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Multilingual Product Retrieval Agent through Semantic Web and Semantic Networks

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This paper presents a method for the multilingual product retrieval agent through XML and the semantic networks in e-commerce. Retrieval for products is an important process, since it represents interfaces of the customer contact to the e-commerce. Keyword-based retrieval is efficient as long as the product information is structured and organized. But when the product information is expressed across many online shopping malls, especially when it is expressed in different languages with cultural backgrounds, buyers' product retrieval needs language translation with ambiguities resolved in a specific context. This paper presents a RDF modeling case that resolves semantic problems in the representation of product information and across the boundaries of language domains. With adoption of UNSPSC code system, this paper designs and implements an architecture for the multilingual product retrieval agents. The architecture is based on the central repository model of product catalog management with distributed updating processes. It also includes the perspectives of buyers and suppliers. And the consistency and version management of product information are controlled by UNSPSC code system. The multilingual product names are resolved by semantic networks, thesaurus and ontology dictionary for product names.

Key words : Multilingual Product Retrieval, XML, Semantic Web, Semantic Networks, E-commerce, UNSPSC

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1. Introduction

An e-commerce system that is web-architected supports distributed intelligence, reliability, scalability, and flexibility. It has tiers, which is different from a traditional architecture. First, the client tier is extremely thin. Second, the business rules tier is based on components, not a single monolithic layer. These days many researchers are moving toward application architecture issues. The architecture issues address the impending problems without losing flexibility and potential appropriation. One of the key processes in the architecture issues is searching for products or retrieval services for the potential buyers in Internet. From the point of buyers' view

the searching processes over the World Wide Web are tightly related with efficiency in the electronic transactions.

Classification systems for products play a key role in developing solutions for product retrieval using standard frameworks for e-commerce(Zhao, 2003). That is, it is important to standardize e-catalogs of the classification system for products. In reality, e-catalogs are developed independently in each industry. Therefore, we need to integrate product information across industries and across languages for globalized e-commerce environment. The complexities of language translation and product information representation are mixed in web-based e-commerce sites. And endeavors to solve these complexities lead to the Semantic Web implementation in e-commerce. The advances of integration technologies and mechanisms based on web paved the way to design a multilingual product retrieval agent with semantic processing capabilities. We propose an architecture for a multilingual product retrieval agent based on the Semantic Web to solve the complexities of language translation and product information representation.

2. Literature Review

To process product information in Internet for e-commerce we need to develop XML-based knowledge representation(Anutariya et al. 2003). Self-describing features of XML trigger problems of integration among web-based documents(Choi and Joo, 2002). Each developer may use a different set of XML tags and structures, which result in the chaos of semantic interpretations. This limitation of XML invokes Semantic Web activities(Cruz, 2001; Fu et al. 2002). Semantic Web can give formal structures to web-based documents, enabling the software agents to automate semantic processing on behalf of users.

XML has definite limits on semantic representation of structures in a consistent way (Chao-Min, 2000). So it may be used for integration mechanism at the conceptual level for the product retrieval agents. Therefore, we need Semantic Web implementation technology to deal with various product information and multilingual problems involved in globalized e-commerce environments, even when we are using the e-catalogs(Baron et al. 2000; Stanoevska-Slabeva and Schmid, 2000).

RDF(Resource Description Framework) is a cornerstone of Semantic Web, in which RDF represents semantic relations by subjects, predicates and objects(Fensel et al. 2003; Geroimenko and Chen, 2003). RDF provides minimal consistency without losing flexibility, and it delegates domain-dependent representation to ontologies(W3C, 2000). Some ontologies are contained in a e-catalog system(Stanoevska-Slabeva and Schmid, 2000). Semantic Web will make computer-operated web data possible to be automated, integrated and reused(Berners-Lee, 2001; Berners-Lee, 2000).

Ontology is used for knowledge

representation of facts or states defined by the entities and their relationships. Ontology is an enabler for Semantic Web technologies (Desmontils and Jacquin, 2003). Ontology provides relevant domain knowledge to RDF (Broekstra et al. 2002; Horrocks and Hendler, 2002), which has relational structures among resources, properties, and values. Well-defined ontologies on relevant domain is a prerequisite for semantic applications in e-commerce(Gruber, 1993).

