Research and Implementation of a New Retrieve for Auto Parts BOM

Sang FENG and Gui-ming ZHANG
Mechanical and Electrical Engineering of Guangdong University of Technology, Guangzhou, China

Keywords: Auto parts, BOM, Retrieve, Tree structure model, Inheritance code.

Abstract. For wide varieties of auto parts and it is difficult to be managed, a new method was put forward. The method is based on the conventional depth retrieve method and breadth retrieve method. It was raised for the data type of multilayer structure of auto parts. According to the tree structure characteristics of auto parts BOM, the method was introduced inheritance code and hierarchy field in the original BOM. The introduction of inheritance code allows a single part to inherit information from its parent part. Parts can be quickly located at which hierarchy in the BOM by the hierarchy field. For the introduction of them, the retrieve of the traditional tree structure model has changed from nonlinear relationship into a linear search, which improve search capacity and the efficiency of the retrieve system.

Introduction

With the increasing improvement of quality of life, the car has come into the life of ordinary people gradually. With strong desire for automotive products and requirement to car for its entire quality and security, it is stimulating the rapid development of automotive technology. For the increasing replacement of automotive cars, lightweight product has become one of the important goals of each automobile enterprise for a long term, which resulting in a great number of replacement of auto parts. Therefore, it has to carefully been screened each auto part as well as do a lot of trials when developing a new car.

Automotive history can be traced back to one hundred years ago. Thus, it brings up the prosperity of the automotive industry. However, auto parts BOM management system in many auto part enterprises is relatively poor. They frequently encounter difficulties in the manufacturing. In order to meet the demand of production and research, automotive research institutes or companies have collected a lot of traditional vehicle configuration data, which can be provided with a reference for developing a new car model. Since thousands of parts make up of a car, it would be a large and complex BOM composed by parts. If engineer can not quickly, efficiently and correctly get data they needed from BOM, it will decreased efficiency. Therefore, it is great significant for the study of the BOM retrieve methods. Domestic and foreign researches on how to increase efficiency of retrieving BOM are continuous.

Principle of Tree Structure Model

The relational database has the advantages of simple structure and operation. So, a research was performed according to the basic principle of tree structure relational database. A multilayer tree structure (three hierarchies) auto parts BOM was introduced in this paper for the convenience to carry out the research, which was to convey the relationship between the parts. The tree structure is a kind of nonlinear structure model. It is widely used in the field of files directory management in operating system for it is simple and intuitive. The single root tree structure is shown in Figure1, it is mainly composed of branch nodes and leaf nodes. Node which have no parent node (the parent part) is the root node, like node A. And no lower level node (the child part) are leaf nodes, like node F, H, etc. The rest of nodes are branch nodes, like node D. Branch node can also become child node of other nodes, like node B.
Conventional Retrieve Methods

The conventional tree structure BOM retrieve method mainly contains the depth traversal method and breadth traversal method. Principle of the former method retrieves from the root node (A) and then to B, E, F, C, D, B, H until the last part. The advantages of this method are reflecting well relationship between parent part and child part. But, it consumes massive system resources when retrieving a large number of parts. Consequently, it seriously decreases the efficiency of retrieve. The principle of the latter method retrieves from the same as root node, and then in the order of B, C, D, E, F, B, H until the last part. This retrieve method has higher efficiency than the former method. It is preferable when traversing a BOM consists of a large number of parts, but it can not reflect the relations between parts.

A New BOM Retrieve Method

The advantages of new BOM retrieve method accumulate advantages of depth traversal method and breadth traversal method. In the actual manufacture, it is very common that one part is installed in other different parts. Therefore, there are many parts with the same name in auto parts BOM. Besides, cars consists of thousands of auto parts. All these make the BOM become very complicated. Any automobile enterprise has collected several hundred thousand and even millions of data of auto parts, which is composed of thousand of single root tree structure model. It may cause the computer to crash when using conventional retrieve method to retrieve the huge BOM. Problem can be solve by the new retrieve method proposed in this paper. Each part can be uniquely identified by introducing id in the same car model. At the same time, hierarchy field was also introduced to identify the part in which hierarchy. The introduction of above two fields in the complex BOM makes it become more redundant, but it greatly improves the retrieve efficiency of BOM[3,4].

Selection of Database

In order to solve the problems of data management difficulties generated by data prosperity, engineers introduce object-oriented technology into the database. The object relational database combines relational database and object-oriented technology in the field of database to deal with complex data types. Database in this paper is PostgreSQL. PostgreSQL is a free object relational database server[5] (database management system). It supports most abundant data types in the world at present. Some data types even commercial databases are not available. PostgreSQL support most of the SQL standard and realize the complex query[6].

Example Applications

Basic information of the object table is shown in Figure 2. Data of the table is over 130,000, including dozens of car models.
Figure 2. Basic information of the table.

Figure 4 is a simple tree structure BOM extracted from a complete auto parts BOM. And Figure 3 is its table form (data changes). Inheritance code (id) relates to the inheritance relationship between child part and parent part, and it identifies all the parts in the same car model uniquely. Field of class quickly locates part in the BOM.

