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Development of a Wiki-based Feature Library for a Process Planning System

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***Abstract*—**A manufacturing feature can be defined simply as a geometric shape and its manufacturing information to create the shape. In a feature-based process planning system, feature library plays an important role in the extraction of manufacturing features with their proper manufacturing information. However, to manage the manufacturing information flexibly, it is important to build a feature library that is easy to modify. In this paper, a Wiki-based feature library is proposed.

***Keywords*—**Manufacturing feature, feature library, feature ontology, process planning, Wiki, MediaWiki.

I. Introduction

COMPUTER Aided Process Planning (CAPP) offers the ability to integrate a Computer Aided Design (CAD), which allows automation of product design, and a Computer Aided Manufacturing (CAM) system, which allows automation of manufacturing. In order to allow the CAD system to interface with the CAPP system, feature technology has emerged as the enabling technology to convert CAD product data to manufacturing information [1]. Many different approaches have been developed to extract features from the CAD product data [2].

For the extraction of manufacturing features for the generation of process plans, it is necessary to develop a feature library that consists of pre-defined features and the manufacturing information to create the shape of the features [3].The manufacturing information consists of the required machine and tool data, the estimated cost and time data, etc [4]. It is necessary to develop a feature library which is easy to modify or to costumize, since manufacturing technologies are progressing, and also that manufacturing information used in a particular factory may not be the same as the other factory. However, in general, feature libraries are not developed in a way that is easy to modify, especially by people without information technology background.

On the other hand, in the context of collaboration on the web, Wiki has proven itself to be a user-friendly interface. For example, the community of Wikipedia.org, the free content encyclopedia is becoming larger and larger. There have been more than 450,000 people who gave their contributions, either by creating or editing articles in Wikipedia. Wiki is a discussion medium, a repository of ideas and a tool for collaboration. It is a simple publishing system that is easy to learn and quick to use [5]. In Wiki, people can create or edit a Wiki page using a simple syntax to write content. So, it is normal to make an assumption that an extended Wiki will be useful for the development of a feature library which is easy to modify.

In this paper, a development of a Wiki-based feature library is described. The feature library consists of the function feature ontology and the manufacturing feature ontology. Sub-classes of the function features are created based on the required functions of the face elements that construct the features as intended by the designers. Sub-classes of the manufacturing features are created based on the existing manufacturing methods to create the shape of the manufacturing features. To make the feature library be useful for the extraction of manufacturing information to create the shape of the manufacturing features, the relation between the two ontologies is defined. The development of the structure of the feature library is described in section 2. Section 3 describes the modification of a Wiki software for the development of a Wiki-based feature library. Section 4 states the conclusions drawn from the research.

II. The Structure of the Feature Library

A. Considering the Designer's Intention for the Extraction of Manufacturing Features with Their Proper Manufacturing Information

For the extraction of proper manufacturing information to create the shape of manufacturing features, it is important to understand the designer's intention. For example, a through-hole feature may require a cylindrical grinding to create the shape, while the other through-hole feature may require threading to create the shape, depending on why the designer designed the geometrical shape. Thus, it is necessary to consider the designer's intention for the extraction of manufacturing feature with their proper manufacturing information.

In this research, the designer's intention is represented by the functions of the face elements that construct the features. The face element is defined as a geometrical entity that is bounded

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by a set of edges. The functional data of the face elements can be described as basic function, mechanism utilized for realization of the basic function, and condition and direction of the motion. The detail explanation of the functional data elements is given in other reports [6][7]. Table 1 shows the contents of functional properties of face elements that are used for the creation of the function feature ontology.

TABLE I
CONTENTS OF FUNCTIONAL PROPERTIES

Basic Function	Mechanism utilzed for realization of the basic function	Condition and direction of the motion
Transmission of motion	1: friction-mech., 2: gear-mech., 3: link-mech., 4: cam-mech.	1: liner, 2: smooth-liner, 3: very-smooth-liner, 4: round, 5: smooth round, 6: very smooth round
Constraint of motion	1: rigidity-mech., 2: ball-bearing-mech., 3: sliding-mech.	1: liner, 2: weak-radial, 3: strong-radial, 4: weak-thrust, 5: strong-thrust
Fixation of motion	1: bolt-and-nut, 2: bolt-only, 3: friction-mech., 4: bearing-fit, 5: key-fit, 6: river-fit, 7: shrinkage-fit	1: stationary-object, 2: revolutionary-object

B. Creation of the Function Feature Ontology,the Manufacturing Feature Ontology, and the Relation Between the Two Ontologies

Fig.1 shows the function feature ontology, the manufacturing feature ontology, and the relation between the two ontologies. Two steps for the creation of the function feature ontology, the manufacturing feature ontology, and the relation between the two ontologies are as follows.

