

Modularity analysis scheme in support of environmentally conscious design for electromechanical products – Yue Yu

The objective of this research is to develop a theoretical framework of multi-objective, modularity analysis for discrete electromechanical product design. The research will result in an environmental awareness feedback to support design decisions at the early stage of product design in terms of environmental objectives such as disassemblability, recyclability, and material selection. The research is based on the concept of modular product design. Graph theory and fuzzy logic theory are applied in module formulation.

While the product functional objectives are raised by product designers, the environmental objectives are introduced into the product modular design simultaneously. Product physical architecture is represented by a fuzzy connected graph, where the fuzzy relationships in the graph contain environmental objectives and influence module formulation. The final product modules combining all objectives are searched by a graph-based clustering algorithm.

Based on the theoretical modularity analysis scheme, an environmentally conscious design support (ECDS) model is developed for modular product design. The model mainly focuses on adaptive design (redesign). The functions of the proposed model include:

1. An abstract graph representation for modular product architecture;
2. Converting environmental objectives into measurable, quantitative values;
3. A generic algorithm to calculate tradeoff factors among different objectives;
4. A generic algorithm to generate multi-objective solution;
5. Integrating design support model with CAD packages;
6. Integrating design support model with environmental database management.