A Class of Linear Space Compactors for Enhanced Diagnostic

Thomas Clouqueur

COE Technical presentation

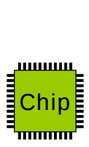
May 26 2005

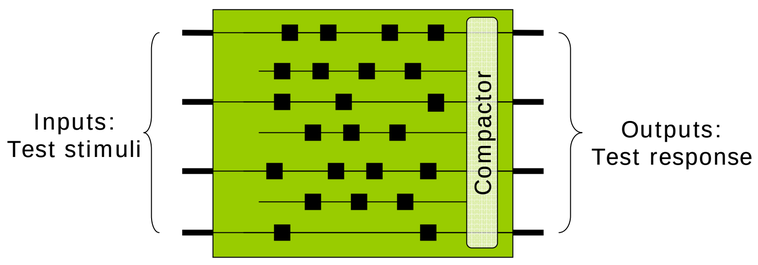
Overview

- Introduction to test response compaction.
  - Motivation.
  - Linear Space Compaction technique.
- Compactor for diagnostic.
  - Challenge of diagnostic.
  - New compaction scheme:
    - Main idea.
    - Properties and evaluation.
- Conclusion and Future work.

Need for compaction

- Ubiquitous Networked Media Computing: need for circuits for intensive computation and with high reliability.
- Our focus: test VLSI circuits (processor, ASIC…)
  - Complexity, desired reliability.
  - Economics: fast test required (cost=1yen/sec).
- Testing scheme: scan.





Linear compactors

- Compactors implemented with xor trees and represented by matrices.

n inputs

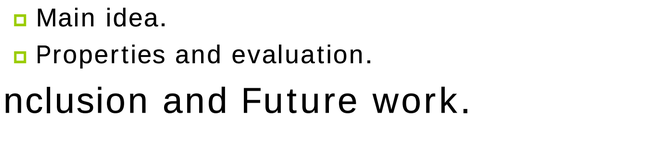
$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 \\ 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

m outputs

- Matrices correspond to check matrices of error correcting codes.

Compaction technique

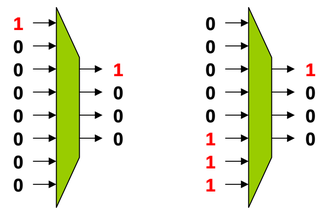
- Example: parity check.



- In general, compactor characteristics are:
  - Compaction ratio.
  - Error detection capabilities.

Challenge of diagnostic

- Diagnostic:
  - Definition: identify faults that cause erroneous behaviour.
  - Our goal: identify error locations at the input of the compactor.
- Challenge:



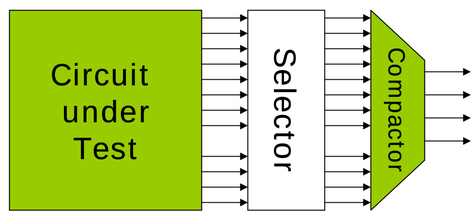
  - One signature corresponds to several error patterns.
  - In general, only part of the error patterns can be correctly identified.

Diagnostic capability

- Error identification for given compacted output *o*:
  - Scheme: out of all the error patterns that can cause *o*, return error pattern of smallest weight (if it exists).
  - Implementation: build dictionary.
  - Property: for a check matrix of distance *d*, *t* errors can be identified correctly given $2.t<d$

Approaches for diagnostic

- General approach:
  - Method: reduce compaction ratio during diagnostic phase.
  - Impact: requires applying test several times to observe all the response.



Main idea

- Feature: keep some compaction during diagnostic phase.
- Scheme: modify the compactor matrix.
  - Build matrix such that the distance of the submatrix used for diagnostic is larger than the distance of the entire matrix.
  - Goal: improve diagnostic performance.

Matrix design and properties

$$H = \begin{bmatrix} 0\ldots01 & H_0 \\ 0\ldots01 & \\ \ldots & \\ 0\ldots01 & \\ 0\ldots10 & H_0 \\ 0\ldots10 & \\ \ldots & \ldots \\ 1\ldots11 & H_0 \\ 1\ldots11 & \\ \ldots & \\ 1\ldots11 & \end{bmatrix}$$

- Properties assuming H_0 has distance d_0:

$$d = \begin{cases} 4 \text{ if } d_0 \geq 4 \\ d_0 \text{ otherwise} \end{cases}$$

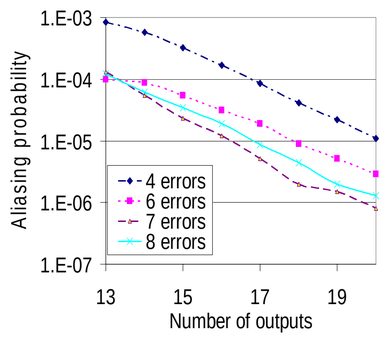
- During diagnostic, submatrix has distance d_0 if d_0 even and $d_0 + 1$ if d_0 odd.

Application with Golay code

- Golay code:
  - Perfect code of distance 7.
  - Check matrix is 23x11.
- Properties:
  - Pass/fail mode: guarantee to detect up to 3 errors.
  - Diagnostic mode: guarantee to identify up to 3 errors and detect presence of 4 errors out of 23 inputs.

Performance evaluation

- Aliasing probability:



- Misdiagnostic probability:

Number of errors	Misdiagnostic probability
5	84%
6	14%
7	88%
8	12%
9	88%
10	12%

Conclusion and future work

- Space compactor proposed can:
  - Detect errors in pass/fail mode.
  - Identify errors in diagnostic mode with compaction.
- Future work:
  - Investigate the use of codes other than Golay.
  - Investigate diagnostic with time compactors.

15