1) Creating a function feature ontology. A function feature is defined here as a geometric shape and its functions as intended by the designer. For the creation of a function feature ontology, first, features such as slot, step etc are listed up. This research uses the list of features proposed in [8]. Then, sub-classes of these features are created by describing the required functions of the face elements that construct the features.
2) Creating the manufacturing feature ontology. First, manufacturing features such as step, slot etc are listed up. Sub-classes of these manufacturing features are created by describing the general manufacturing methods to create the parent classes. Sub-classes of these sub-classes are created to have their relation with the function feature ontology. The relation between the classes in the lowest level of the manufacturing feature ontology and the function feature ontology represents how the manufacturing features should be manufactured to fulfill the required functions of the face elements that construct the manufacturing feature.

In Fig.1, an "internal turning and milled blind-hole" feature class is created to relate the round blind-hole feature class of the manufacturing feature ontology with the "round blind-hole with 2 faces require: Basic: fixation, Mechanism: bearing fit, Motion: stationary-object, 1 face requires: Basic:constraint, Mechanism: ball-bearing, Motion: strong-thrust" class of the function feature ontology. This is done since the internal turning and milling can create the round blind-hole as intended by the designer. Then, in the development of the feature library, a collection of possible manufacturing information, such as machine and tool data, etc for the instances of the "internal turning and milled blind-hole" feature class should be prepared so that when a round blind-hole feature is extracted by a feature recognition method, and the functional properties of face elements that construct the round blind-hole feature lead to the extraction of the "internal turning and milled blind-hole" feature class, a proper manufacturing information can be extracted automatically from the instances of the manufacturing feature class. Thus, by developing the feature library based on the proposed structure, the feature library can be useful for the automatic extraction of manufacturing features with their proper manufacturing information. The automatic

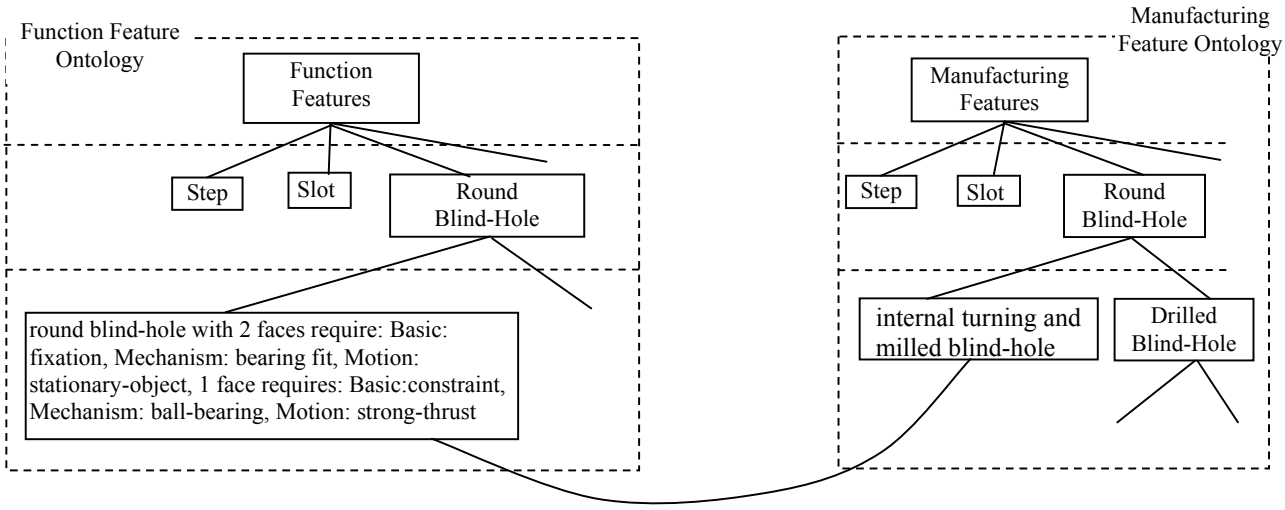

Fig. 1 Function Feature Ontology, Manufacturing Feature Ontology, and the relation between the two ontologies

extraction of manufacturing features with their proper manufacturing information is very useful for the realization of a manufacturing feature-based CAPP system.