Semantic networks represent hypernyms of word senses in the form of isa-hierarchies. WordNet (Miller et al. 1993) is a kind of semantic networks for English based on psycholinguistic theories. It represents lexical concepts in the form of isa-hierarchies of each word sense. Synonym sets(synsets) express lexical concepts of English nouns, adverbs, adjectives and verbs. Each synset represents one underlying lexical concept. This paper refers to WordNet for nouns as a knowledge base for disambiguation of word senses in English product names.

Semantic networks for Korean nouns have been built for sets of ISA hierarchies for Korean nouns, which is called Korean Noun Networks (KNN)(Moon, 2001). The ISA hierarchies consist of nodes and edges. The nodes represent synonym sets of Korean nouns and English WordNet. The edges represent hypernymous relations among nodes. In this paper, KNN are utilized to automatically extract sets of hyponymous concepts. This paper refers KNN as a knowledge base for disambiguation of word senses in Korean product names.

There are many kinds of agents for e-commerce, for example, agents for recommendation, agents for negotiation, agents for comparison shopping, agents for e-catalog management and etc. Agents proposed in this paper have common characteristics with agents for recommendation and comparison shopping. Agents for recommendation need to meet the conditions as follows. Firstly, acquisition of users' information should follow the semantic relationships of web-based documents or contents. Secondly, agents have to show flexible responses to changes in web site contents. Thirdly, they need to accommodate, incrementally and persistently, user requirements' change. Fourthly, they should have natural user interfaces. Fifthly, they need implicit methods to draw user

<Table 1> General Characteristics of E-commerce Frameworks

Framework	Structure	Applicable Industry	Major Groups
ebXML	horizontal	General	OASIS, UN/CEFACT
RossetaNet	vertical	IT/EC/SM	IBM, Intel, and other commercial corp.'s
BizTalk	horizontal	General	Microsoft
eCo	horizontal	General	CommerceNet

requirements. Finally, they should allow continuous learning for performance enhancements. With these features enabled, we need distributed agent for management of product codes using e-catalogs(Baron et al. 2000).

Standardization can contribute to reduce development costs(Zhao, 2003), and to facilitate interoperability among heterogeneous systems (Jhingran and Pirahesh, 2002). Several propositions for standardization have been published for interoperable B2B business frameworks. Most of them are based on XML. The most popular standardized frameworks are BizTalk by Micoroft, RossettaNet by IBM and Intel, ebXML by UN/CEFACT and OASIS. <Table 1> summarizes these popular frameworks.

There are two kinds of product code for e-commerce: product classification codes and product identification codes. Product classification codes enable categorical searches by grouping similar products, and product identification codes match a specific product to a code. UNSPSC (Universal Standard Products and Services Classification) code systems has been developed especially for e-commerce. It is the one of the best code system for alignment of diverse systems in distributed environments. The characteristics of UNSPSC code system are as follows. Firstly, it fits e-commerce, ERP, spend analysis and etc. Secondly, product categories are adjustable to almost all of the industries. Thirdly, the classification is detailed and publicly accessible without restriction.

Central repository model is for the alignment of e-catalog storages by ebXML and UDDI technologies. There are other e-catalog alignment models such as the single server model, the virtual catalog model, and the mediator model.

3. Design of Multilingual Product Retrieval Agent

The architecture utilizes the central repository model for e-catalog management. Central repository model is a pull model that the users register their product codes voluntarily, and the repository maintains the catalog information providing access to anyone. We used UNSPSC as product code system which provides consistent digit-based universal product and service codes across language variants.

The proposed architecture reflects both buyers' and suppliers' perspectives in product information integration. Structures in the directories of product information may be maintained individually. The digit-based product code system gives the consistency across different mechanisms involved.

Ambiguity and uncertainty involved in synonyms, homonyms and polysemys can be processed for product names by semantic networks, thesaurus and ontology dictionary for product names. [Fig. 1] illustrates examples of synonyms which will be solved by semantic networks for each language. [Fig. 2] illustrates examples of a pair of homonyms and a pair of polysemys which will be solved for convenient

user interfaces by ontology dictionary and thesaurus for products, from the viewpoint of buyers and suppliers. Referencing thesaurus may provide relevant terms and concepts, but it can not provide semantic differences in computer-operable ways. So, ontology dictionary for product names is introduced for differentiation of polysemys illustrated as in [Fig. 2].

RDF is a representation of metadata for resources(Moon, 2001; Jhingran and Pirahesh, 2002). Generally, it applies to information on the web sites. Ontologies on product information may be integrated with RDF modelings to facilitate product retrieval on web sites. In [Fig. 3], 'Shoes' is represented by RDF codes. The UNSPSC code of Shoes is 53111600: 53 for segment, 11 for family, 16 for class, 00 for commodity. <Table 2> shows the composition of UNSPSC code for 'Shoes', 'Men's Shoes', 'Women's Shoes', 'Skate Shoes'.

