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G. KRIVOULYA, M. LAPTEV

Kharkov National University of Radio Electronics, Ukraine

MODELING COMPUTER SYSTEM STATES ON THE STRUCTURAL LEVEL IN THE FORM OF FINITE STATE MACHINE

The construction of diagnostic model of computer system states in the form of finite state machine is considered in the article. The advantage of the model consists in the fact to determine the transitions from one state of the computer system to diagnostic state having the number of input signals.

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

Introduction

At current stage of development of the informational technologies the capability and reliability of the computer systems (CS) became the key factors of success in business, science and engineering. Yearly costs of the supporting and repairing CS exceed total costs of the devises and the software as for single user such for corporations.

The diagnostic of CS is one of the main approaches for support its operable. The goal of the diagnostic systems is detect and eliminate the fail-risk sections.

Modeling computer system states in the form of finite state machine

The most of the diagnostic models use the modeling graphs for presenting the CS structure on the structural level [1, 2]. In this case the metrics of general diagnosability are being calculated for the whole structure of CS, taking into accounts the diagnosability of its units [3].

However, in the given papers the system-level model of functional states CS is not considered. This kind of model is required for building diagnostic software of CS at the fundamental (structural) level.

The aim of this work is to develop the model of functional states of CS in the form of finite state machine (FSM). For modeling we will use an abstract FSM which usually is defined by five symbols $K=\{Q, A, \delta, \lambda, F\}$, where:

$Q = \{q_0(t), ..., q_n(t)\}$ – the set of final states of FSM;

A – the FSM alphabet (the finite set of input signals ($X = \{x_1, x_2, \ldots, x_{13}\}$) and intermediate symbols or literals);

δ – the transition function - defines the mapping of form $\delta : Q \times A \to Q$ (the transition from one state to another under the action of input alphabet symbols);

λ – the output function, its form depends on the type of FSM;

F – the set of dedicated states, which is the subset of the set Q.

The set of states F is used for modeling of the diagnostiable states of CS. Under the influence of the input signals FSM passes from one state to another. If the input sequence is recognized then the FSM passes to a final dedicated state from the set F.

The basic functional states of CS

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

q_0 – initial state. Power supply is on.

q_1 – correct state. CS corresponds to all requirements of normative-technical and/or design documentation.

q_2 – faulty state. CS is not capable to fulfill the specified functions.

q_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.

q_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.

q_5 – nonoperable nonrepairable state. The state in which CS further exploitation is impossible.

q_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.

q_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.

q_8 – ultimate state. CS further exploitation is no more allowable or advisable or its operable state recovery is inadmissible or inexpedient.

q_9 – CS pending. The state in which CS further exploitation is no more allowable.

q_{10} – final state. Power supply is off.

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

The signals (events) changing the CS state

The signals (events) are the actions forcing the model to make a transition from one state to another are given below.

x_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.

x_2 – fault (defect). The event consisting in inadmissible deviation of almost one of the characteristic properties or system variables from the standard (normal, usual) behavior.

x_3 – recovery. This event consists in the transition of the computer system from the nonoperable state to the operable by the way of system repair.

x_4 – CS elements wreck. The event which results to the transition of the element from operable state to the nonoperable one.

x_5 – 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.

x_6 – 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.

x_7 – personnel error. The event invoking defects in CS as a result of incorrect usage of the system by its operator.

x_8 – rebooting. The event transferring CS in the nonoperable state after CS pending.

x_9 – external action on CS. The event transferring CS in the nonoperable state as a result of external action.

x_{10} – CS loading. The event consisting in the execute of BIOS program and the preparation of the CS to the start of work

x_{11} – saving. The event consisting in the CS latest state saving.

x_{12} – testing conservability of the structure. The event performing if testing of conservability of the structure is necessary.

x_{13} – 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.

The transitions between the states of CS under forcing of input signals

Describing possible transitions of the CS from one state to another under forcing of input signals are given below.

$x_1 : (q_1 \rightarrow q_2)$

$x_2 : (q_3 \rightarrow q_4, q_6 \rightarrow q_7)$

$x_3 : (q_2 \rightarrow q_1, q_4 \rightarrow q_3, q_7 \rightarrow q_6)$

$x_4 : (q_6 \rightarrow q_8)$

$x_5 : (q_6 \rightarrow q_8)$

$x_6 : (q_5 \rightarrow q_{10}, q_8 \rightarrow q_{10})$

$x_7 : (q_1 \rightarrow q_9, q_3 \rightarrow q_9, q_6 \rightarrow q_9, q_8 \rightarrow q_9)$

$x_8 : (q_9 \rightarrow q_8, q_9 \rightarrow q_6, q_9 \rightarrow q_3, q_9 \rightarrow q_1)$

$x_9 : (q_3 \rightarrow q_5)$

$x_{10} : (q_{11} \rightarrow q_1, q_1 \rightarrow q_3, q_3 \rightarrow q_6)$

$x_{11} : (q_{10} \rightarrow q_{11})$

$x_{12} : (q_0 \rightarrow q_{11})$

$x_{13} : (q_0 \rightarrow q_{11})$

Fig. 1 showing the states model of CS.

