Technique of Computer Forming of Digital Devices Schemes Fragmentation Structure for Decomposition Diagnosis

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***Abstract* – In article component relations forming method, underlying in procedure approach to digital devices diagnosis, was described; correction rules for choice of digital objects fragmentation final variants were puts; fact that in optimal structure component formation relations, characteristics of which agrees with characteristics of complete graphs under fixed digital devices diagnosis depth was proved.**

Key words – component relations forming method, digital devices schemes fragmentation structure, decomposition diagnosis, digital devices decomposition.

I. Introduction

Decomposition approach to digital devices diagnosis is effective every time, when complicated and laborious task of faultiness finding are attempted to replace by several easy tasks solution by electrical (switching) forming of research objects structure as interconnected schemes fragments for their consecutive testing. At that not only intelligence resources for corresponding diagnosis procedure training, but realization time in industrial welfare are economized [1].

Research task is developing of technique of computer forming of digital devices schemes fragmentation structure for their next testing on basis of decomposition criterions of research objects covering component multitudes creation..

II. View basic characteristics of digital devices decomposition

Modelling of object fragmentation process should begun from determination of object fragmentation basic characteristic - λ - digital devices component-wise diagnosis depth and *p* - decomposition level and schemes fragments complexity.

It's known that digital devices fragmentation graph basic characteristics are interconnected by using of the next formal dependences: $N = \sum_{i=1}^{z} i \cdot a_i = \lambda + \Delta$, where a_i - quantity of components of λ-structure with complexity *i*, at which equalities are right: $p = a_1 + a_2 + ... + a_h$ and $\lambda = p + \Delta - \delta$ (*h* - elements number of series *N* with maximum complexity $z = max(i)$, Δ - quantity of elements intersections, δ - characteristic of components completeness, according to [2, 3]). We introduce several notions and determinations for structures analysis.

Determination 1. Complicated (simple) component. $V_i \in V$ is scheme fragment for which $|V_i| > 2$ ($|V_i| = 2$), where V - λ-structure components set.

Determination 2. Inside simple succession (ISS) is succession of simple components, which intersect and connect the complicated fragments (*s* - common quantity of this connections).

Determination 3. Singular inside simple succession (SISS) (without simple components) is intersection of complicated schemes fragments (where $s' \le s$ - quantity of singular connection successions).

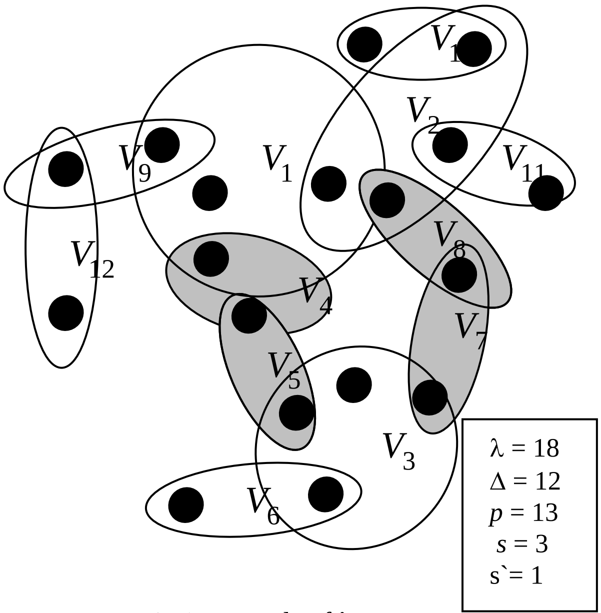

Fig.1. Example of λ- structure

There is fragmentation structure example on fig.1, where $(V_4 \cup V_5)$ and $(V_7 \cup V_8)$ - ISS between complicated components $V_1, V_2\ i\ V_3$ and $(V_1 \cap V_2)$ - SISS for which $|V_1 \cap V_2| = 1$.

λ-structures forming begins from determination and concordance of complexities $\lambda' \in \lambda$ of components

($a = p - a_2$) by characteristic *N* (where $\lambda' < \Delta$) of object decomposition. For simplification of forming process we will consider that all ISS-connections are singular.

III. Fragmentation characteristics dependencies on object diagnosis depth for basic component structures

We will analyse fragmentation characteristics dependencies on object diagnosis depth for basic component structures: chain structure, ring structure, radial structure.

Assertion 1. For forming of radial, ring and chain structures with parameters < λ, Δ, δ > of graph *G* nodes set equality $\Delta = \left\lfloor \frac{\lambda}{2} \right\rfloor$ is right.

