

Case-Based Circuit Design Support System

ABSTRACT

We have developed experimental system to illustrate Case-Based Reasoning. In design task, it is very important to store and utilize design cases, for the designer is often required to cope with a variety of design objects within a limited time. This system supports a user in designing a new digital circuits using similar precedential circuits.

KEY FEATURES

Structural indexing

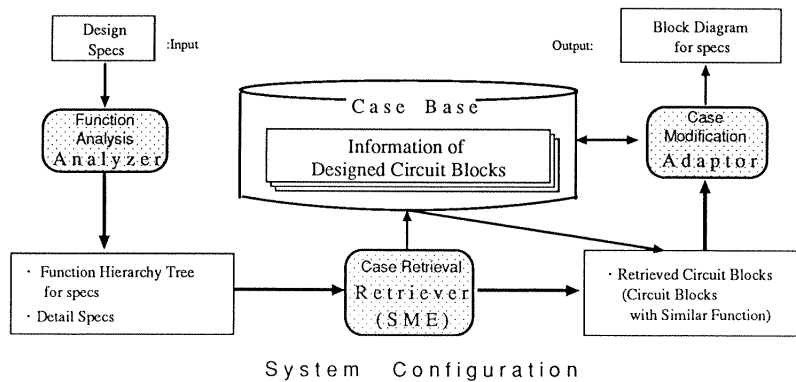
Functional hierarchy trees, that represents functional structures of design objects, are created interactively and used as indices for case retrieval.

Flexible case retrieval mechanism

Structure Mapping Engine(SME) retrieves the cases whose functional structures are similar to the design object's. To shorten run-time, cases are retrieved parallel. The structures of the design object and cases are mapped into each processor in good balance.

Case modification mechanism

System verifies detail specs of retrieved cases, modifies them, recovers design failures with SME, and combines circuit blocks.



ABSTRACT

Recently, Case-Based Reasoning (CBR) is paid attention, as a methodology for acquiring and utilizing knowledge efficiently. We have developed case-based circuit design support system to illustrate the effectiveness of CBR.

In design task, it is very important to store and utilize design cases, for the designer is often required to cope with a variety of design objects within a limited time. This system supports to design new digital circuits using similar precedential circuits.

APPROACH

Here, we have focused on how to extract the available similar cases.

- Structure-Mapping Engine(SME) is a kernel engine of case retrieval.
- Each case is given the tree-structured representations of its function.

OVERVIEW OF SYSTEM

Structural indexing

- Functional hierarchy tree represents hierarchical relations between primary function and secondary functions in a tree form to arrange the functions of the design object systematically.
- Each node of functional hierarchy tree is a simple sentence representing a function.(Fig.1)

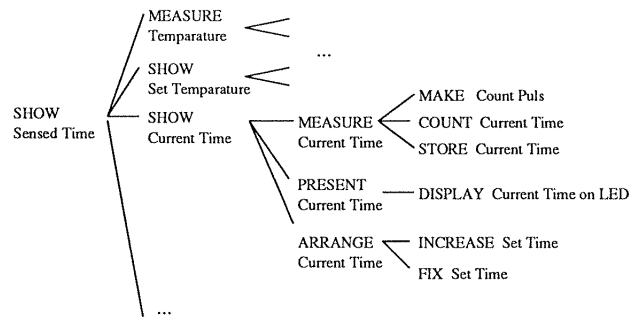


Fig.1 Functional hierarchy tree for a digital clock
in additional function with sensing temperature

- Partial functional hierarchy tree is a partial tree divided according to a series of data flow between functions. (problem division)
- Partial functional hierarchy tree of given problem is a key in case retrieval.
- Cases(Circuit blocks) have their own functional hierarchy tree as index.

Flexible case retrieval mechanism

1. Case Retrieval with SME

- SME can extract structurally similar cases to the given problem, if higher relations in given structures are same between the case and the problem, even if the lower relations and entities are not same.
- SME evaluates the similarity between functional hierarchy trees and retrieves circuits which have most similar functions as a whole even though the details are different. (Fig.2)

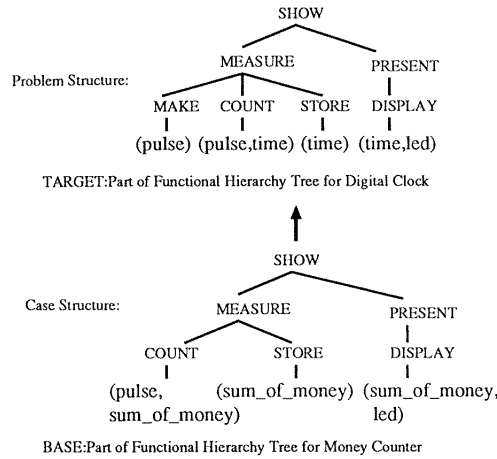


Fig.2 Example of Case Retrieval with SME

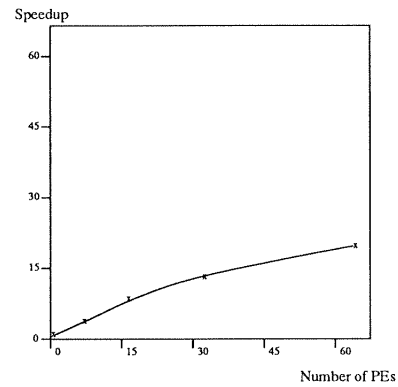


Fig.3 Speedup by Pallalel Retrieval

2. Parallel Case Retrieval

- Cases are retrieved in parallel by distributing the problem and the cases to each processors in good balance.
- Speedup of about 20-fold is attained using 64 processors in the case of 22 partial functional hierarchy trees and 180 cases.(Fig.3)

Case modification mechanism

1. Verifying the retrieved cases

System verifies the availability of the retrieved cases by modification rules, if there are some incompatible detail specs. Modification rules deal with changing carry or number of devices, replacing another block, etc.

2. Failure prediction and recovery

Precedential failure situations and recovery informations represented with causal relations are also stored into case base. SME also predicts similar failures and advices the failure recoveries.(Fig.4)

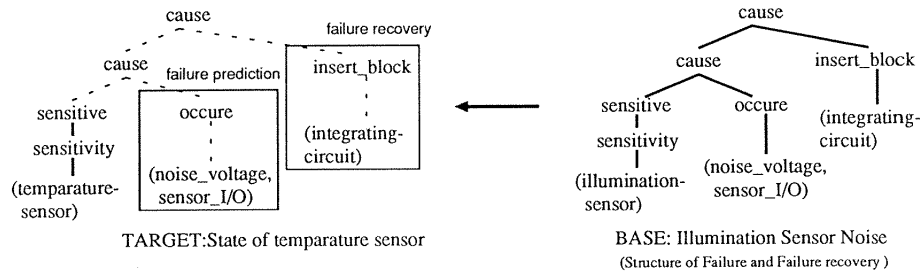


Fig.4 Failure prediction and recovery with SME

RESULT

Through experiments of non-stereotyped circuit, we confirmed the effectiveness of CBR method with SME. We also confirmed the effectiveness of parallel processing for case retrieval task requiring a long run time.

OUTLINE OF DEMONSTRATION

We deal with an application problem of telemeter circuits (a performance monitor of air-conditioner).

- For 22 partial functional hierarchy trees for the input problem, available circuits are retrieved from 180 design cases, modified and combined.
- Design result is a block diagram with 118 functional circuit blocks
- System shows how similar circuits are retrieved and modified.