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Research on Technology of Database for the Complex Assembly System

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Abstract

Database technology is the key technology to ensure assembly control data validity, completeness, consistency, security in the complex assembly system. A database model supporting complex assembly system was presented based on the requirement analysis of complex assembly system in data storage and extraction. The embedded database was used to storage the share visualization data for portable devices. The spatial database was built to storage the dynamic assemble process message (such as parts, frocks and assemble environment spatial position provided by Indoor GPS system). The distributed database systems supporting static model data and dynamic assembly process data storage constitute the data framework of complex assembly system.

Keywords: *complex assembly, embedded database, spatial database, indoor GPS*

1. Introduction

Digital Assembly is one of key technologies in the digital design and manufacture and an important part of product digitization. Digital assembly of complex products is an important aspect in digital product life cycle is an important aspect which requires large amounts of product engineering data support. Complex products digital assembly system is mainly involved in two major categories of information: digital assembly process information and digital assembly process quality control information including the assembly model information, assembly process model information, assembly environment model information, assembly process knowledge, assembly quality control information. Digital assembly process information is the precondition of each functional module in assembly system. Assembly quality control process digital information is the results of the implementation process by functional digital module in assembly system. The method of store and operation this information will directly affect the operation performance of digital assembly systems. Therefore, the study of database technology supports the digital assembly system is essential.

If the digital assembly system data is stored by the document, there are the following problems [2, 3]:

a) Limited amount of information stored result insufficient supporting information in sequence planning, interference checking and other aspects.
b) Model information appears redundant, increases the system memory space, and slows down the system speed. Information also may lead to ambiguity.
c) The structure expression of stored information is not facilitate to retrieval and access to useful information.
d) Information storage structure cannot be fully utilized and waste the resources of structural expression.
e) Low integration of information stored.

These defects affect the digital assembly operation of the system. Using the database technology in digital assembly system, using standard query and access functions, establishing storage system of data information integrity, reasonable storage structure can solve the above these problems, thus improve the performance operation of digital assembly system.

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In the complex products digital assembly and assembly quality control system, the database management system used to access, generate, maintain and manage complex product assembly and quality control process model including assembly object model, assembly environment model, assembly process model, assembly quality control object model, assembly quality control environment model and assembly quality control process model, and establish assembly model libraries, assembly knowledge library, assembly process library, assembly environment library, assembly quality control model library, assembly quality control environment library and assembly quality control process library to provide data support of the complex products digital assembly functional.

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2. A Complex Assembly System Database Model

In complex products digital assembly and assembly quality control system, the assembly and assembly quality control process models in the data layer include digital assembly process model and the digital assembly quality control process model in two parts, of which the assembly process model including the assembly object model, assembly environment model, assembly process model; and assembly quality control process model including assembly object model, the assembly quality control environment model, the assembly quality control process model and so on.

2.1. Digital Assembly Model [1]

Digital assembly process model include the assembly object model, assembly environment model, assembly process model and so on.

Assembly object model is the key to digital assembly to organize and guide digital assembly, which describes the geometric information of parts to be assembled, location information, and assembly relations between parts and assembly constraint information of organization structure.

Assembly environment model describes the information structure of geometric information and physical information in a variety of environmental, equipment, tools and assembly personnel in the assembly site to analysis the influence of variety of auxiliary equipment, tools, staff in the assembly process to assemble and maintainability.

Assembly process model describes the environment model in order to adapt the assembly of parts, components assembly path information structure, used to guide the assembly operation.

2.2. Digital Assembly Quality Control Process Model [4]

In assembly quality control process model, the assembly quality control object model is the key assembly quality control activities to organize quality control activities and achieve quality control objectives. It describes the physical and geometric information of the components to be assembled, physical information of the staff assembly, physical and geometric information of tooling equipment, the physical information of the assembly environment (such as the workshop).

Assembly quality control environment model describe the impact and influence level for the assembly quality by a variety of objects (the environment, tooling, equipment, tools and assembly personnel) in the assembly site and set up the assembly dynamic constraints relationship between the assembling quality control object and assembling quality through real-time data online or offline quality control analysis.

Assembly quality control process model describes the parts measured data and geometric model matching, parts and assembly tooling positioning, parts and tooling assembly path re-planning, parts assembly quality inspection, assembly tooling adjustment information adapt to assembly.

