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A Study on Agricultural Product Warehouse Management based on Ontology

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온톨로지기반 농수산물 창고관리에 관한 연구

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Abstract

This paper proposes an ontology-based context aware system model for the purpose of storing and managing agricultural products using ubiquitous sensors to share and distribute information. In these days, according to penetrating ubiquitous technologies into our way of life, the importance of information is increasing gradually. The importance of ontology in a domain is getting as well. Therefore, this paper designs and build an ontology-based agricultural products warehouse model using context aware state information obtained by using wireless sensors. Also, it shows the result described by graphical ontology results to share common understanding on the structure of context information among users, devices and services to enable semantic interoperability owing to the information of the context aware state of the warehouse.

요 약

본 논문에서는 농수산물을 저장·관리를 목적으로 유비쿼터스 센서로부터 획득한 상황 정보를 활용하여 창고관리 정보를 공유하고 분산시키기 위한 온톨로지 기반 상황인지 시스템 모델링에 관하여 제안한다. 오늘날 우리 생활 속에 유비쿼터스 기술이 확산됨에 따라 정보에 대한 중요성은 더욱 증가하고 있다. 뿐만 아니라, 하나의 도메인에 대한 온톨로지의 중요성도 또한 증가하고 있다. 그러므로 본 논문에서는 상황정보 상태에 대한 정보를 획득하기 위해서 무선 센서로부터 획득한 정보가 온톨로지에서 활용될 수 있도록 온톨로지 기반의 농수산물 웨어하우스 모델을 설계한다. 이를 통해 농수산물용 창고 관리가 상황정보에 따라 사용자, 장치들 및 서비스 사이에 의미가 상호 연동할 수 있는, 의미정보 구조에 대한 공통의 이해를 공유할 수 있도록 온톨로지로 표현된 결과를 보인다.

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Ⅰ. INTRODUCTION

A recent warehouse management system which is necessary to store and distribute agricultural products and others operates on managing from production to cultivation and distribution. By using the information derived from the warehouse management system, it is an affirmative effect that customers place confidence in the originality and cultivation data of agricultural products. The reason that confidence of agricultural products such as food is very important is needless to mention.

However, in spite of delivering without delay, the courses to deliver the agricultural products from production to customers have many delivery processes in which require periods and temporary places to store the products. In case of agricultural productions, storing the products in warehouses is crucial to affect the freshness and quality of goods. Therefore, it needs a warehouse with maintaining the optimum condition to keep the freshness of products.

The development of warehouse management system based on technology using RFID/USN brings a problem awaiting solution to store and keep the freshness of the agricultural product in an agricultural exportation with strengthning the competitiveness[1]. Therefore, this paper is to solve and suggest a methodology as an expediency with ontology modeling.

In ubiquitous environment, using tools such as RFID/USN, by pushing computers into the background, embodied virtuality will make individuals more aware of the people on the other ends of their computer links and cope with the state of the changeable of which is a context aware[1,2,3]. It has been used to be characterized the faced environment in accordance with the state of people, place, physical computing device[4]. With the context aware information which has received from sensors, it can build OWL based context ontology and use abstraction to manage efficiently sensor data.

The rest of this paper is organized as follows. Part 2 begins the discussion on related work. In part 3, it reviews and describes the modeling concept, followed by the architecture design and analysis briefly in sub-sections. Finally, part4 is the conclusion.

Ⅱ. RELATED WORKS

To secure the harmonious flow of all supply-chain, it needs a Warehouse Management System(WSM) which has functions of warehousing of goods and taking goods out of the warehouse, storing, preservation of quality and processing of information for the product[1]. The warehouse management generally has implied the functions of inventory control, storing, classification and distribution. However, in addition to the above things, the warehouse management has more various functions to create valuable added things.

WMS consists of 3 steps : inbound process, outbound process and internal process. The warehouse management service generally has functions of receiving data for expected arrival of goods and processing the work information management of warehousing operators. According to the service functions, the warehousing management service also has functions that set the proper strategies and make reports.

In outbound process, WMS has functions that set an output schedule, review the amount of shipping and manage the status of shipping. In according to the above, functions of WMS has contained stocktaking of warehouse and histories of stock information etc.

