Database Model for Step-Geometric Data – An Object Oriented Approach

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Abstract. Information systems in today's manufacturing enterprises are distributed. Data exchange and share can be performed by computer network systems. Enterprises are performing operations globally and e-manufacturing enterprises not only obtain online information but also organize production activities. The present manufacturing scenario demands the communication among different CAD/CAM/CAE systems usually involves a huge amount of data, different formats, and proprietary platforms. To deal with such difficulties, the tool we need must be equipped with the some feature like platform independency. To full fill this, we developed an object oriented database tool to retrieve and store the GEOMETRY model data from a STEP file using JAVA. This tool operates around a model that uses a well-defined configuration management strategy to manage and storage of GEOMETRY data.

Keywords: Object Oriented, Database Model, JAVA, STEP, CAD/CAM, Geometric Data.

1 Introduction

Information systems and computer technologies are playing key role in modern industries and business. Every day the companies make strategic business decisions to improve their position in the market. They examine the business value chain to improve the product innovation, customer intimacy, and operational efficiency. The product development is one of the key weapons in the war for a competitive advantage. The policy in the product development is in the form of five 'rights', viz. the right information, in the right format, for the right people, in the right location, and at the right time. The design and development of the product in small-scale and large-scale industries are managed with CAD/CAM/CAE systems, these systems are heterogeneous nature. For many years manufacturing has been seeking to exchange product model data by defining an extended entity relationship model covering the life cycle of geometrically defined products. The life cycle was defined to be from initial conceptual design to detailed design, to manufacturing, to maintenance and final disposal. The systems to be supported life cycle phases were to include all kinds of engineering design systems including Computer Aided Design (CAD), Computer Aided Engineering (CAE), Computer Aided Manufacturing (CAM), Computerized

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Numerical Control (CNC) and Product Data Management (PDM)[1-5]. In this paper, a database model for step-geometry has been developed for geometrical data and communicated this data in Client/Server environment. The main objectives are

- To share CAD data files by different users by using a Standard for the Exchange of Product model data (STEP) as the standard to represent product information.
- To avoid format mismatch by the development of a Translator to store STEP Geometry Data into Oracle Database

2 Introduction to STEP

This standard, ISO 10303 [6-8], is informally known as STEP (STandard for the Exchange of Product model data). Its scope is much broader than that of other existing CAD data exchange formats, notably the Initial Graphics Exchange Specification (IGES), a US standard that has been in use for nearly twenty years. Whereas IGES was developed primarily for the exchange of pure geometric data between computer aided design (CAD) systems, STEP is intended to handle a much wider range of product-related data covering the entire life-cycle of a product.

The development of STEP has been one of the largest efforts ever undertaken by ISO. Several hundred people from many different countries have been involved in the work for the past sixteen years, and development is as active now as it ever has been in the past. STEP is increasingly recognized by industry as an effective means of exchanging product-related data between different CAD systems or between CAD and downstream application systems [9].

3 Literature Survey

In a CAD/CAM International context, there are several existing standards for data exchange, such as Initial Graphics Exchange Specification (IGES), SET, VDA-FS, EDIF, etc. The most popular exchange standard in use is the IGES. Although IGES is best supported as an interchange format for geometric information, it cannot fulfill the completeness requirement in representing product data.

Bhandar. M.P., et al.[10] proposed an infrastructure for sharing manufacturing information for the virtual enterprise. They use the STEP model data as the standard to represent complete information of a product throughout its life cycle. It integrates geometric representation and adds additional information, such as the process models, for different stages of the product development. And they used the Common Object Request Broker Architecture (CORBA) as the communication tool, and the World Wide Web (WWW) as their infrastructure. They categorize transmission protocols for translating data on the network system into two groups: the high level programming languages and the low level function calls that are embedded in the operating systems. CORBA is the high level programming language used as an interface that handles objects in a network environment and generates communication programs for both client and server, so both sides can manage their objects directly. With CORBA, local clients can transmit, manipulate objects, and send messages.

