4), the message remains in the IBD and the node timer (T_5) is adjusted. Otherwise, the message is transcribed from the

IBD to the BDCh and the timer of the system time of the fourth state, ie the beginning of the transmission on the channel (T_6) is corrected.

In the epilogue phase, the value of the third state (T_7) is formed - the system timer of the end of message processing. The scheme of operation of the MNPEND module is presented in fig. 3

Conclusion. Improvement of ACS PP engines will allow to create methods of management of GTE, which carry out adaptation of management of PP to operating conditions, integration of management of working process in the engine and flight modes, compensation of failures in the engine and ACS

Construction of digital electronic systems of distributed structure for ACS GTE using SMART-subsystems (intelligent sensors and actuators) will significantly increase reliability, reduce equipment weight by 30-40 percent, improve control quality, and, consequently, improve engine performance, reduce costs for production and operation. The basis for the creation of intelligent distributed systems is the use of high-temperature electronic element base, primarily radio sensors of engine parameters with built-in transceivers with low power consumption and special power sources. The sensors must contain one or more sensing elements, a controller and a network interface and can perform digital interference filtering, active signal correction when changing external conditions, calculation of derivatives, spectral evaluation of signals, self-monitoring. The error of measurements of engine parameters should not exceed 0.1-0.2 percent of the upper limit of measurement.

The simulation model of virtual channels of ACS GTE is characterized by a high ratio of system and processor time, which makes it possible to solve design problems related to the study of direct areas of information exchange.

To implement the computational process of distributed modeling, it is proposed to use the interface of sockets of processing modules. Sockets provide full access to LAN capabilities, directly causing interrupts. According to the research results, network interactions at the level of IPX and TCP sockets can be used as communication software for distributed ACS of aviation engines.

References

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