3-D Assembly Process Information Generation Technology Based on Virtual Assembly

Zhang Dan, Zuo Dunwen, and Xue Shanliang

Abstract The process of interactive virtual assembly contains mass of assembly process information which is described and saved by assembly hierarchical liaison model. Assembly BOM and 3-D assembly process files generation technology is presented. Data structure of single hierarchical assembly BOM is described, and mapping method of assembly data from assembly hierarchical liaison model to assembly BOM is given. Assembly process files data model is described. The generation flow of 3-D assembly animation based on Pro/Toolkit and assembly process files structure is presented. An application case is given to verify the validation of the proposed technology which can improve the process file editing efficiency.

Keywords Virtual assembly • Assembly hierarchical liaison model • Assembly bill of material • 3-D assembly process files

1 Introduction

With the development of CAD and Virtual Reality technology, assembly process planning of new product in virtual environment becomes a research hotspot [1–3]. Applying virtual assembly technology to complex product's assembly process planning can solve problems caused by traditional assembly process planning method effectively. Also it can improve the planning efficiency and shorten the design cycle. And results of virtual assembly process planning which includes

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assembly **Bill Of Materials** data and assembly process files can be used to instruct assembly manufacture in workshop. Traditionally, assembly BOM are obtained by product structure configuration in PDM systems or integration with CAPP systems, and assembly process files are compiled by assembly processors in CAPP systems [4]. There are less research on generating 3-D assembly process information automatically after assembly process planning in virtual reality environment.

By assembly sequence and path planning in the virtual assembly system, not only the assembly process is simulated and validated, but also the product assembly information model is built in the virtual assembly system [5, 6]. The model called assembly hierarchical liaison model saves all kinds of process information in interactive virtual assembly effectively. Accordingly this paper discusses the automatic generation technology of assembly BOM and process files based on the assembly hierarchical liaison model. The technology can shorten period of assembly process files compiling greatly.

2 Assembly Hierarchical Liaison Model

The **Assembly Hierarchical Liaison Model** divides a product into four levels according to complex degree of its assembly relationship: product level, component level, module level and part level. The product level is the top in the model. Nodes in component level are components of the product, which means a product is composed of these components. Nodes in the module level are units of nodes in the component level, and they are composed of nodes in the part level. The part level is the bottom of the model, and it denotes the minimum unit in whole assembly. The nodes in each level are expressed by directed graph data structure. The vertex and directed edge in the graph denote assembly unit and relationship respectively [7].

The assembly unit is divided into three types: part, sub-assembly and cable harness. The relationship describes the assembly constraint and sequence, which is shown in Fig. 1.

3 Generation of 3-D Assembly Process Information

3.1 Generation of Assembly BOM

AHLM describes the product structure in assembly stage, so the assembly BOM can be gotten by mapping from AHLM to the BOM view hierarchy structure. The mapping includes two steps: Hierarchy extraction and parts combination. The mapping operation is shown as Fig. 2 in which (a) denotes the AHLM of an assembly A_1, (b) is the assembly tree structure and (c) is the BOM view hierarchy structure.