Regli[11] discusses the feature of Internet-enabled CAD systems. He brings out two features that Internet tools should have: access to information, access to tools and collaborators. Smith and Muller[12] discussed the database used by CAD/CAM systems. They focus on obtaining a multi-view database system for information sharing for establishing a Concurrent Engineering environment. E.Ly[13] builds a distributed editing system on the network so that the editing processes can be carried out on it. He uses a WWW browser as the working platform and the JAVA as the programming language. Evans and Daniel[14] discusses JAVA ability comparing the communication abilities between the traditional COI and the JAVA'S CORBA in a WWW browser.

Brown and Versprille[15] discuss issues on information sharing through the network among different CAx systems. They focus on feature extraction methods of traditional CAD/CAM databases. They use CORBA as the tool to transmit features, and store them in an object-oriented database system and suggested using other tools other than CORBA for transmission, such as Microsoft's ActiveX components. Kimuro et.al[16] discuss a Continuous Acquisition of Logistic Support (CALS) environment with CAD databases using agents. They use such technology to query distributed CAD data-bases as a centralized database system.

4 Optimization Model for STEP File

As depicted in Figure 1, optimization models are constructed for database, which in turn is constructed from the EXPRESS[17] entity database using descriptive models and aggregation methods. The class of optimization models selected to analyze of models implicitly defines the EXPRESS entity database. This model helps in.

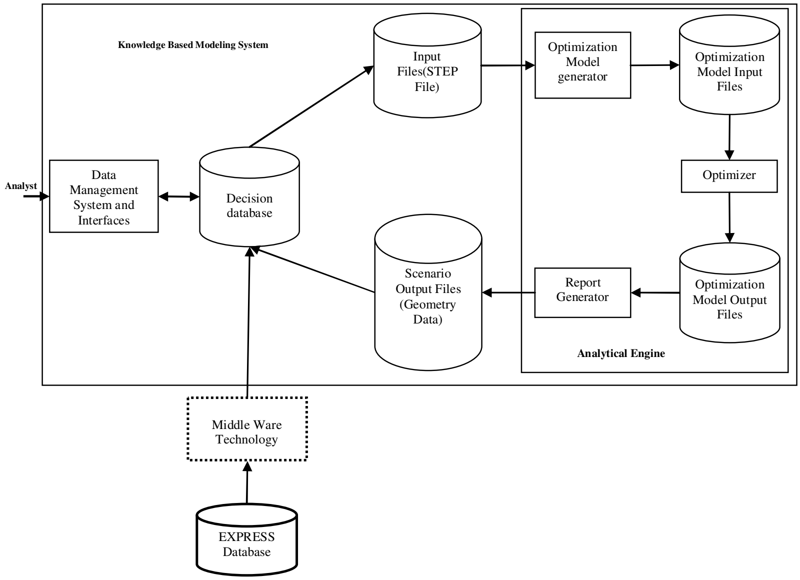

Fig. 1. Optimization model

- Organizational behaviorists have studied the relationship between exploration of new possibilities and the exploitation of old certainties in studying how organizations learn in adapting to a changing world.
- Exploration includes activities described as search, risk taking, experimentation, discovery, and innovation.
- Exploitation includes activities described as refinement, production, efficiency, implementation, and execution. Organizations that over-emphasize exploration are liable to suffer the costs of experimentation without reaping many benefits.
- Their exploratory activities produce an excess of underdeveloped new ideas and a dearth of distinctive competencies.

5 Data Management

Generally Conceptual data models are generally used for engineering information modeling at a high level of abstraction. However, engineering information systems are constructed based on logical database models. So at the level of data manipulation, that is, a low level of abstraction, the logical database model is used for engineering information modeling. Here, logical database models are often created through mapping conceptual data models into logical database models. In this data management, we used conceptual design for stores the PDM, geometric data from STEP file.

i. Database Systems

In this paper we use the Oracle 10g as the database. Oracle 10g as like the other relational database systems such as Ms Access and DB2 are used by engineering organizations to store and manage configuration control data. The strength of relational systems is in their ability to store large amounts of data in a highly normalized, tabular form, and to perform efficient queries across large data sets. Relational systems use SQL for both data definition and data manipulation.

