COMPRESSION OF TEST DATA IN REGULAR PMC DIAGNOSIS MODELS

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Abstract System-level diagnosis aims at the identification of faulty units in a self diagnosable distributed systems for elimination, repairing or recovering of these units. Identification is carried out by means of system syndrome analysis and/or data mining of diagnosed system (e.g. for syndromes, models of inter unit testing, system topology). Complexity of such analysis in a great extent depends on the productivity appreciation of diagnosis model and evaluation of diagnosis processes characteristics. The Huffman coding technique of system syndrome carrying out are proposed based on test data compression of syndromes for diagnostic graph.

The PMC diagnostic model. The increasing complexity of distributed information systems has motivated researches to integrate coding techniques for diagnostic data flows. [1, 2, 3]. Autonomic, fault-tolerant self-managing systems rely on the technical states of system units (modules, services of built-in self-diagnosis) [2].

The structure of self – diagnosable distributed system may be defined by diagnostic graph G(V,E), where V is the set of system autonomic units and E is the set of directed links (v_i , v_j), v_i , v_j $\in$V, between these units[3]. Every graph G(V,E) may be decomposed on regular sub graphs G_j - structures L_j , in such a way, that

$$G(V,E)=\bigcup_j G_j,\ G_j=(V_j,E_j),\ n_j=|V_j|,\ V_j\subseteq V,\ E_j\subseteq E,\ V=\bigcup_j V_j, E=\bigcup_j E_j.$$

Diagnostic syndrome

$$A_j=\{A_j^i\}\quad |A_j^i|\le|E_j|,\ A_j^i=\{a_{xy}\,|\,\exists(v_x,v_y)\in E_j\}$$

must be processed, where a_{xy} is the state test result for a unit pair (v_x, v_y).

There are different diagnostic models (DM), which may be used for given A_j. The most known are PMC and BGM models (Fig. 1).

Tester unit	Unit under test	PMC test result	BGM test result
fault-free	fault-free	0	0
fault-free	faulty	1	1
faulty	fault-free	0 or 1	0 or 1
faulty	faulty	0 or 1	1

Figure 1 – PMC, BGM system-level diagnosis models

Syndrome compatible sets. There is a problem of model choosing in system-level diagnosis systems based on the system state space comparison, especially for typical net structures (chains, rings, stars).

For example, the chain structure

$$L_j=l_j(G_j,A_j^i)=\left(n_j,V_j,E_j,A_j^i\right)\ E_j=\{(v_i,v_{i+1})|\ v_i,v_{i+1}\in V_j, i=1,2,\ldots,n_j-1\}$$

For every structure Lj and given DM there are syndrome compatible set (SCS) of unit states for the every syndrome. The maximum number of SCS for structure Lj is called as maximum syndrome appreciation (MSA).

Base set S0 of unit states X, Y (for fixed outcome) is the Cartesian product S0 = X x Y. The set of subsets Z, for which $Z \subset SO$, $Z \neq SO$, $Z \neq \varnothing$ is used as base unit states subsets for the generalized diagnosis model.

The base set S0 of unit states (fault-free/ faulty) for pair (x,y) may be designated as X0,X1,X2,X3. Let as define the test pattern as the number of state pairs for (v_x,v_y) (|Z|) for some test result. Thus for units v_x,v_y the admissible unit states set are defined by Boolean functions: for 1 patterns (m(1), m(2), m(4), m(8)); for 2 – patterns (m(3), m(5), m(6), m(9), m(10), m(12)); 3-patterns (m(7) m(11), m(13), m(14)). For example, m(9) = X0 + X3

The model uncertainty may be considered as pair wise comparison, based on models interaction. For example PMC, BGM system-level diagnosis models can be compared as intersection set m(14) and difference sets m(5), m(13).

Results. Huffman coding technique of system syndrome is proposed based on nodes weights $W_i = p^{n-n1}(1-p)^{n1}$, where $n1 = |V_{fi}|$ is a number of failed units in system state pattern, p is a unit fault-free state and n is a number of units, i.e. n = |V|. Thus the system state tree is transformed in Huffman tree with lower code patterns length.

Some algorithmic approaches are considered for finding of system state patterns with minimum number of n1. The code redundancy rate in a great extent depends on the source entropy and quality of channels. Thus the asymmetric channel model for message transmission in PMC system level diagnosis for different test results is proposed. This model can be used for an entropy appreciation of channel quality.

Some problems on message dependability are considered based on conditional probability. Techniques and evaluations, based on system syndromes are proposed for typical regular structures (chains, rings, stars). These evaluations simplify the diagnosis processes and data processing.

Future works. An experimental work must be conducted in the future for finding the more effective algorithmic and programming solutions in distributed system-level diagnosis systems, which take into account bidirectional test results in syndromes.

References

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