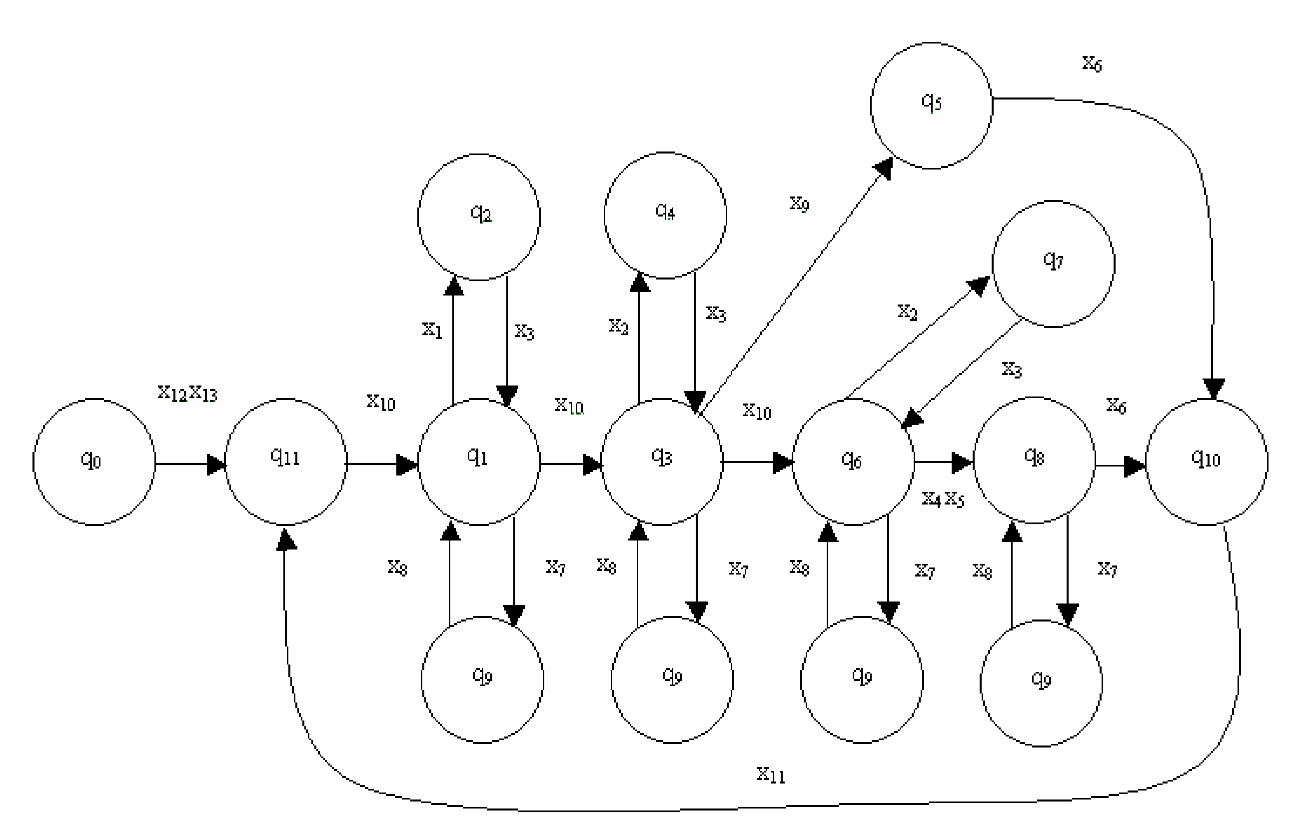

Fig. 1. The states model of CS

As a rule, the transitions of the FSM from one state to another performing on the equal term Δt. For concerned CS the time Δt may changing subject to the properties characterizing transition. The properties of transitions are given below.

1. Checkability – is the property of CS characterizing it testability by the given means of diagnostics (monitoring).

2. Reliability – is the property of CS saving in the time and in the desired limits values of all parameters characterizing capability for fulfil necessary functions in the specified conditions, technical service, storing and transportation.

Reliability is the complex property which subject to CS function may include reliability, repairability and durability or combination of it properties.

3. Useability – is the property of CS repulsing as a appearance the failure as a time of faulty state. Useability is the complex of reliability and repairability properties.

4. Reliability – is the property of CS uninterruptedly saving operable state in the some period of time.

5. Repairability – is the property of CS concluding in suitability of supporting and recovering operable state by the way of technical service and repair if the conditions of exploitation and technical service is correct.

6. Durability – is the property of CS saving the operable state before moment of ultimate state if the system of service and repair is determined.

Improving the metrics of properties causes shortening the time Δt of transitions between states. Such methods can be usefully for shortening the downtime.

Conclusions

The model of CS states in the form of FSM was offered as one of the diagnosis methods of CS. The advantage of this model is that it is quite easy to determine the transitions of the CS from one state to another having the set of input signals. The transition flowgraph is constructed with the use of transition table to describe the behavior of CS in the obvious graphic form. The properties of CS giving the possibility to characterize the system in some state more legibly were described in the given work.

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