International Journal of Advanced Culture Technology Vol.6 No.1 50-59 (2018)
https://doi.org /10.17703/IJACT.2018.6.1.50

IJACT 18-1-7

Development of Voice Guide Service for Pharmaceutical Information based on Ontology

Kyung Min Lee[1], Min Soo Kang[2†], Yong Gyu Jung[2†]

[1]*Department of Medical IT Marketing, Eulji University, Korea*
[2]*Department of Medical IT, Eulji University, Korea*
kyungmin066@gmail.com, {mskang,ygjung}@eulji.ac.kr

Abstract

Generally, disabled people have a lot of bad health status at low income levels, the need for health care is higher than for non-disabled people. Although the number of persons with disabilities is increasing with each passing year, their medical services and support are still limited and limited. This problem is not so different from approach to medical information. Conventional medical information is usually printed and transmitted to the patient, but visually impaired people have difficulty accessing such printed information. In the case of the visually impaired, there are many cases where it is not possible to read not only the printed letter but also the braille because the acquired incidence is high. Therefore, this paper tried to solve this problem by transmitting the information of medicine by voice using RFID. In addition, ontology was used to select more accurate drug information. Currently, there are drug information sites provided by the Ministry of Health and Welfare. However, since duplicate information is scattered on these sites, the ontology was used to build up the database.

Keywords: *RFID, Medical information, Visual impaired, Voice guidance, Ontology.*

1. Introduction

More comprehensive and ongoing medical services are needed because people with disabilities are more likely to have a weaker health status than non-disabled people.

According to a survey conducted by the Ministry of Health and Welfare in 2014, the most desirable social support for people with disabilities was income security (38.5%) and medical benefits (32.8%) Figure 1. In other words, the degree of feeling of the actual social support they feel is low, and the majority of people with disabilities feel uncomfortable or difficult about the current medical services Figure 2.

Manuscript Received: February 10, 2018/ Revised: February 23, 2018/ Accepted: March 3, 2018
Corresponding Author: mskang@eulji.ac.kr and ygjung@eulji.ac.kr
Tel:+82-31-740-7153
Dept. of Medical IT, Eulji University, Korea

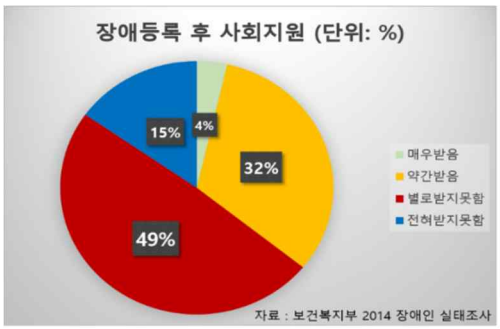

Figure 1. Requirements for society and the country

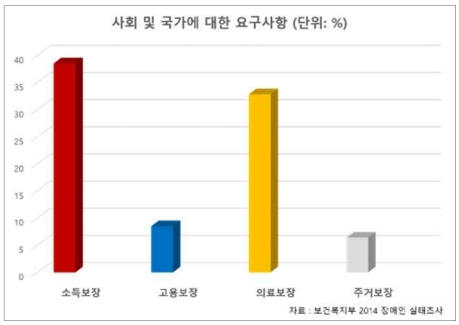

Figure 2. Social support after disability registration

According to the Ministry of Health and Welfare, the number of people with disabilities in Korea is increasing, but the number of people with visual impairments is remarkably increased. The estimated number of blind people is steadily increasing every year, and it has increased about 1.5 times in 9 years Figure 3. Because disabled people generally have a lot of bad health status at low income levels, the need for health care is higher than for non-disabled people.

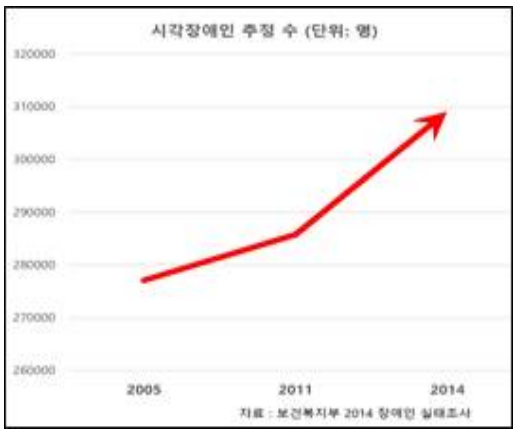

Figure 3. Estimated number of blind people by year

These services, however, are generally offered to non-disabled people, as is the case with drug information. Because information about medicines is usually printed and provided, visually impaired people have difficulty accessing them. Therefore, in this paper, we propose a method for effectively delivering drug information through voice to the visually impaired, which is difficult to access to drug information.

