Computational Synthesis of Product Architectures Based on Object-Oriented Graph Grammars

Abstract:
Computational design synthesis aims to iteratively and automatically generate solution spaces of standard and novel design alternatives to support the innovation process. New approaches are required to generate alternative solutions at the function and behavior level as well as to ease the computational modeling of design knowledge. This paper introduces the approach of object-oriented graph grammars for the computational synthesis of product models based on a Function–Behavior–Structure (FBS) representation. The approach combines the advantages of a generic and systematic design method with a highly computable graph representation and object-oriented concepts. Through this combination, advances in terms of extendibility, efficiency, and flexible formalization of declarative and procedural engineering knowledge are achieved. Validation of the method is given through the synthesis of hybrid powertrains. The generation of hybrid powertrain solution spaces is shown, especially focusing on the impact of an evolving vocabulary, or building blocks, for synthesis. Future work includes integrating search methods in the synthesis process along with quantitative evaluation using simulation methods.

Stichworte:
computational design synthesis; FBS; graph grammar; conceptual design; innovation process

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