<table>
<thead>
<tr>
<th>part</th>
<th>id</th>
<th>class</th>
<th>brand</th>
<th>weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Accessories</td>
<td>0040000000000000000000000000000000000000000000000000000000000000000</td>
<td>1</td>
<td>Volkswagen</td>
<td>18.551</td>
</tr>
<tr>
<td>2 Park assist system</td>
<td>0040000000000000000000000000000000000000000000000000000000000000000</td>
<td>2</td>
<td>Volkswagen</td>
<td>0.116</td>
</tr>
<tr>
<td>3 Sensor support</td>
<td>0040000000000000000000000000000000000000000000000000000000000000000</td>
<td>3</td>
<td>Volkswagen</td>
<td>0.019</td>
</tr>
<tr>
<td>4 Sensors</td>
<td>0040000000000000000000000000000000000000000000000000000000000000000</td>
<td>3</td>
<td>Volkswagen</td>
<td>0.191</td>
</tr>
<tr>
<td>5 Park assist front system</td>
<td>0040000000000000000000000000000000000000000000000000000000000000000</td>
<td>2</td>
<td>Volkswagen</td>
<td>0.206</td>
</tr>
<tr>
<td>6 Sensor support</td>
<td>0040000000000000000000000000000000000000000000000000000000000000000</td>
<td>3</td>
<td>Volkswagen</td>
<td>0.037</td>
</tr>
</tbody>
</table>

Figure 3. Table form of BOM.

Instance: weight of Sensor support is needed to be queried. Sensor support’s parent part is Park assist front system, and its id is 0040000000000000000000000000000000000000000000000000000000000000000. It’s clear that there are two parts with the same name of Sensor support at the third hierarchy of BOM. If only querying by a simple SQL code: “select distinct part, model, weight from TABLE_NAME where class = '3' and part = 'Sensor support’” (TABLE_NAME is the name of the table). Two parts with the same name Sensor support will be got. In this case, the user can not directly determine which result is what they need. However, it is clear to see from Figure 4 that the results can be identified only to determine whose parent part is Park assist front system. Each car consists of thousands of parts which made up a monomer BOM. A huge BOM is composed of hundreds of thousands of monomer BOM. In this BOM, it may exist many auto parts with the same name. And the same in the monomer BOM (like this case). Only query hierarchy by hierarchy to determine parent part of the each part can we get the results.
Now a research is carried out for the table (cars_mass). Execute SQL code: “select distinct model, id, weight, part from cars_mass where class = '3' and part = 'Sensor support' and Brand = 'Volkswagen'”. The result of the query is shown in Figure 5.

![Figure 5 The result of query.](image)

On above result, No. 2 and No. 5 cannot be filtered out by model. However, the introduction of the id identifies all the parts in the same car models uniquely. According to the principle of inheritance between parent part and child part, results can be got by the following steps:

Step 1: Execute SQL code: request.getParameter("firstClass").request.getParameter("secondClass").request.getParameter("thirdClass") to respectively obtain parts selected by user in three hierarchy BOM. firstClass is the name of a linkage drop-down menu shown in Figure 8 (part III), whose value is Accessories. (By analogy secondClass, and thirdClass).

Step 2: Execute SQL code: “select distinct id from cars_mass where part = 'Sensor support' and class = '3' and brand = 'Volkswagen'” to get id of the Sensor support. Two results are obtained when querying and they are returned to the user. A destination image is shown in Figure 6.

![Figure 6. Query to get id.](image)

Step 3: For the id of the Sensor support has been got. According to the principle of inheritance between parent part and child part, we deduce that the id of parent part in the second hierarchy of the BOM is id=004$010$000$000$000$000$000$000$000$000$000$. Similarly, id of the part in the first hierarchy is id=004$000$000$000$000$000$000$000$000$000$000$.

Step 4: Execute SQL code: “select distinct part from cars_mass where id = '004$010$000$000$000$000$000$000$000$000$000$000$' and brand = 'Volkswagen'” to get parent part of the Sensor support. And then we get part=Park assist front system in the second hierarchy of BOM.

Step 5: This step carries out in the first hierarchy to get parent part of Park assist front system. Execute SQL code: “select distinct part from cars_mass where id = '004$000$000$000$000$000$000$000$000$000$000$000$000$' and brand = 'Volkswagen'”. And then we get part=Accessories in the first hierarchy of BOM.

Finally, It can determine that parent part of Sensor support is Park assist front system. and parent part of Park assist front system is Accessories. we get final results by executing SQL code: “select distinct part, brand, model, weight from cars_mass where id =
'004$010$004$000$000$000$000$000$000$000$000$000$' and brand = 'Volkswagen'. The result is shown in Figure 7.

We can accurately determine that which part is the user finally selected for inheritance relations between parent part and child part. For the id identifies all the parts in the same models uniquely, users do not need to remember complex id. According to the match between id and part, when users select a part, the retrieve system will find the id of the part. It means that the query of the part to the BOM is transferred into the query of id by the system. Figure 8 is the interface of retrieve system. Part I is the type of the query (default value is the weight of the part). Part II is the selection of brand and model, and the weight of the car. Part III is the selection of parts and the weight of the part.

When query on Figure 8, results will be got which is shown in Figure 9. Finally we are able to determine that weight = 0.037 on Figure 5 is the result user need.

Extension

According to statistics, the modern auto parts BOM can be traced back to at least 8 hierarchies. Method proposed in this paper is still available. In this case, the key step is confirming the parent part by child part. User can get all information of the part selected in the interface of retrieve system. For the introduction of inheritance code, efficiency of this retrieve method is higher than the conventional method. It cleverly avoid querying many single root BOM models which does not meet the
conditions of user. Therefore, it is more efficient. In the retrieve method, we determine part’s id by the inheritance relationship between parent part and child part.

**Summary**

In order to quickly retrieve a huge and complex BOM, this paper proposes a new retrieve method which is based on inheritance relationship between parent part and child part. Computer is good at dealing with linear relationship data. This retrieve method transformed conventional tree structure from nonlinear relationship into a linear relationship by using inheritance code, which make it greatly improve its retrieve capacity and efficiency. New retrieve method works well.

**Acknowledgement**

This research was financially supported by the Automotive Engineering Institute of Guangzhou Automobile Group Co., Ltd.

**References**