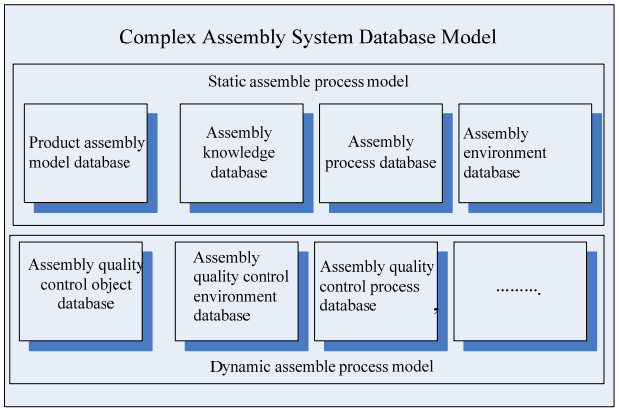

Figure 1. A Complex Assembly System Database Model

3. The Spatial Database

Complex assembly system need fast and accurately tracking measurement of the key points on the assembly products to ensure the accuracy and controllable assembly of assembly products, and monitor and alarm the situation in which the assembly process cannot run caused by factors such as interference with the deformation of the assembly workpiece.

iGPS (Indoor GPS), as its principle as GPS, use triangulation principle to establish three-dimensional coordinate system, the difference is that instead of using infrared laser satellite (microwave) signals. It uses infrared light emitted by the signal transmitter; a number of receivers will be able to independently calculate their current location. iGPS provides a new approach for large-size precision measurement. iGPS system not only enables continuous, real-time, dynamic, a large number of measurement point coordinate space, and can automatically test, calibration, monitoring, tracking the entire production of the installation process.

In the use of indoor IGPS technology for complex product assembly for digital measurement, matching, positioning, inspection, assembly process of adjustment, there are a large number of measurement data, model data, positioning control data, quality test data, assembly process data, assembly quality control data orderly flow and conversion. iGPS system working process will generate a lot of space data. Spatial data is the property containing the location data, spatial data needed for the establishment of appropriate data models and management mechanisms. IGPS system, database technology is a key technology to ensure the effectiveness, integrity, safety, consistency of monitoring data in the positioning, testing, and measurement of the complex assembly process using iGPS [5, 6].

Oracle Spatial provides a SQL schema and functions that facilitate the storage, retrieval, update, and query of collections of spatial features in an Oracle database. Oracle Spatial is designed to make spatial data management easier and more natural to users of location-enabled applications and geographic information system (GIS) applications. Once spatial data is stored in an Oracle database, it can be easily manipulated, retrieved, and related to all other data stored in the database. The Spatial data model is a hierarchical structure consisting of elements, geometries, and layers. Layers are composed of geometries, which in turn are made up of elements. An element is the basic building block of geometry. A geometry (or geometry object) is the representation of a spatial feature, modeled as an ordered set of primitive elements. A layer is a collection of geometries having the same attribute set [7].

A large number of spatial data (mainly spatial coordinate data) produced by iGPS system and assembly quality control information (including information on the object model of quality control assembly, the assembly quality control object information, parts match the measured data and geometric models, parts and assembly tooling positioning , spare parts and tooling assembly path, assembly tooling adjustments and other information) can be saved in Oracle spatial database through the data conversion interface, and be used to guide the assembly workers, parts and assembly tooling assembly to adjust action.

4. Embedded Database

Assembly quality control data visualization sharing technical means (1) to achieve the interactive assembly quality control information to help users (such as assembly quality control managers, assembly workers, members of the assembly process) to interact easily manage, access and using quality control data; (2) to achieve multi-dimensional assembly quality control information display, allows users to see objects or events that a number of attributes or variables data, and data according to their values of each dimension of its classification, sorting , combination and display; (3) to achieve the visibility of assembly quality control information, image data is available, curve, two-dimensional graphics, and animation to display three-dimensional body, and analysis the relationship between their patterns and visual.

Computing capability of the PDA visualization system is weak, so the visual information needs to download from a shared server through wireless network and stored locally. Multimedia animation can be stored as media files, but the assembly quality control data sets still needs to be stored in a relational database.