Specially, RFID is capable of reading and writing

compared to conventional bar-code system including processing several tasks at the same time, so that the technology is evaluated as an innovative technology in logistics industry[2]. In addition, to keep optimal states of goods inner warehouse using USN in ubiquitous environment, much research has been done in the area of context-aware computing in the past few years[5]. So, context-aware computing has been drawing much attention from researchers since it was proposed about a decade ago. A number of context-aware system have been developed to demonstrate the usefulness of this new technology, such as Context Toolkit[6], HP's Cooltown[7] and MIT's AIRE spaces[8], whereas some other systems are still under research.

Context-aware systems, however, have never been widely available to everyday users because building context aware systems is still complex and time-consuming task. Therefore, this paper is first to consider the context-aware system models based on ontology using OWL to support various tasks in some other aspects and show the usefulness. The existing context models is classified into three categories[5]:

A. Application-oriented approach:

In this approach, a lot of context aware systems model represent context only for specific applications. For example, HP's Cooltown[7] project proposed a web-based context model which retrieves object using URL. The application oriented approach lacks the formal basis and does not support knowledge sharing across different systems.

B. Model-oriented approach:

This approach generally uses conceptual modeling methodology to represent context. ER-based context model was proposed by several projects [9][10]. Also, the context can be easily managed with relational databases. Though this approach supports formality, this does not address issues including knowledge sharing and context reasoning.

C. Ontology-oriented approach:

Ontology-oriented methodology is focusing on constructing an ontology for context in a specific domain to reach the goals of knowledge sharing across distributed systems. The context is developed based on RDF to represent context by means of session profiles. Therefore, it uses a warehouse domain to share the information for context aware using wireless sensors.

III. ONTOLOGY BASED WAREHOUSE MANAGEMENT

In this part, it describes a typical scenario in order to illustrate our modeling concept and show ontology-based context aware system architecture.

3.1 SYSTEM ARCHITECTURE

In this part, it describes ontology classes and shows ontology-based context aware system model architecture. The system model aims to help application programmers to build context aware services efficiently.

The architecture is composed of three component modules as shown in figure 1:ubiquitous sensor layer, diagnostic context, context aware services.

Context aware service module: at this layer, the context aware services module can serve to convert the diagnosis of the context state from the internal context and external provider to OWL representation so that contexts can be shared and served by other components.

Diagnostic context module: diagnostic context component consists of external/internal contexts, context Db used by external and internal contexts and context rule interface which uses ontology. Context DB provides the service that other components can query and manipulate context stored in the database.

Ubiquitous sensor layer: ubiquitous sensor can get and serve the information of the context aware from device sensors and context sensors to be diagnosed of which the result is transferred to

diagnostic context component.

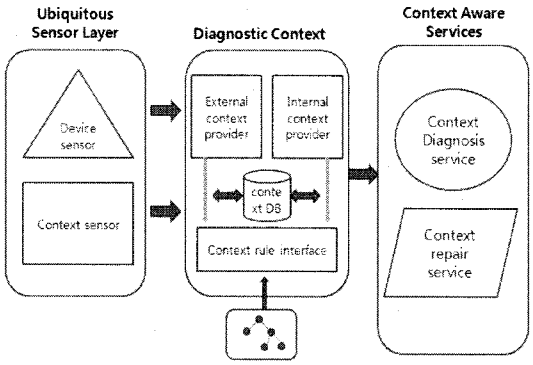


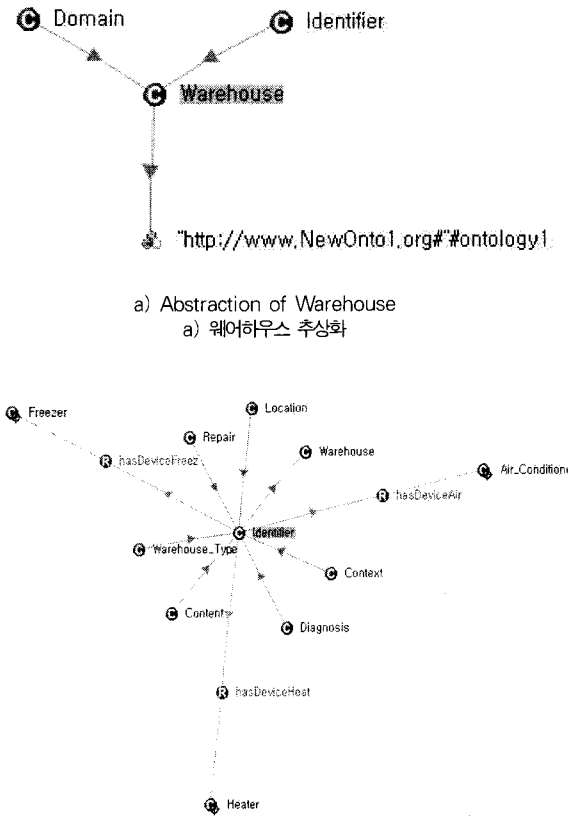
Fig 1. Overview of context aware model architecture
그림 1. 상황인지 모델 구조