III. The Wiki-Based Feature Library

A. Semantic Extension of MediaWiki

MediaWiki is a Wiki software that is written in PHP and uses MySQL database. It is being used to run the Wikipedia and also other encyclopedia and dictionary sites. MediaWiki is a very useful tool for collaborative content management.

An extension of MediaWiki to enable the writing of the labeled link has been proposed [9]. This extension has enabled the Wiki to write Resource Description Framework (RDF) statement, which consists of subject-predicate-object triple. The Wiki syntax is [[Term:target_page|property]]. The RDF triple is <source_page> <property> <target_page>. Each time the Wiki syntax is used, the Wiki engine will store the RDF triple into a table in the Wiki database. By directly querying the table, the labeled link relation will be displayed as follows.

1) On the source_page: -> property -> target_page
2) On the target_page: <- property <- source_page
3) On the property: source_page -> target_page

Fig.2 illustrates the RDF triple construction and the relation of pages displayed on the Wiki pages in the extended MediaWiki. The extended MediaWiki as an extension of MediaWiki has the benefit of having all the functions available in MediaWiki as a content management system, and can be used as an editor of metadata according to simple RDF statement.

The running system of the extended MediaWiki is available at http://semanticwiki.jp. It uses the MediaWiki 1.3.11 version as the base system.

The development of the Wiki-based feature library is based on the extended MediaWiki proposed in [9].

B. Developing a Wiki-Based Feature Library

For the development of the Wiki-based feature library, further extension of MediaWiki is done. New namespaces are created. Namespace ("FF:") is created to deal with the function feature ontology, and namespace ("MF:") for the manufacturing feature ontology. New tables are also created in the Wiki database to deal with the new namespaces.

For the creation of the function feature ontology, the Wiki syntax [[FF:feature_subclass|subclass]] is used (see Fig.3). When the Wiki syntax is written on the parent class page, the Wiki engine will store the RDF triple into a table which deals with the namespace ("FF:") in the Wiki database. By directly querying the table, the labeled link relation will be displayed as follows.

1) On the parent class page: -> subclass -> feature_subclass (see Fig.4)
2) On the feature_subclass page: <- subclass <- parent class (see Fig.5)
3) On the subclass page: parent class -> feature_subclass (see Fig.6)

The "FF:subclass" page can be used to see all the class-sub-class relations of the function feature ontology.

For the creation of the manufacturing feature ontology, the Wiki syntax [[MF:feature_subclass|subclass]] is used. When the Wiki syntax is written on the parent class page, the Wiki engine will display the labeled link relations in the same way as in the function feature ontology. The "MF:subclass" page can be used to see all the class-sub-class relations of the manufacturing feature ontology.