D. Richard Hipp develop open-source embedded database engine, SQLite, all of the 3 million lines of source code around the compiled program size 250kb, even down to 125kb or so. SQLite can manage up to 2TB of data to support SQL statements, is extremely lightweight relational database, providing B-tree to store the data model to Base 64 system will encode the binary data into ASCII form storage, no data type, but retained most of the features of the database, provides SQL92 Most of the standard support, support for multiple tables, indexes, transactions, views, triggers and a series of user interface and driver [8, 9].

The assembly quality control data sets can be stored in SQLite running in PDA.

5. The Dsitributed Complex Assembly Database Systems

The distributed database systems supporting static model data and dynamic assembly process data storage constitute the data framework of complex assembly system [4, 5].

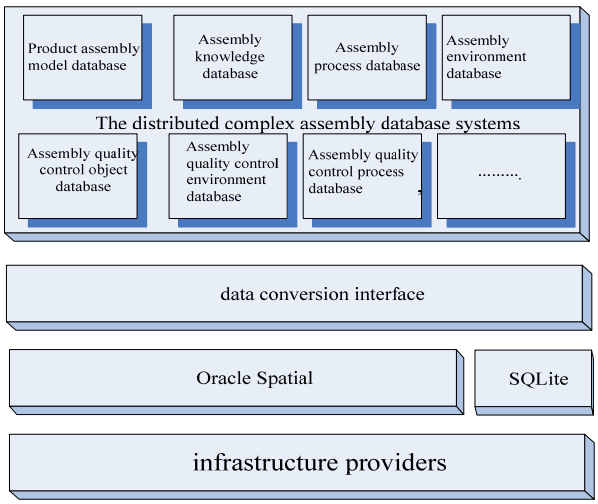

Figure 2. The Distributed Complex Assembly Database Systems

5.1. Product Assembly Model Database

The structure of product assembly model database will directly affect the product assembly model information storage. Product assembly model information includes the parts of their property information, the composition of the product parts information, and product information in the relationship between the parts.

5.2. Assembly Knowledge Database

Many digital assembly system function module needs the support of assembly knowledge. Knowledge library is thus one of the indispensable databases to support digital

assembly system. Knowledge database store a variety of tables of assembly knowledge. According to the assembly of different types of knowledge, the number of fields for each table is also different.

5.3. Assembly Process Database

The assembly sequence planning is important to the digital module assembly system. Assembly process planning needs store the assembly sequence and assembly path information in the assembly process. Assembly process database includes the assembly sequence database and the assembly path database. Assembly path database mainly store each part of the assembly path information in the digital assembly system. Assembly sequence database storage products the main part assembly optimized sequence information. This information is the prerequisite and foundation assembly.

5.4. Assembly Environment Database

In reality, all of the assembly is in a certain environment for the conduct of the assembly. Digital assembly system is the use of computer technology to build digital assembly environment, the assembly simulation of reality. Assembly Environment mainly store assembly conditions and the environment. Assembly Environment database structure can be divided into three parts: the assembly tool database, assembly fixture database and assembly scene database. Assembly tool database store required assembly tools information, the assembly fixture database mainly store assembly fixture information. The assembly scene is display space in which the assembly of parts assembled in the digital environment.

5.5. Assembly Quality Control Object Database

Assembly quality control object model describes the physical and geometric information of the components to be assembled, physical information of the staff assembly, physical and geometric information of tooling equipment, the physical information of the assembly environment (such as the workshop).

5.6. Assembly Quality Control Environment Database

Assembly quality control environment model describe the impact and influence level for the assembly quality by a variety of objects (the environment, tooling, equipment, tools and assembly personnel) in the assembly site and set up the assembly dynamic constraints relationship between the assembling quality control object.

5.7. Assembly Quality Control Process Database

Assembly quality control process model describes the parts measured data and geometric model matching, parts and assembly tooling positioning, parts and tooling assembly path re-planning, parts assembly quality inspection, assembly tooling adjustment information adapt to assembly.

6. Conclusion

In the complex assembly system, database technology ensure assembly control data validity, completeness, consistency, security. Based on the requirement analysis of complex assembly system in data storage and extraction, this paper gives a database model supporting complex assembly system. In this database model, the share visualization data for portable devices is storaged in the embedded database and the dynamic assemble process message (such as parts, frocks and assemble environment spatial position provided by Indoor GPS system) is storaged in the spatial database. The distributed database systems supporting static model data and dynamic assembly process data storage constitute the data framework of complex assembly system. This model supports various types of data storage and solves the information storage problems in complex assembly system.

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