Ontology-based assembly feature model: A framework for assembly sequence planning system

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1. Introduction

Assembly sequence planning is the most important part of an assembly process planning and researches into this issue have been carrying out in the world wide. Assembly planning aims to identify and evaluate the different ways to construct a mechanical object from its components. Traditional assembly planning is manual and based on the experience and knowledge of industrial engineers. However, manual analysis does not allow the feasibility of assembly sequences to be easily verified. In recent years, solving and optimizing the ASPP has been attempted by using various approaches, and the general idea of these approaches can be formulated as follows: given a geometrical and technological description of a product, find an assembly sequence that satisfies the precedence relations between operations and meets certain optimization criteria. At the same time, many intelligent algorithms or efficient computation algorithms have been put forward, such as chaotic particle swarm, neural network, genetic algorithm, artificial immune etc. However, to implement the automation of generating assembly sequence, there is not enough to only consider the geometric information. Thereafter knowledge-based reasoning is put forward. Here, knowledge consists of geometric information, assembly method, assembly tools and machines, and other knowledge related to the assembly sequence.

As a result of analyzing the existing approach for generating assembly sequence and information models for assembly sequence planning, it can be summed up that currently information of component itself is underutilized and little feature and algorithm-based system for generating the assembly sequence. Consequently, a systematic assembly sequence planning approach is required that allows for

- generating the appropriate information of model for assembly sequence, and
- application of the information model to a planning method, and
- developing a planning strategy and algorithm.

2. Theoretical framework

The paper presents a novel approach that tries to fulfill the above mentioned requirements. The new theoretical framework for assembly sequence planning system is based on assembly feature attribute model. Fig.1 shows the overview of the theoretical framework for assembly sequence planning system. The framework can be divided into three main phases:

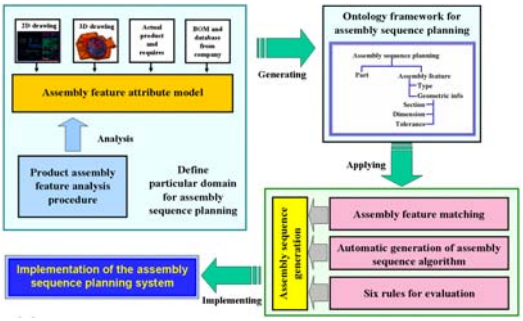

Fig. 1 Overview of the theoretical framework for assembly sequence planning system

(1) Product assembly feature analysis procedure: as shown in the upper left part of Fig.1, this phase is used to extract assembly feature attribute model and define particular domain and scope of the ontology in order to applying in assembly sequence planning.
(2) Ontology framework for assembly sequence planning: as shown in the upper right part of Fig.1, the ontology-based assembly feature attribute model represents an intelligent knowledge model for each product, it is an initial point for the automated determination of the assembly sequence planning.
(3) Generation of assembly sequence: as shown in the lower right part of Fig.1, this phase is used to implement assembly sequence planning through assembly featuring matching, automatic generation of assembly sequence algorithm, and six rules for evaluation.

3. Implementation of the framework

The implemented assembly sequence planning system has several generic sections, which underpin the framework's integration of assembly feature with assembly sequence planning system. As Fig. 2 shows that, firstly, each part should be summarized its own characteristics which are used to construct ontology-based assembly feature model. And then, an ontology-based product model allows the description of all required product assembly feature within a uniform model and reduces the complexity of the product description where it is not necessary to assembly. After that, by using a redefined matching method for solving assembly feature mapped, it is possible to generate all alternative assembly sequences efficiently within an automation algorithm. In combination with the six rules which are used to narrow down the alternative sequences, the optimal assembly sequence should be evaluated effectively among the alternative assembly sequences.

In doing so, possible alternative solution and optimal process are separated, and it is possible to select the final solution by different purposes based on actual assembly condition. Furthermore, it is beneficial to the assembly sequence planning system easily expandable and integrated in different phases of the life-cycle of the assembly process system.

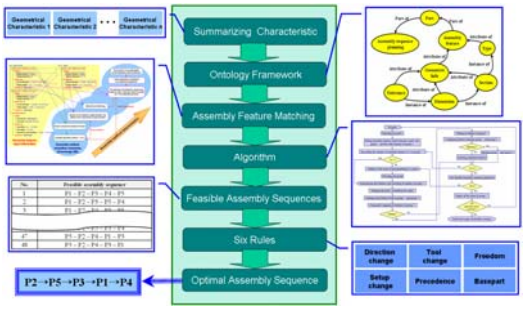

Fig. 2 The procedure for developing assembly process planning system

4. Conclusion

This paper introduced a novel framework for the creation of ontology-based assembly feature models and their integration with assembly sequence planning system. The implemented framework contains functionality that supports; assembly feature analysis, assembly feature matching, algorithm of assembly sequence planning, and evaluation rules. Future research will expand the advantage of the framework and focus on assembly process planning system.

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