ii. STEP Data Mapping To ORACLE 10G

The Oracle 10g implementation uses the mapping for STEP data from EXPRESS entities to the relational model. Each entity is mapped to a table with columns for attributes. Each table has a column with a unique identifier for each instance. Attributes with primitive values are stored in place, and composite values like entity instances, selects, and aggregates are stored as foreign keys containing the unique instance identifier. The corresponding EXPRESS Entity database designs are shown in Tables 1,2.

iii. Design of Geometric Entity Database

Geometric database having fields id, entity, entity_data0, entity_data1,….,entity_data m as shown in Table 2. Purpose of this database is to store Geometric data after separating the data from STEP file. The first field id have the information of the entity, entity have the information of entity, entity_data0 have information of the entity data, and so on.,

Table 1. Express Entity Database Design

Field Name	Data Type
entity	Text
Data1	Text
Data_type1	Text
Data2	Text
Data_type2	Text
….	
Data m	Text
Data_type m	Text

Table 2. Geometric Entity Database Design

Field Name	Data Type
id	Text
entity	Text
entity_data0	Text
entity_data1	Text
entity_data2	Text
…..	
entity_data m	Text

6 Implementation

In this paper an interactive user interface program is developed to extract STEP – Geometric data from neutral format STEP file using JAVA language as shown in In this work an interface program is developed to extract Product data(PDM), Geometric data from neutral format STEP file using Java. EXPRESS Schema entity definitions for Product and Geometry data are stored in Oracle 10g and these are used in backend for validation[17]. The Geometry data as Cartesian-point, oriented-edge, edge-curve, vertex, axis-placement information etc, information extracted from STEP file as per back end Express Schema entities database. The extracted data is inserted into Geometry database. Template is designed using Java 1.7 for the execution of interface program shown Figure 2.

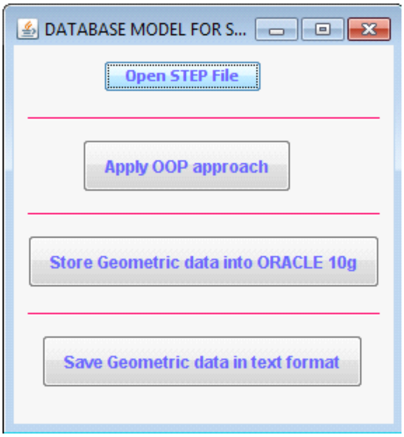

Fig. 2. Object Oriented Database Construction model

Process for Design the Geometric DATABASE MODEL

Step1: Select the STEP file and save it in variable STEPVARIABLE
Step2: Open the file STEPVARIABLE in read mode
Step3: Read a line from STEPVARIABLE and assigned to a variable STEPLINE
Step4: If STEPLINE equals to null GOTO Step 8
Step5: Separate the entity, entitydata1,entitydata2,…., entitydata m from STPLN in following manner.
 i Read character by character from STEPLINE
 ii Extract the entity, assigned to a variable ENTITY
 iii Extract the entity data , assigned to a variable ENTITYDATA1
 iv Extract the next entity data, assigned to variable ENTITYDATA2, …ENTITYDATAM until end of the STEPLINE
Step6: Search the back end EXPRESS entity database for ENTITY in column “entity”.
Step7: If found store the ENTITY along with the ENTITYDATA1, ENTITYDATA2, . ., ENTITYDATAM in the Database “Geometry”
Step8: Otherwise increment the counter in STEPVARIABLE and GOTO Step 3
Step9: STOP

7 Case Study

In this work, following model is designed using the solid modeling techniques. A Gas-Regulator consider for testing the interface program. The model of Gas-Regulator is created using CATIA V5 R16, as shown in Figure 3.