[Fig. 3] illustrates an example ontology of shoes represented in RDF codes. The RDF codes show the hierarchy of product information.

[Fig. 4] shows one of XML implementation examples of properties for Skate Shoes.

[Fig. 5] illustrates the architecture in which our proposed retrieval agent works. The main characteristics of the proposed product retrieval agent are as follows:

- Knowledge bases: common product code (UNSPSC), product ontology, common e-catalogs, bilingual dictionary, multilingual semantic networks and thesaurus
- Perspectives: buyers' and merchants' perspectives
- Management model of e-catalogs: central

lorry --- truck purse --- pocketbook

[Fig. 1] Examples of Synonyms in Product Names

foil -> sheet metal, foil -> fencing sword
bonnet -> hat, bonnet -> protective covering (ex. a part of car)

[Fig. 2] Examples of Homonyms and Polysemys in Product Names

<Table 2> Examples of UNSPSC Codes for Products

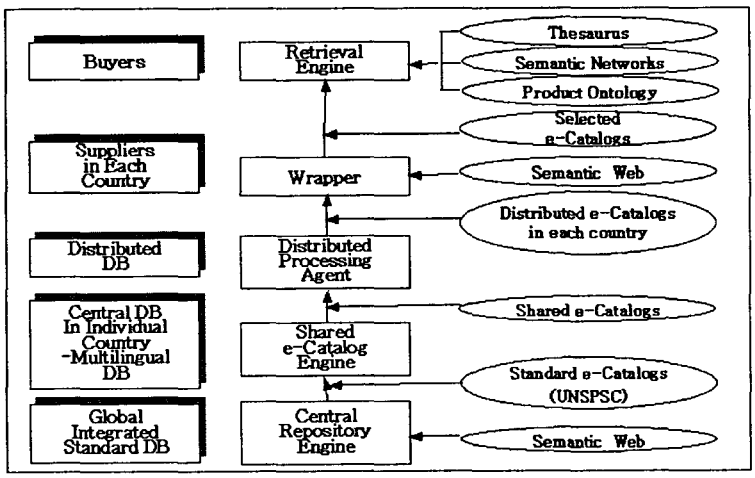
Product	Segment	Family	Class	Commodity
Shoes	53	11	16	00
Men's Shoes	53	11	16	01
Women's Shoes	53	11	16	02
Skate Shoes	49	15	16	02

```
<rdf:RDF xml:lang="en"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
<rdf:Description ID="Shoes">
  <rdf:type resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdfs:subClassOf rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
  </rdf:Description>
<rdf:Description ID="Men'sShoes">
  <rdf:type resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdfs:subClassOf rdf:resource="#Shoes"/>
  </rdf:Description>
<rdf:Description ID="Women'sShoes">
  <rdf:type resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdfs:subClassOf rdf:resource="#Shoes"/>
  </rdf:Description>
<rdf:Description ID="SkateShoes">
  <rdf:type resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdfs:subClassOf rdf:resource="#Shoes"/>
  </rdf:Description>
</rdf:RDF>
```

[Fig. 3] Examples of XML Representation of Product Ontology

```
<RDF xmlns:a="http://mislab.hufs.ac.kr/catalog#">
<rdf:Description ID="SkateShoes">
  <a:Price_Of>$50.00</a:Price_Of>
  <a:Color_Of>Gray</a:Color_Of>
  <a:Size_Of>5</a:Size_Of>
  <a:Width_Of>Medium</a:Width_Of>
  </rdf:Description>
</rdf:RDF>
```

[Fig. 4] XML Representation of Properties for Skate Shoes



[Fig. 5] Architecture of A Product Retrieval Agent

repository model with distributed processing environments

- Level or range: buyers, merchants, suppliers, product information processing procedures in each country, globally integrated standard catalogs

In this paper we utilized semantic networks to solve ambiguities about synonyms, homonyms and polysemys in system implementation. The architecture covers overall interactions among components involved in product retrieval processes. The architecture is based on central repository model of e-catalog management using globally integrated standardization around product information. Central repository model is an alignment model for industry e-catalog storages using ebXML and UDDI. And the classification structures are to be implemented in XML, specifically in Semantic Web..