3.2 Ontology-based context aware scenario

In In this part, it uses a temperature sensor and an humidity sensor to measure physical context information, and it describes a typical scenario in order to illustrate our modeling concept using conceptual ontology for warehouse in table 1. The main advantage of our context model is also sharing common understanding on the structure of context information among users, devices and services to enable semantic interoperability.

"Today is the 24th of January 2010. The thermometer in a warehouse stands at zero degree centigrade at 6 AM. The hygrometer indicates 25% humidity in the warehouse." it can pull together other devices through the above context aware information.

For instance, there are two storages "refrigerated storage" and "room temp storage", it needs to let the heater operate when the degree of room temp storage is a sharp decline. If there is no getting back to the original situation over a certain period of time, the heater could have any problem to operate and it needs (notifying and repairing) the situation or the device(heater). Figure 2 briefly shows a warehouse ontology diagram.



a) Abstraction of Warehouse
a) 웨어하우스 추상화

b) Warehouse ontology case
b) 웨어하우스 온톨로지 예

Fig 2. OWL based wareouse ontology diagram
그림 2. OWL 기반 웨어하우스 온톨로지 다이어그램

3.3 Conceptual ontology for warehouse

In this paper, the warehouse ontology model has two sub-classes named "Domain" and "Identifier". The domain class means a type of warehouse and Identifier class is a unique number of warehouse. The warehouse ontology model supports to retrieve the form, location and contents of the warehouse. Each warehouse using context information from sensors is able to operate own devices in the warehouse and to notify the state information to do another thing

Table 1. Conceptual Ontology for Warehouse
표 1. 웨어하우스의 개념 온톨로지

Classes	Specification
Domain	Classification by contents stored
Device	Heater, Freezer, Airconditioner, devices to keep the inside state
Identifier	ID of Warehouse
Warehouse Type	Cold store, room temperature store, thermo store
Location	Position of the store
Contents	Things stored in warehouse
Context	Abstraction for diagnosis and repair
State Info	Components for state information

3.4 Analysis

The following figure 2 shows the result of comparisons between conventional logistic warehouse management system and ontology-based warehouse management system.

Table 2. Feature Comparison of Proposed System
표 2. 특징 비교

Features	conventional logistic management system	ontology- based management system
accuracy of context information	simplicity	granularity
level for context aware	2 level (true/false)	more than 2 level
complex query process	No	Yes

Generally, the accuracy of context information to check the state condition in conventional logistic warehouse management system is very simple, such as yes or no. Otherwise, in ontology-based warehouse management system, the accuracy is various and granularity because there are so many parameters(classes) defined by users. In addition, in case of context aware steps, there are only two sides, true or false, in conventional logistic warehouse management system. However in ontology-based warehouse management system, there might be various cases defined by users. Also on a user query processing aspect, it is possible to process a complex queries. For instance, if a device is broken down, WMS ontology-based could make up query to notify a repair to its center and send the state condition to any proper place where the device will be repaired.

IV. CONCLUSION

In this paper, it presents an ontology-based context aware system model for the purpose of storing and managing agricultural products using ubiquitous sensors to share and distribute information. With the context aware information which has received from sensors, it can build OWL based context ontology and use abstraction to manage efficiently sensor data.

For this environment, it describes a typical scenario in order to illustrate our modeling concept and show ontology-based context aware system architecture. Also, we got the result of comparisons between conventional logistic warehouse management system and ontology based warehouse management system.

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