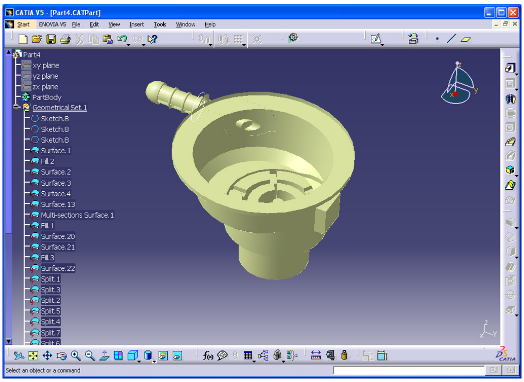

Fig. 3. Assembly of GAS-Regulator

Here we presents STEP file for GAS-Regulator model.

```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION(('CATIA V5 STEP Exchange'),'2;1');
FILE_NAME('C:\\Documents and Settings\\Administrator\\Desktop\\STEP
FILES\\GASREGULATORBODY.stp','2013-07-20T05:35:15+00:00',('none'),('none'),'CATIA Version 5 Release 16
(IN-10)','CATIA V5 STEP AP203','none');
FILE_SCHEMA(('CONFIG_CONTROL_DESIGN'));
ENDSEC;
/* file written by CATIA V5R16 */
DATA;
#5=PRODUCT('Part4','','',(#2)) ;
#1=APPLICATION_CONTEXT('configuration controlled 3D design of mechanical parts and assemblies') ;
#14=PRODUCT_DEFINITION(' ',' ',#6,#3) ;
#16=SECURITY_CLASSIFICATION(' ',' ',#15) ;
………..
#88=CARTESIAN_POINT('Axis2P3D Location',(-21.6430454254,-41.,16.7157007856)) ;
#92=CARTESIAN_POINT('Limit',(-28.3930454254,-41.,16.7157007856)) ;
……….
#6104=DIRECTION('Axis2P3D XDirection',(0.988395467625,0.,-0.151902598982)) ;
#6108=DIRECTION('Axis2P3D Direction',(0.,-1.,0.)) ;
……………..
#7062=ORIENTED_EDGE('',*,*,#7059,.F.) ;
#7129=ORIENTED_EDGE('',*,*,#7101,.T.) ;
…….
#7065=OPEN_SHELL('Surface.18',(#7192)) ;
#7193=OPEN_SHELL('Surface.19',(#7320)) ;
#98=SHELL_BASED_SURFACE_MODEL('NONE',(#97)) ;
#4101=SHELL_BASED_SURFACE_MODEL('NONE',(#4100)) ;
………….
#821=EDGE_CURVE('',#820,#813,#818,.T.) ;
#826=EDGE_CURVE('',#820,#406,#825,.T.) ;
……………
#7228=VERTEX_POINT('',#7227) ;
#7286=VERTEX_POINT('',#7285) ;
#7288=VERTEX_POINT('',#7287) ;
………
ENDSEC;
END-ISO-10303-21;
```

Data Base has no information before executing above program as shown in Table 3.

Table 3. Geometric Entity Database

id	entity	entity_data0	entity_data1	…..	entity_datam

Table 4. Data in the Geometric Entity Database

id	entity	entity_data0	entity_data1	…	entity_data m
88	CARTESIAN_POINT	'Axis2P3D Location'	21.6430454254,-41.,16.7157007856		
6104	DIRECTION	'Axis2P3D XDirection'	0.988395467625		
7191	FACE_BOUND	‘ ‘	,#7188		
7288	VERTEX_POINT	‘ ‘	#7287		

After execution of this program, above empty database shown in table 3 is filled with geometric data as shown in table 4. This information is useful for further processing.

8 Conclusions

Now-a-days knowledge demanding production is arisen in engineering industry especially in design, analysis and manufacturing. In which new information requirements are proposed in data knowledge sharing and reusing in richer information types like CAD/CAM. To overcome the some problem arisen in the above said industries especially in STEP, in this paper, we proposed a new method to maintain object oriented STEP-Geometric database using object oriented approach with JAVA. This approach maintains STEP-GEOMETRY Database as well as propose easily understandable user interface. In future we will apply this method for STEP-GEOMETRY XML Ontology and downstream applications.

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