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G. KRIVOULYA[1], M. LAPTEV[1], WAJEB GHARIBI[2]

[1]Kharkov National University of Radio Electronics, Ukraine
[2]College of Computer Science, King Khalid University, Kingdom of Saudi Arabia

THE DIAGNOSTIC MODEL OF COMPUTER SYSTEM IN THE FORM OF PETRI NET

The construction of structural computer system model in the form of automatic, limited Petri Net are considered in the article. Proposed model can be used for building diagnosability provision of the computer system.

diagnostic model, computer system, reliability, maintainability, durability, failure, correct state, faulty state, operable state

Introduction

Increasing quantity and complexity of current computer systems (CS) usability leads to necessity of it quality service. Modern computer engineering decides this problem by creating the diagnostic systems and automatic searching for the faults. With usage of them service and repair becomes simpler (1). For modeling the automation diagnostic system of CS necessary to have structure model of CS (2), which permit to define CS transitions from one state to another having different combination of input signals. In this work the structural model of CS in the form of automatic, limited Petri Nets (PN) are proposed.

The diagnostic model of computer system in the form of Petri Net

It is possible to model wide class of the systems with the help of the PN. The most convenient PN for modeling systems in which parallel cooperative processes took place. However modeling defines only correct operation of the system but at the necessity to analyse diagnostiable there is a need to make analysis of the modeling system which permit more deeper understood behavior of the system if the fault presence.

Therefore for more detail exploring properties of the diagnostic model expediently to have given model in the PN view. In this way well-handled usage automatic, limited PN.

In the work [3] the limited PN are proposed. They can be used in the real-time expert systems with the binary logic when the activity of any of the system component either influences on its state or not. The local structure of output procedure can be represented as the controlled system with the binary logic in the heterogeneous expert system.

To describe the limited PN the following determinations are used.

1. The system *A* is called the controlled system with the binary logic if it is the set of components with $P=\{p_i\}, i=\overline{1,n}$ various characteristics; each of the components can be in one of the two states: it can be active or not. The set of transition functions from one state to the other is determined on the set $P=\{p_i\}, i=\overline{1,n}$ of components. Each of these functions depends on the number of active components and some system event (internal or external). If there are functions which depend on the interactive input action, the system *A* is called the interactive controlled system with the binary logic.

2. Component p_i, ingoing into system *A* is called active at some point of time *t* if is has an essential influence on the system reaction. Component p_i, ingoing into system *A* is called inactive at some point of time *t*

if is its presence in the system is inessential while changing the state.

3. The state S_i at some point of time t or the scenario S_i of the system A is a set of active components $S_i = \{p_i^k, p_i^{k_2}, ..., p_i^{k_r}\} \subseteq P$, if is p_i^k active and $S_i = \{p_i^k, p_i^{k_2}, ..., p_i^{k_r}\} \subseteq P$, if p_i^k isn't active. The transition from the state to a state is accomplished step-wise by the activation of the other set of components. The process of functioning of such system is undetermined because it is impossible to foresee which set can be activated at I point of time beforehand. This process can be formalized in the view of conceptual model, constructed on the base of Petri net theory.

4. Limited PN is a PN with the limited marking, i. e. the cortege $N = \{P, T, F, H, M_0\}$, where $P = \{p_i\}, i = \overline{1,n}$ is the set of positions, $T = \{t_i\}, j = \overline{1,m}$ is the set of transitions and $P \cap T = \varnothing$; are reflections $F : P \to T; H : T \to P$, assigned by the incidence matrixes $F : P \times T \to \{0,1\}$ and $H : T \times P \to \{0,1\}$, that is $F(p,t) = 1$, if the transition t is incident to the position $p, H(t,p) = 1$, and $p, H(t,p) = 1$, if the position p is incident to the transition $t; M_0 : P \to \{0,1\}$ – the initial marking.

5. The scenario S_i is a marked set of vertexes from the set $P : S_i = \{p_i^1, p_i^2, ..., p_i^{k_r}\}$, where $p^j{}_i \in P$, $S_i \subset P, m^j{}_i(p^j{}_i) = 1$ The scenario S_i is determined by the marking $M_i = \{m_i^1(p_1), m_i^2(p_2), ..., m^n{}_i(p_n)\}$, which represents the binary set of n bits where the vertex $p_j \in S_i$, if the marking is $p_j \in S_i$, and the vertex $p_j \notin S_i$, if vertex marking is $m^j{}_i(p_j) = 0$.

6. The scenario S_i is called connected by the transition t_k with the scenario $S_j(S^{t_k}{}_i \to S_j)$, if some subset $S^k{}_i$ which consists of the vertexes containing in the scenario $S_i : S^k{}_i = \{p^{k_1}{}_i, p^{k_2}{}_i, ..., p^{k_r}{}_i\} \subseteq S_i$, initializes the activation of some subset of vertexes which go into the scenario $S_j : \{p^{m_1}{}_j, p^{m_2}{}_j, ..., p^{m_s}{}_j\} \subseteq S_j$, .

7. The net which was produced by the transition t_k of the scenario *Si* with the scenario *Sj* which are determined on the set of all available scenarios, is called the primitive limited PN. It is described by the statement $P = S_i \cup S_j, T = \{t_k\}$, . Incidence functions form in the following way:

$$F : P \times T \to \{1\} \forall p \in S_i, P \times T \to \{0\}$$
$$\forall p \in S_j \setminus S_i \cap S_j, H : T \times P \to \{0\}$$
$$\forall p \in S_i \setminus S_i \cap S_j, T \times S \to \{1\}.$$

The initial mark is $M_0 : P \to \{0,1\} : m^k{}_0(p_k) = 1$, if $p_k \in S_i$, and it is $m^k{}_0(p_k) = 0$, if $p_k \in S_j$.

