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ABSTRACT TITLE, 400 WORDS AND ONE PAGE (USE STYLE: Title)

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ABSTRACT

Evaluating the similarity between 3D Computer-Aided Design (CAD) models is a critical challenge in modern industrial design, especially as complex designs grow. Accurate similarity assessment enhances design reuse, reduces redundant modeling efforts, and optimizes resource management. CAD model similarity evaluation applications include model retrieval, shape recognition, quality control, and design optimization.

Existing CAD model similarity evaluation methods rely on semantic or geometric feature comparison. However, each approach has limitations: semantic comparisons often lack geometric precision, while geometric methods struggle with contextual meaning. Companies underutilize valuable CAD, CAM, and ERP data, while decision-making phases remain costly and time-consuming due to extensive designer involvement. A hybrid solution is required to improve accuracy and efficiency in similarity assessments.

This research aims to develop an integrated similarity evaluation model leveraging semantic and geometric feature analysis. The objective is to enhance accuracy and robustness in comparing 3D CAD models while addressing challenges related to shape variability, scale differences, and assembly complexity.

The research follows a structured approach with four phases:

1. Contextualization: A comprehensive literature review establishes the research foundation and identifies existing methodologies.

2. Identification: Key insights from the literature are analyzed to define specific research needs and formulate the problem.

3. Proposal: A hybrid similarity evaluation model is developed by integrating semantic and geometric feature analysis.

4. Testing & Evaluation: Multiple techniques are compared, and evaluation criteria are established to measure effectiveness. Results are analyzed for feasibility and reliability, leading to refinements if necessary.

Our approach integrates semantic feature extraction using Visual Studio and SolidWorks with geometric feature analysis via a Siamese neural network model. The Jaccard index quantifies semantic similarity, while ResNet-50 with a contrastive loss function evaluates geometric similarity.

Preliminary results indicate that the combined approach significantly improves similarity estimation compared to standalone methods. The model effectively captures both structural and contextual relationships between CAD models. However, challenges remain, including handling large component datasets and sensitivity to semantic attribute selection.

This research advances CAD model retrieval, design automation, and engineering knowledge reuse. The findings have the potential to streamline design workflows, reduce development costs, and enhance computational efficiency in industrial applications. Future work will refine the model to improve scalability and adaptability to industry-specific requirements.