ABSTRACT

A Framework for Solid Model Based Shape Similarity Comparison of Mechanical Parts. (December 1995)

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The human ability to assess similarity of shapes, relative to a decision making context, plays a key role in attaining expert levels of performance for many engineering and manufacturing tasks. Experienced personnel in a domain can recognize two parts as similar in one context and not similar in another. This ability goes beyond geometric or topological similarity to include the *implications* of a shape in the context at hand. Many knowledge intensive tasks within an enterprise (e.g., concurrent engineering, collaborative design, process planning, cost estimating) require this capability. The inability to automate this context-dependent shape similarity capability is therefore a key inhibitor to advanced CAD/CAM/CAE applications. However, before a context dependent capability can be achieved, a robust, retargetable, shape similarity approach must be established. This dissertation presents an innovative approach for assessing shape similarity based on a CSG/sweep based solid model. The unique boundary model converted from the CSG tree is used as the underlying representation scheme for shape similarity comparison. Shape similarity is formalized based on the isomorphic boundary face subsets. The isomorphism function preserves the face adjacency relationships and enforces the matched faces to have similar geometric attributes. A divide-and-conquer strategy is employed to discover the isomorphic boundary face subsets. At the "divide" step, the shape composing information, called partial shape descriptors, are extracted from the solid models. The "conquer" step is

achieved through hypotheses and evaluation. As a proof of concept, a prototype system based on the proposed framework has been implemented. Shape similarity results between various mechanical parts with complicated intersecting features are presented.