A Diagnostic Test Generation System and a Coverage Metric*

(Summery)

Yu Zhang and Vishwani D. Agrawal

Auburn University, Department of Electrical and Computer Engineering, Auburn, AL 36849, USA

yzz0009@auburn.edu, vagrawal@eng.auburn.edu

Abstract *— A diagnostic automatic test pattern generation (DATPG) system is constructed by adding new algorithmic capabilities to conventional ATPG and fault simulation programs. The system generates tests to distinguish between fault pairs through different output responses. Given a fault pair, by modifying circuit netlist a new single fault is modeled and targeted for detection by a conventional ATPG. The test distinguishes the given fault pair. In the fault simulator faults are partitioned into different groups according to their output responses. Thus, fault pairs that a simulated vector can distinguish between are split among separate groups. Faults that form single-fault groups are dropped from further simulation. Using a proposed diagnostic coverage (DC) metric, we observe improved DC in most benchmark circuits. Cases of low DC have helped identify new open problems.*

1 Diagnostic ATPG System

Figure 1 shows a diagnostic ATPG system implemented in the Python programming language. Blocks 1 and 2 form a conventional detection coverage ATPG system. In our system, these consist of Atalanta and Hope from Virginia Tech. Block 4 is an exclusive test generation program that implementing core algorithm. Internally, it also uses Atalanta for detecting the newly modeled fault. Block 3 is a diagnostic fault simulator [1].

2 Diagnostic Coverage Metric

We group faults such that all faults within a group are not distinguishable from each other by test vectors, while each fault in a group is pair-wise distinguishable from all faults in every other group. Suppose, we have sufficient vectors to distinguish between every fault pair, then there will be as many groups as faults and every group will have just one fault.

Prior to test generation all faults are in a single group we will call . As tests are generated, detected faults leave and start forming new groups, , , . . . , where n is the number of distinguishable fault groups. For perfect detection tests will be a null set and for perfect diagnostic tests, $n = N$, where N is the total number of faults. We define *diagnostic coverage*, *DC*, as [1]

$$DC = \frac{\text{Number of detected fault groups}}{\text{Total faults}} = \frac{n}{N}$$

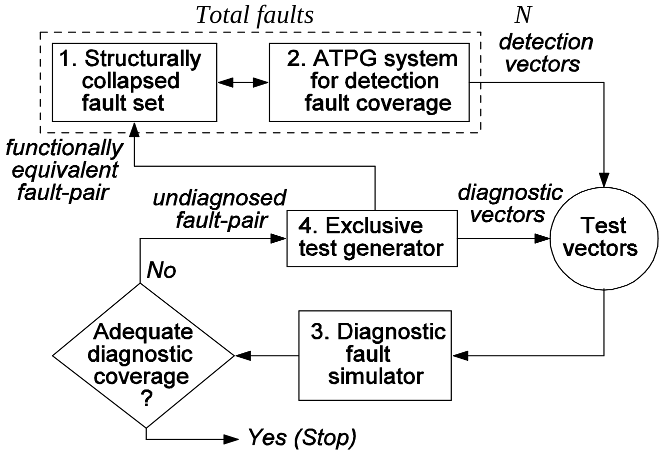

Figure 1. Diagnostic test generation system.

3 Result

DC in Table 1 will improve when we prove that most undiagnosed (aborted) pairs are in fact equivalent fault pairs.

4 Reference

[1] Y. Zhang and V. D. Agrawal, "An Algorithm for Diagnostic Fault Simulation," *Proc. 11th IEEE Latin-American Test Workshop*, March 28-31, 2010.

Table 1 Diagnostic Fault Simulation of ISCAS'85 benchmark circuits.

Circuit	Number of faults	Detection test Generation				Diagnostic test Generation					
		Detection vectors	*FC* %	CPU s**	*DC* %	Exclu. vectors	Abort. pairs	Equv. pairs	Max. group size	*DC* %	CPU s**
c432	524	51	99.24	0.032	91.99	18	13	0	2	97.51	1.75
c499	758	53	100.00	0.032	97.36	0	12	0	2	98.40	0.39
c880	942	60	100.00	0.047	92.57	10	55	0	2	94.16	2.77
c1355	1574	85	100.00	0.046	58.90	2	740	0	3	59.38	26.06
c1908	1879	114	99.89	0.047	84.73	20	300	1	8	86.46	10.84
c2670	2747	107	98.84	0.110	79.10	43	494	1	11	86.42	26.70
c3540	3428	145	100.00	0.125	85.18	29	541	3	8	89.69	22.03
c6288	7744	29	99.56	0.220	85.32	108	842	172	3	86.87	27.15
c7552	7550	209	98.25	0.390	85.98	87	904	236	7	86.85	26.36

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