Argument. We will prove this equality with mathematical induction technique. At λ = 4 we have Δ = $\left\lfloor \frac{\lambda}{2} \right\rfloor = \left\lfloor \frac{4}{2} \right\rfloor = 2$ (for radial and chain structures according to tables from [2, 3]). If equality is right by λ = *n*, then equality should be right by λ = *n* + 1. There are two cases: let *n* = 2*k* (1-st case), then we have $\Delta = \left\lfloor \frac{2k}{2} \right\rfloor = \lfloor k \rfloor = k$, and by *n* = 2*k* + 1 (2-nd case) we have $\Delta = \left\lfloor \frac{2k+1}{2} \right\rfloor = \left\lfloor k + \frac{1}{2} \right\rfloor = \lfloor k \rfloor = k$, where *k* - integer.

The assertion has been proved.

Assertion 2. For radial, ring and chain structures with parameters < λ, Δ, δ > equality $\delta = (\lambda + 1) mod 2$ is right.

Argument. We will prove this equality with mathematical induction technique. At λ = 4 we have $(4+1) mod 2 = 1$ - as odd number. If equality is right by λ = *n*, then equality should be right by λ = *n* + 1. As λ - any number, then we will view two cases: let *n* = 2*k* (1-st case), then we have $(2k+1) mod 2 = 0$, and by *n* = 2*k* + 1 (2-nd case) we have $(2k+1+1) mod 2 = 0$ as for even number, where *k* - integer.

The assertion has been proved.

The "compact" component relations search has given rise to analysis of structures with maximum connection activities (s^1) between complicated fragments. It was proved, that the same structures activities is described the complete graph characteristics [3]. In that case components quantity is connected with diagnosis depth by using of the next equation: $\lambda = 1/2\, p \cdot (p-1)$. If we will view only integer (whole numbers) decisions and one of roots values modulo, then we will receive: $p_1 = \left| \frac{1 - \sqrt{1 + 8 \cdot \lambda}}{2} \right|$, $p_2 = \frac{1 + \sqrt{1 + 8 \cdot \lambda}}{2}$, where $\lambda = 3, 6, 10, 15, 21 \ldots$ - numerical succession, and $\sqrt{1 + 8 \cdot \lambda}$ - odd number. This fact enable to describe the sequence of filling (by nucleuses) of incomplete components (at value λ modelling) and compact forming structures.

Property 1. For structures with fragmentation characteristics < λ, Δ, p_2, δ > equality $\lambda + \delta = \lambda_{st} + p_2$ is right, where $\lambda = p + \Delta - \delta$ and λ_{st} - starting value.

Radial and chain structures have the additivity property, which is favourable to complicated structures decomposition into independent simple groups, for which equality $\lambda = \sum_i \lambda_i$ is right. Such process was accomplished at the expense of intercomponent connections decrease and components quantity increase.

λ-structures modelling provides for the starting definition of characteristic's $\delta = \delta_2 + \delta_a$ constituents (δ_2, δ_a) connections. On basis of complete (incomplete) forming components quantity publicity we can found the current value *t* terminal ISS.

Assertion 3. For λ-structures with fragmentation parameters < *p*, Δ, *t*, δ_2, δ_a > equality $t = a_2 - \delta_2$ is right.

Argument. On basis of structures transformation rules ($\alpha_{t \to s}$, $\alpha_{s \to t}$) we will view forming, for which equality $s^1 = s$ is right.

Then terminal components quantity is $t = \frac{\lambda - s^1 - (a - \delta_a) - \delta_2}{2}$. Taking into account $s^1 = \Delta - a_2$, by incomplete fragmentation fragments quantity $a - \delta_a$, we have the numerator $\lambda - \Delta + a_2 - a + \delta_a - \delta_2$. Using equality $\lambda - \Delta = p - \delta$ and components quantity value $p = a + a_2$, we have $p - \delta + a_2 - a + \delta_a - \delta_2$. After successive transformations $a + a_2 - \delta_a - \delta_2 + \delta_a + a_2 - \delta_2 - a$ we have as a result $2a_2 - 2\delta_2 = 2(a_2 - \delta_2)$, and after value substitution to numerator we have equality, which proved.

The assertion has been proved.

Corollary. For fragmentation structure with parameters < λ, *a*, a_2, Δ, δ_a, > equality

$t = \sum_{i=3}^{p} i \cdot a_i - 2 \cdot s - (a - \delta_a)$ is right, where $s = \Delta - a_2$ and $\delta_2 = a_2 - t$.