Data consistency is maintained by 8-digit (optionally 10-digit) coded UNSPSC. UNSPSC code system is well suited for external interoperability for product information, and is specifically developed for electronic commerce. The problems of static product code system can be alleviated by the semantic networks that support semantic-based retrieval process from the buyers' perspective.

4. Implementation of the Agent for Product Retrieval

In this chapter, we describe the main implementation algorithms of ambiguous product names which are not included in UNSPSC code system for convenient multilingual product retrieval processes. And we define several functions for algorithms for the multilingual product retrieval agent, as follows.

UNSPSC(user) : a set of UNSPSC list translated into language used by the user.
UNSPSC_CODE(pn) : UNSPSC code of pn in UNSPSC list.
SYNSET(pn) : a set of synset of pn extracted from semantic networks.
HYPERNYM(pn) : an ordered list of hypernyms extracted from ontology dictionary for product pn.
HYPONYM(pn) : an ordered list of hyponyms extracted from ontology dictionary for product pn.
SEMANTIC_NETWORKS(user) : a set of semantic networks for the language used by the user.
THESAURUS(user) : a set of thesaurus for product names written in language used by the user.
RELATED(pn) : an ordered list of a product name related with pn in thesaurus.
TRANSLATED(pn) : translated pn into English using bilingual dictionary.

When a retrival keyword is not a product name but a product category, the algorithm for a product category suggests product names belonging to the product category and lets the user select a product name which the user wants to retrieve.

```
ProductCategory(pn, user) :
  Input of pn(a product name or product category name)
  From the user;
  if (pn is found in UNSPSC(user)) and (CATEG(pn) = 00)
  then U_code = UNSPSC_CODE(user)
  else exit();
  EndIf;
  for i = 1 to 99 {
    U_code = U_code + 1;
    if U_code is found in UNSPSC(user)
    then display U_code and its corresponding pn;
  }EndFor

  Let the user select what he wants to retrieve from the
  displayed lists;
```

```
   if the user selects one item,
   then return the item and UNSPSC_CODE(item);
EndProductCategory
```

Algorithm for synonyms in product names selects the product name and code from UNSPSC code system for each language, using semantic networks and a product ontology dictionary for product names.

```
RetrievalForSynonyms(pn, user) :
   Input of a product name (pn) from the user;
   if pn is found in UNSPSC(user)
   then return the UNSPSC code
   else if SEMANTIC_NETWORKS(user) is not found
            then { pn = TRANSLATED(pn); user=English;}
        EndIf;
   EndIf;
   find SYNSET(pn) from SEMANTIC_NETWORKS(user);
   if SYNSET(pn) is null   then exit();
    for each i in SYNSET(pn) {
       if i is found in UNSPSC(user)
         then return i &UNSPSC_CODE(i);
       for each j in HYPONYM(i) from SEMANTIC_
       NETWORKS(user)
          if  j is found in UNSPSC(user) then display i&j;
       for each k in HYPERNYM(i) from SEMANTIC_
       NETWORKS(user)
          if k is found in UNSPSC(user) then display i & k;
    }  EndFor

   Let the user select what he wants to retrieve from the
   displayed lists;
   if the user selects one item,
   then return the item and UNSPSC_CODE(item);
EndRetrievalForSynonyms
```

Algorithm for homonyms in product names selects the product name and code from UNSPSC code system using ontology dictionary for product names.

```
RetrievalForHomoyms(pn, user) :
   Input of a product name (pn) from the user;
   If pn is found in UNSPSC(user) more than once
       then find all pairs of pn & UNSPSC_CODE(pn)
       else exit();
   EndIf;
   for each i in all pairs of pn & UNSPSC_CODE(pn) {
   find HYPERNYM(i) from a pn ontology dictionary;
   display i & HYPERNYM(i);
   } EndFor

   Let the user select what he wants to retrieve from the
   displayed lists;
   if the user selects one item,
   then return the item and UNSPSC_CODE(item);
EndRetrievalForHomonyms
```

Algorithm for polysemys in product names selects the product name and code from UNSPSC code system using a product ontology dictionary and thesaurus for product names.

```
RetrievalForPolysemys(pn, user) :
   Input of a product name (pn) from the user;
   If pn is found in the entry of THESAURUS(user) more
   than once
       then find all pairs of pn & UNSPSC_CODE(
       RELATED(pn))
       else exit();
   EndIf;
   for each i in all pairs of pn & UNSPSC_CODE
   (RELATED(pn))
       display i & RELATED(i);

   Let the user select what he wants to retrieve from the
   displayed lists;
   if the user selects one item,
   then return the item and UNSPSC_CODE(item);
EndRetrievalForPolysemys
```

The product names and the product codes extracted by the above algorithms make it possible to perform efficient and exact product retrieval from the shopping mall websites which employ semantic webs.