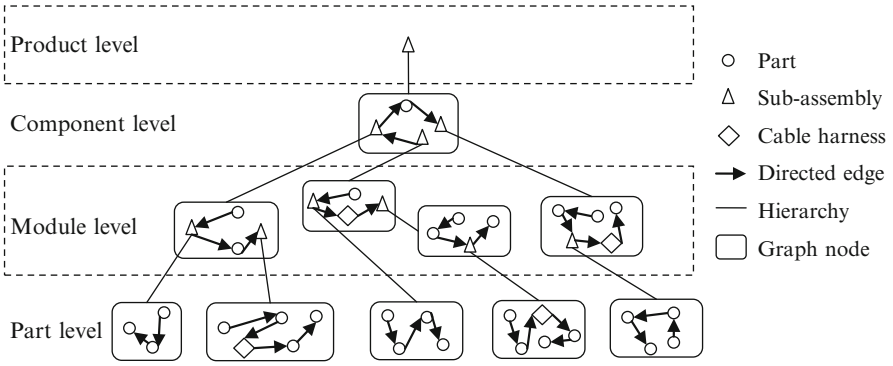

Fig. 1 The schematic diagram of AHLM

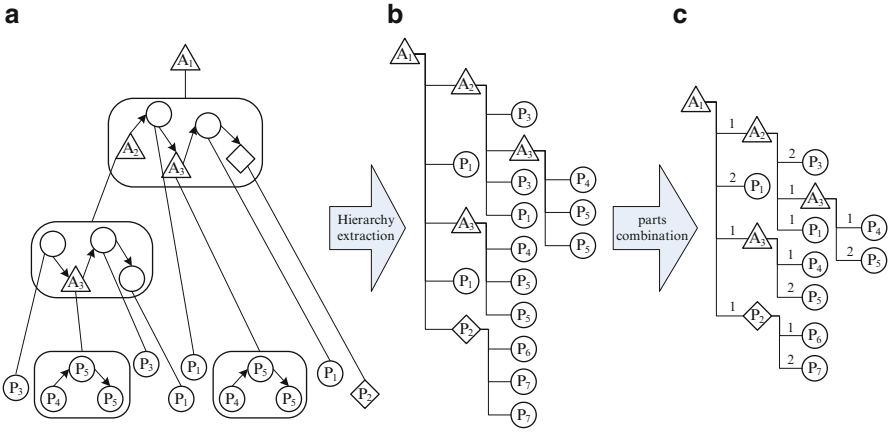

Fig. 2 The figure shows the mapping operation from AHLM to assembly BOM. This operation generates an assembly tree after getting the graph data from product level, component level, module level and part level respectively in AHLM

3.2 Generation of Assembly Process Files

3-D Assembly Process Animation 3-D Generation. Assembly process animation which can instruct workers intuitively is the important part of an assembly process file. The assembly process information which mainly includes assembly path and assembly sequence can be recorded during product virtual assembly. The 3-D assembly process animation is made by second development interface Pro/Toolkit of Pro/Engineering in ANIMATION module. The animation file generated from the module can be a video file with MPEG format which has advantages as: the compression of images is higher and needs less storage space, thus it's suitable for networks transmission and play.

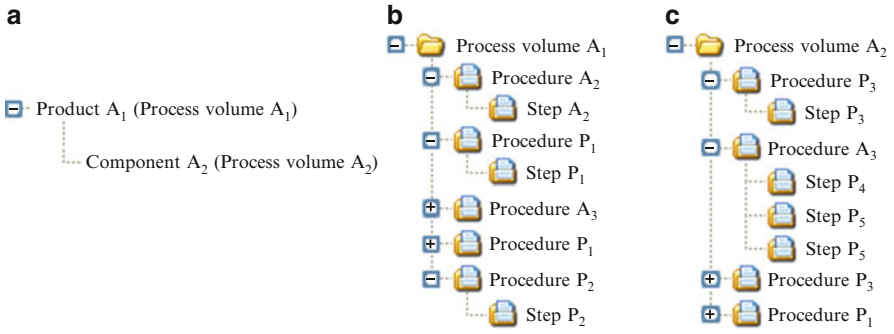

Fig. 3 The generation of process volume catalog tree by assembly tree can be combined by following steps: First, only preserve the assemblies in produce level and component level, and generate respective catalog tree nodes which is shown in (**a**). Second, generate the procedure nodes in process volume catalog tree according to the next nodes in assembly tree which is shown in (**b**). At last, generate the step nodes by decomposing the remaining nodes in assembly tree, and put the information of assembly parts, fixture, excipient in directed edge into assembly step tables in database which is shown in (**c**)

Assembly Process Files Structure Generation. In graph node of AHLM, each vertexes records parts for assembly and their assembly path information. Each directed edge records assembly sequence and process information among parts corresponding to the assembly step content, assembly BOM, fixture and assembly excipient information in assembly process files data model respectively. So we can generate assembly process files structure and their main content (Fig. 3).