8. Limited PN is a PN produced by the set of symbols – transitions T on the set of scenarios S.

The final set of PN positions

Besides the standard states, which describe serviceability of CS, the latest may become into another possible states, which are given below.

p_0 - initial state. Power supply is on.

p_1 - correct state. CS corresponds to all requirements of normative-technical and/or design documentation.

p_2 - faulty state. CS is not capable to fulfill the specified functions.

p_3 - operable state. The values of all the parameters characterizing the capability to fulfill the specified functions meets the requirements of normative-technical and/or design documentation.

p_4 - nonoperable repairable state. The value of almost one parameter characterizing the capacity of performing of the specified functions does not satisfy the requirements of normative-technical and/or design documentation.

p_5 - nonoperable nonrepairable state. The state in which CS further exploitation is impossible.

p_6 - correct functioning. The state of CS in which it is capable to fulfill the specified algorithms while saving its main parameters determined in the documentation.

p_7 - invalid functioning. The state in which the value of almost one parameter characterizing the capability of fulfilling of the specified algorithms doesn't meet the requirements of normative-technical and/or design documentation.

p_8 - ultimate state. CS further exploitation is no more allowable or advisable or its operable state recovery is inadmissible or inexpedient.

p_9 - CS pending. The state in which CS further exploitation is no more allowable.

p_{10} - final state. Power supply is off.

p_{11} - conservability. The state in which CS saving structure and values of internal parameters in the desired limits if power supply is off.

The final set of PN transitions

Transitions are the actions forcing the model to make a transition from one state to another are given below.

v_1 - permanent failure, intermittent failure or breakdown. The event consisting in the stoppage of CS capability to perform the required function. Permanent failure is the failure that does not disappear until its reason is eliminated. Intermittent failure is the transient failure of the same character that occurs many times.

v_2, v_3 - fault (defect). The event consisting in inadmissible deviation of almost one of the characteristic properties or system variables from the standard (normal, usual) behavior. v_4, v_5, v_6 - восстановление (парирование).

v_4, v_5, v_6 - recovery. This event consists in the transition of the computer system from the nonoperable state to the operable by the way of system repair.

v_7 - CS elements wreck. The event which results to the transition of the element from operable state to the nonoperable one.

v_8 - CS elements ageing. This event consists in the step-by-step transition of the CS from operable state to the nonoperable one as a result of intensive system elements exploitation.

v_9, v_{10} - the termination of CS work. The event consisting in the termination of all the processes being executed by the CS and the fulfilling of preparation procedures required for CS shutdown.

v_{11}, v_{12}, v_{13}, v_{14} - personnel error. The event invoking defects in CS as a result of incorrect usage of the system by its operator.

v_{15}, v_{16}, v_{17}, v_{18} - rebooting. The event transferring CS in the nonoperable state after CS pending.

v_{19} - external action on CS. The event transferring CS in the nonoperable state as a result of external action.

v_{20}, v_{21}, v_{22} - CS loading. The event consisting in the execute of BIOS program and the preparation of the CS to the start of work.

v_{23} - saving. The event consisting in the CS latest state saving.

v_{24} - testing conservability of the structure. The event performing if testing of conservability of the structure is necessary.

v_{25} - testing conservability of the internal parameters values in the desired limits. The event performing if testing of conservability of the internal parameters values is necessary.

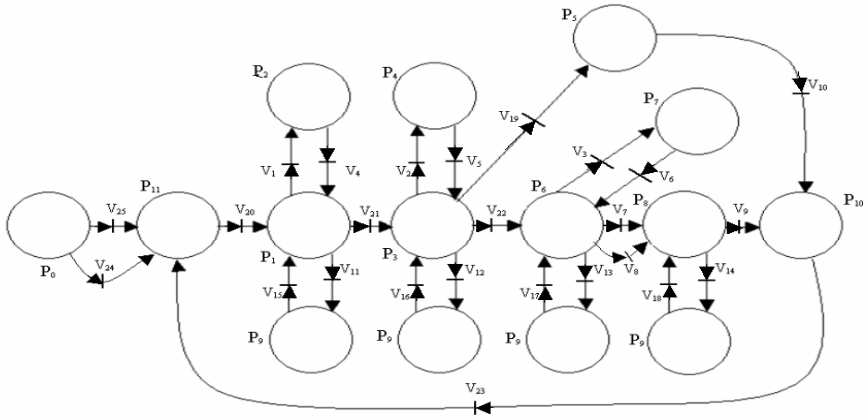

Fig. 1. CS diagnostic model as an automatic PN

Conclusions

The offered mechanism of limited PN is one of the possible methods of modeling of dynamic undetermined structures and processes, as it possesses the following properties: the possibility of definition of the set of operations over the class of distinguished nets; the liveliness and the finiteness of the constructed structure with the help of input operations.

Generally the limited PN allows constructing the algebra for the adequate logic simulation of processes with the binary logic. It is expeditious to distinguish the given class of nets possessing some special features which are essential for the considered problems. These features allow to define the set of operations for the construction of the nets out of the subnets and the primitives and to fulfill the preliminary analysis of the obtained nets. This gives the basis for the design of the mechanism of the logical structure simulation and the controlling of the processes in the dynamic undetermined systems of CS diagnostics.

Diagnostic CS model as a automaton PN shown on the fig. 1. Transition of the automaton PN has one input and one output.

Functional model of CS states in the form of PN was proposed. The model of CS functional states in the form of PN can be used in the automation diagnostic systems.

Diagnostic model as a PN allows exploring the CS behavior on presence dead-end top by giving parallel input signals.

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Рецензент: д-р техн. наук, проф. В.И. Хаханов, Харьковский национальный университет радиоэлектроники, Харьков.