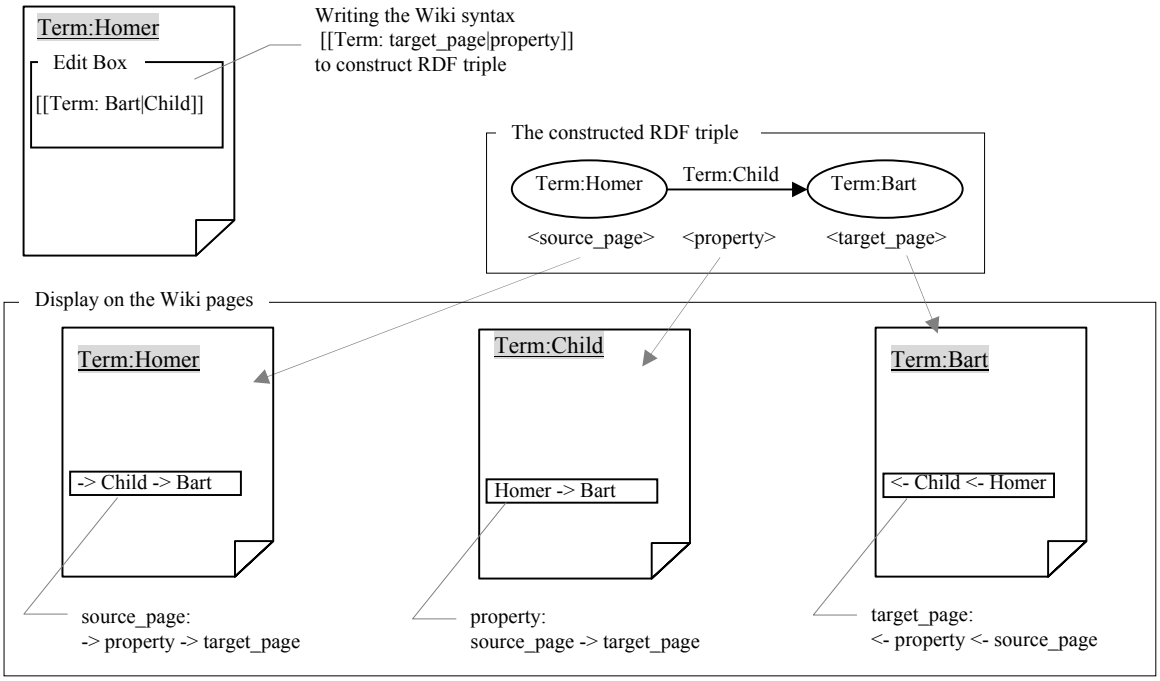

Fig. 2 RDF triple construction and the display on the Wiki pages in the extended MediaWiki

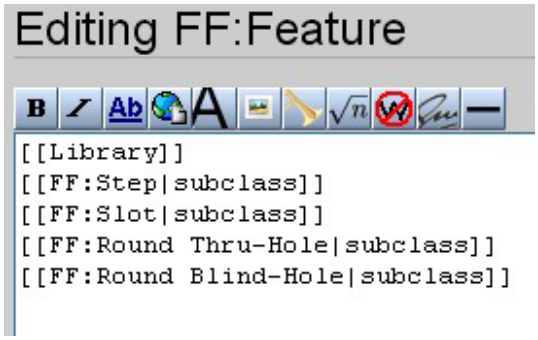

Fig. 3 Writing the Wiki syntax [[FF:feature_subclass|subclass]]

Fig. 4 Display on the parent class page

Fig. 5 Display on the feature_subclass page

Fig. 6 Display on the subclass page

For the class-instance relation in the manufacturing feature ontology, the Wiki syntax [[MF:feature_class]] is used. When the Wiki syntax is written on the instance page, the Wiki engine will display "Class:feature_class" on the instance page. On the feature_class page, the instance will be listed under the "MF Instance" column.

Fig.7 and Fig.8 illustrate the page relations of the function feature ontology and the manufacturing feature ontology in the Wiki-based feature library, respectively.