The suggested algorithms were tested for the agents of keyword-based product retrieval. If the product name for retrieval exists in UNSPSC code system in English or in the other languages, the agent returns the exact UNSPSC code number and the product retrieval is performed well as the

user wants.

If the product name for retrieval is "lorry" in English, which is a synonym of "truck" in UNSPSC code system, the agent searches synonym sets of the word "lorry" through semantic networks. Each member of synonym sets is compared with product names in UNSPSC code system. And its hyponyms and hypernyms through semantic networks are compared with product names in the code system. When some of synonym sets, hypernyms and hyponyms are matched with the product names in the code system, they are displayed and selected by the user. If the product name for retrieval is the other language than English, the agent utilizes semantic networks for the other language. And if semantic networks for the other language than English do not exist, the agent utilizes semantic networks for English.

If the product name for retrieval is a homonym, which is found more than once in UNSPSC code system, the agent searches hypernyms of the homonym from ontology dictionary in the code system. And its hypernyms are displayed and selected by the user.

If the product name for retrieval is a polysemy, which has more than one meaning, the agent searches related words of the polysemy through thesaurus and semantic networks. All of the related words are compared with the product names in UNSPSC code system. If some of them are matched with product names in the code system, they are displayed and selected by the user.

5. Conclusion

An e-commerce system that is web-architected supports distributed intelligence, reliability, scalability, and flexibility. It has tiers, which is different from a traditional architecture. First, the client tier is extremely thin. Second, the business rules tier is based on components, not a single monolithic layer. These days many researchers are moving toward application architecture issues. Recently proposed semantic web mechanisms provide new opportunities for web product retrieval processing. Keyword-based retrieval is efficient as long as the product information is structured and organized. But when the product information is expressed across many online shopping malls, especially when it is expressed in different languages with cultural backgrounds, buyers' product retrieval needs language translation with ambiguities resolved in a specific context. We presented a RDF modeling case that resolves semantic problems in the representation of product information and across the boundaries of language domains

With adoption of UNSPSC code system, we designed and implemented an architecture for the multilingual product retrieval agent. The architecture was based on the central repository model of product catalog management with distributed updating processes. It also included the perspectives of buyers and suppliers. And the consistency and version management of product information were controlled by UNSPSC code system. The multilingual product names were

resolved by semantic networks, thesaurus and ontology dictionary for product names.

Classification standards representing products in electronic commerce require researches on design and implementation issues to validate the industrial guidelines involved in the standard-setting procedures. UNSPSC code system should be standardized in the product code system and in the integration of product information all over the industries.

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요약

Semantic Web과 Semantic Network을 활용한 다국어 상품검색 에이전트

문유진*

상품검색은 고객들이 전자상거래의 접촉을 시작하는 인터페이스로서 매우 중요한 프로세스이다. 또한 전자상거래는 고객들에게 검색 시 쉽게 접근할 수 있는 프로세스를 제공하여야 한다. 특히 World Wide Web에서 상품정보는 광범위한 고객들이 신속하게 팽창하는 정보를 추적하기 위해서 통합과 표준화가 이뤄져야 한다. 상품 카탈로그(catalogue)에 대한 국제 표준화가 다양한 분야와 업종에서 구축되어져 왔는데, 요즈음은 UNSPSC((Universal Standard Products and Services Classification) 코드로의 수렴에 대한 논의가 활발해지고 있다. 이 표준을 채택하여 이 논문은 다국어상품검색 에이전트의 아키텍처(architecture)를 설계한다. 이 아키텍처는 중앙등록기 모델의 상품 카탈로그 관리를 기반으로 하여 분산처리의 update 프로세스를 채택한다. 또한 이 아키텍처는 구매자 관점과 공급자 관점을 모두 고려한다. 상품정보의 일관성과 버전 관리는 UNSPSC 코드 시스템에 의하여 제어된다. 고객이 사용하기 편리하도록 표준화에 포함되어져 있지 않은 상품명과 다국어 상품명은 Semantic Network, 시소러스(thesaurus)와 Semantic Web의 상품명 온톨로지 등을 활용하여 해결한다. 이를 위한 알고리즘들을 설계하고 또한 구현한다.

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