Property 2. Among being fragmentation cases of number 2*s* to items such items succession exists, which gives rise to complete realization of connections between components.

Process of generation of the cases of connections between components can propose the incorrect connections combinations. Such structures could be declined or corrected by certain procedures $\alpha_{t(s) \to s(t)}$. The transformation result is change of structure fragmentation characteristics values *p*, δ , Δ

Generalized algorithm of structure forming with given λ ***is:***

Step 1. λ-fragmentation parameter are specified;

Step 2. If generation of *L* vectors of components complexity is finished, then go to the step 19;

Step 3. Vector $L = (l_1, l_2, ..., l_h)$, where $2 \le h \le \left\lfloor \frac{\lambda}{2} \right\rfloor + 1$, $l_k \in \{0, 1\}$ and $k = \overline{1, h}$, are generated;

Step 4. If intersection index values have overed, then go to the step 2;

Step 5. Value $\Delta(\frac{\lambda}{2} \le \Delta \le \lambda)$ is specified and characteristic $N = \lambda + \Delta$ and index $m = \sum_k l_k$ are computed;

Step 6. If number *N* fragmentation cases have been overed, then go to the step 4;

Step 7. Fragmentation $\varphi(N, m) = (A_1, A_2, ..., A_m)$ is generated;

Step 8. Reflection $\psi : I \to J$, where $\psi(i) = j$ and $I = \{i \mid i \in \overline{1, m}\}$, $J = \{ j \mid j \in \overline{1, \left\lfloor \frac{\lambda}{2} \right\rfloor + 1}\}$, is executed;

Step 9. If for all $i \in \overline{1, m}$ condition $\left\lfloor \frac{A_i}{\psi(i)} \right\rfloor = \frac{A_i}{\psi(i)}$ is right, then for all *i* indexes $a_i = \frac{A_i}{\psi(i)}$ are determined and $s = \Delta - a_2$, $p = a_1 + a_2 + ... + a_m$ are computed and go to the step 10, else go to the step 6;

Step 10. Well-ordered complexities fragmentation vector $((\underbrace{m, m, ..., m}_{a_m}), (\underbrace{m-1, m-1, ..., m-1}_{a_{m-1}}), ..., (\underbrace{1, 1, ..., 1}_{a_1})) = (A_m^1, A_{m-1}^1, ..., A_1^1)$ is formed;

Step 11. For every pair A_i^1, A_j^1 characteristic $\delta_2^{ij} = s^{ij} - 1$, where $i, j \in \overline{1, m}$, is determined;

Step 12. Value δ_2 for all fragmentation structure $\delta_2^1 = \frac{1}{2} \sum_i \sum_j \delta_2^{ij}$ is computed;

Step 13. If $a_2 < \delta_2^1$, then go to the step 6;

Step 14. If quantity of pairs of connection components V_i and V_j (where $|V_i|, |V_j| = 1, a\ i, j \in \overline{1, m}$) $k \ge 2$, then go to the step 6;

Step 15. If *k* = *1*, then structure is corrected and values $\Delta := \Delta - 1$, $p := p - 1$ are computed;

Step 16. If quantity of pairs of connection components V_i and V_j (where $|V_i|, |V_j| = 2, a\ i, j \in \overline{1, m}$) $k > 0$, then structure is corrected and values $\Delta := \Delta - k$, $\delta := \delta - k$ for all *k* pairs are computed, else go to the step 6;

Step 17. If $z = \sum_i V_i > 0$ (where $|V_i| \le 2$, $i \in \overline{1, m}$) connect with complicated components, then structure is corrected and $k \ge 0$ ($k \le min\{a, z\}$) complete schemes fragments are created;

Step 18. Values $\delta_a = a - k$, $\delta_2 = \delta - \delta_a$, $t = a_2 - \delta_2$ are computed, structure are fixed, superfluous intersections are removed, fragmentation structure's basic characteristics are counted, go to the step 20.

Step 19. Structure don't exist;

Step 20. End of algorithm.

Conclusions

In work component relations forming method, underlying in procedure approach to digital devices diagnosis, was developed; correction rules for choice of digital objects fragmentation final variants were introduced. The authors draw conclusions about expediency of choice digital devices computer fragmentation final variants just on basis of proposed rules and establish, that in optimal structures component formation relations are formed, characteristics of which agrees with characteristics of complete graphs under fixed digital devices diagnosis depth.

Work's practical value is practical using possibility of developed technique, structure forming algorithm, correction rules for effective component relations and structures forming and for choice of digital objects fragmentation final variants, for digital devices component-wise diagnosis.

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