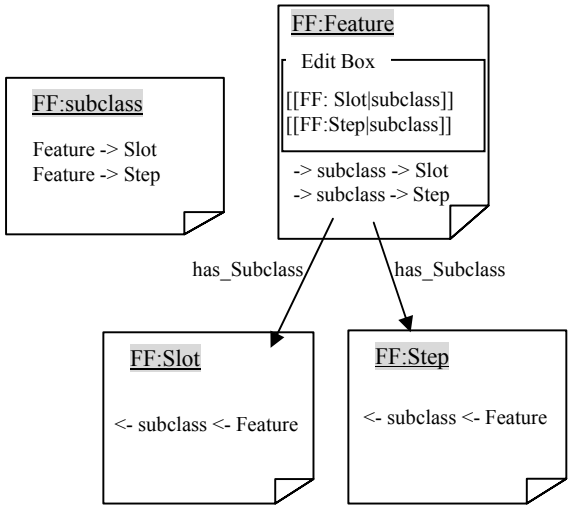

Fig. 7 Page relations in the function feature ontology

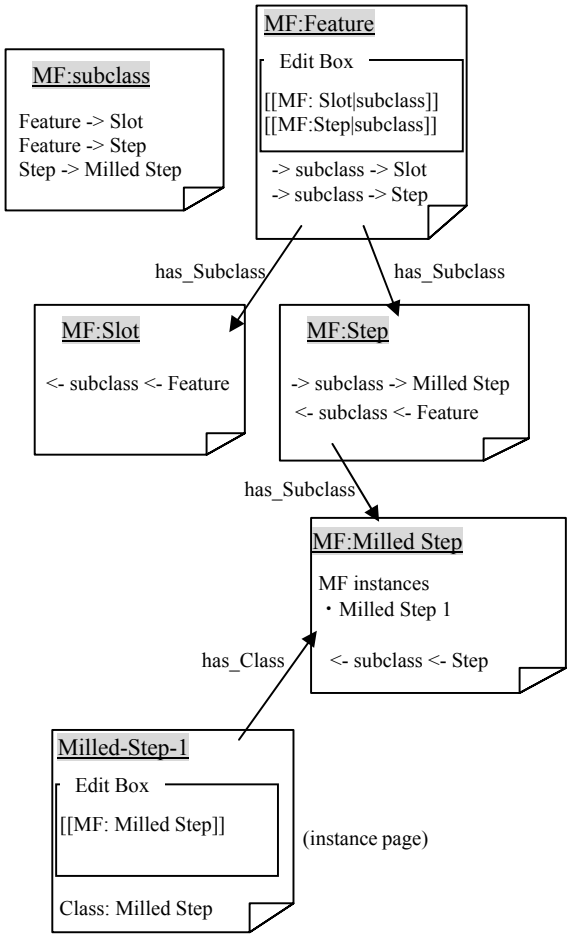

Fig. 8 Page relations in the manufacturing feature ontology

To make the relation between the lowest sub-class of the function feature ontology and the lowest sub-class of the manufacturing feature ontology, the Wiki syntax [[MF:manufacturing_feature_class|related]] is used. Fig.9 shows the Wiki syntax writing on the function_feature_class page. When the Wiki syntax is written on the function_feature_class page, the Wiki engine will display the labeled link relation as follows.

1) On the function_feature_class page: -> related -> manufacturing_feature_class (see Fig.10)
2) On the manufacturing_feature_class page: <- related <- function_feature_class (see Fig.11)
3) On the related page: function_feature_class -> manufacturing_feature_class (see Fig.12)

The "MF:related" page can be used to see all the relations between the lowest sub-class of the function feature ontology and the lowest sub-class of the manufacturing feature ontology.

The Wiki-based feature library is able to construct the function feature ontology, the manufacturing feature ontology, and the relation between the two ontologies. The Wiki-based feature library can be easily, visibly and collaboratively modified. And since the original MediaWiki has the capability to manage contents, it can be used to manage the manufacturing information flexibly.

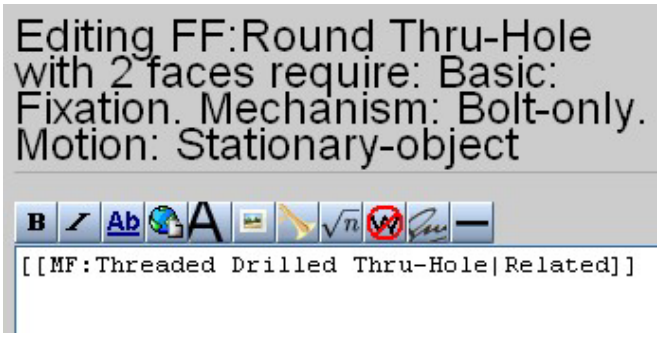

Fig. 9 Page relations in the function feature ontology

Fig. 10 Display on the lowest sub-class of the function feature ontology

Fig. 11 Display on the lowest sub-class of the manufacturing feature ontology

Fig. 12 Display on the "MF:Related" page

IV. Conclusion

This research can be summarized as follows.

1) The feature library consists of the function feature ontology and the manufacturing feature ontology. The relation between the classes in the lowest level of the manufacturing feature ontology and the function feature ontology represents how the manufacturing features should be manufactured to fulfill the required functions of the face elements that construct the manufacturing feature. By developing the feature library based on the proposed structure, the extraction of manufacturing features with their proper manufacturing information for the generation of process plans is made possible.
2) MediaWiki is modified for the development of the feature library. The Wiki-based feature library is able to construct the function feature ontology, the manufacturing feature ontology, and the relation between the two ontologies. The Wiki-based feature library is a very simple system, and as one tries to modify the feature library, one may enjoy the visible modification of the feature library.

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