4 Example

A 3-D assembly process information generation software has been developed by VC++ 6.0 based on a desktop virtual assembly system DVAPPS. An information integration interface with Pro/Engineering Wildfire 4.0 is developed by second development interface Pro/Toolkit. Take a component assembly model of a product for an example to validate the generation technology, which is shown as Fig. 4.

5 Conclusion

Virtual assembly technology supplies a novel low cost approach to solve the complex products' assembly problem, which can take agile and economical assembly process planning. During the planning in virtual environment, AHLM records mass of 3-D assembly process information, so how to fast generate the 3-D assembly process files needs to research. This paper studies on the automatic

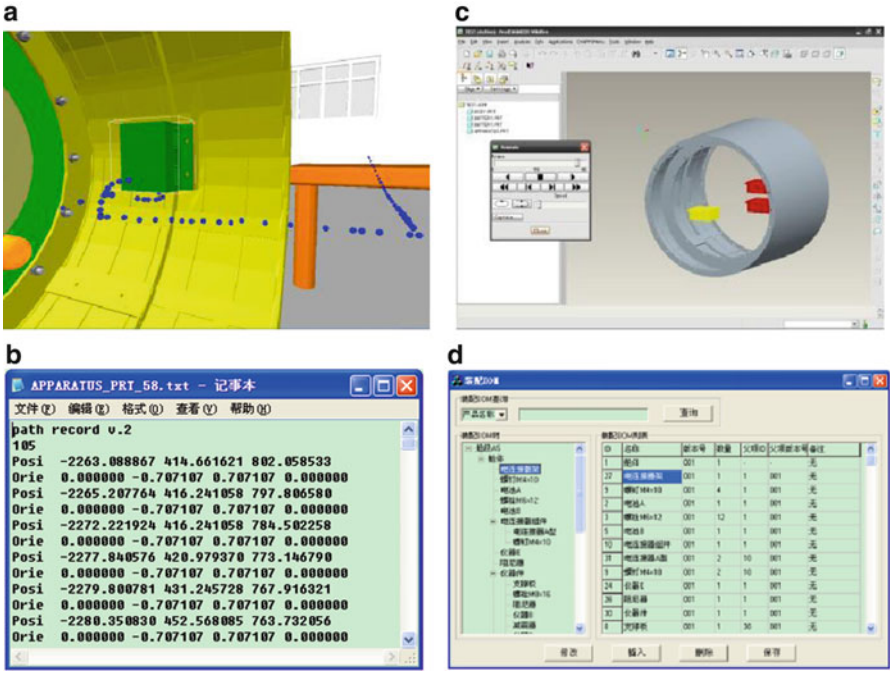

Fig. 4 (**a**) shows assembly path of a instrument part model displayed by a sequence of points in DVAPPS. (**b**) shows the attitude which is expressed by quaternion. (**c**) shows the assembly BOM interface generated according to AHLM. On the *left* of interface shows the tree of assembly BOM and on the *right* the interface shows the list of assembly BOM which supplies operations like insert, modify, save and delete. (**d**) shows the interface of animation generation in Pro/Engineering: Click the sub-menu item "LoadPathFile" on the user-defined pull-down menu "DVAPPSMenu", it will popup file-selection dialog box. When you select path files as (**b**) shows, the system will load the path data by the order of sequence, and automatic call the Pro/Engineer Animation module. Then the animation is made by the module. When click the "Capture. . ." button on the panel of Animation module, it will remind you to save the assembly process animation file with MPEG format

generation technology of assembly BOM and process files based on the AHLM in virtual assembly system. The mapping operation from AHLM to assembly BOM is presented by expressing data structure of assembly BOM. Assembly process files data model is described. Generation flow of 3-D assembly process animation and assembly process files tree structure is presented. Finally effectiveness of the generation technology is verified by an example. The technology can effectively shorten the assembly process files compiling period to improve development efficiency of new product.

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