2. Background and Related Studies

2.1 Pharmaceutical Sites

In order to provide a drug guidance service, information on the relevant drug should be obtained first. Currently, the Korea Food & Drug Administration (KFDA) provides a variety of information related to pharmaceuticals and related information through various websites as shown in Table 1 as a result of various informatization projects (Park, In Jeong, and Park, Dukje, 2010). However, some of these sites have similar or

duplicate information, making it difficult for users to find the information they want. In order to solve this problem, there is a case study on the construction of information on pharmaceuticals using ontology (Karthaus & Fischer, 2003).

Table 1. Providing information and contents of drug information

Drug information provider	Content of information
http://ezdrug.kfda.go.kr	Medicinal product information
http://ezdrug.kfda.go.kr	License number
http://www.kfda.go.kr	Administrative Disposition Company Information
http://www.kfda.go.kr	Information on administrative disposition items
http://www.kfda.go.kr	Safety validity examination result
http://addrug.kfda.go.kr	Additive information
http://addrug.kfda.go.kr	Additive safety information
http://addrug.kfda.go.kr	Domestic Usage of Additives
http://addrug.kfda.go.kr	Overseas Usage of Additives
http://ezdrug.kfda.go.kr	Clinical information
http://ezdrug.kfda.go.kr	Clinical trial information
http://ezdrug.kfda.go.kr	Clinical trial institute information
http://ezdrug.kfda.go.kr	Drug review information
http://betest.kfda.go.kr	Biological Test Information
http://ezdrug.kfda.go.kr	Withdrawal drug information
http://ezdrug.kfda.go.kr	Generic Drug Information
http://opendrug.kfda.go.kr	Quasi-drug information
http://opendrug.kfda.go.kr	Quasi-raw material specification
http://ezcos.kfda.go.kr	Cosmetics Product Information
http://ezcos.kfda.go.kr	Cosmetic company information
http://ezcos.kfda.go.kr	Cosmetic raw material reference information
http://ezcos.kfda.go.kr	Cosmetic Report Product Information
http://herbmed.kfda.go.kr	Herbal medicine information

2.2 Ontology

Ontology is an explicitly formal specification for conceptualizing information in a particular field (Villanueva-Rosales & Dumontier, 2007). It is used for sharing and reusing data in a heterogeneous distributed environment such as the Internet. It is a knowledge representation method designed to understand and process the machine (Park, Injeong, Dukje, 2010). In other words, it is a means to enable consistent communication between humans and heterogeneous information systems. The components of the ontology are shown in Table 2.

Table 2. Ontology Components

Concept	Essential awareness and knowledge in reality
Property	A property that fundamentally belongs to the concept
Relationship	Correlation between concepts
Constraint	Limitations on the relationship between concepts or the value of an attribute
Axiom	A proposition that is the basis of reasoning
Instance	Objects, examples of each concept

The need for ontology development is as follows (Noy, 2001).

- For people and agent programs to share understanding of information structures
- To recycle knowledge of a specific field
- To recycle knowledge of a specific field
- To specify assumptions in the field
- To separate knowledge in the field from operational knowledge
- To analyze your field knowledge

The ontology is being studied and utilized for the purpose of semantic interoperability, standardization, communication, knowledge management and search in various fields. As a part of this study, we applied ontology in medicine field.

2.3 Passive RFID

Since the passive RFID uses the transmitting radio wave of the reader antenna as the tag power source, the recognition area is determined by the characteristics of the reader antenna, the tag antenna and the tag chip. In detail, the tag chip is composed of a charge capacitor for converting the radio wave transmitted from the reader antenna into a power source, a DC power generator, and a modulator part for signal modulation. The tag antenna uses the energy charged in the charge capacitor of the tag chip. After modulation according to the recognition information stored in the chip, the information is re-transmitted to the reader antenna using the backscattering method [1].

As the tag antenna undergoes the modulation process, the internal loss is caused by the parasitic capacitance of the diode inside, the inner connect lines and the capacitors. Finally, the power received by the reader due to backscattering is calculated as equation (1), taking into account the internal losses (Park, Injeong, Dukje, 2010).

The performance of the passive RFID is important in the RFID system because the recognition area is determined according to various characteristics of the reader and the tag antenna, such as the modulation process of the signal, the minimum power for tag operation, and the minimum power for tag recognition. Therefore, we focused on the performance of the antenna when using RFID in this study.

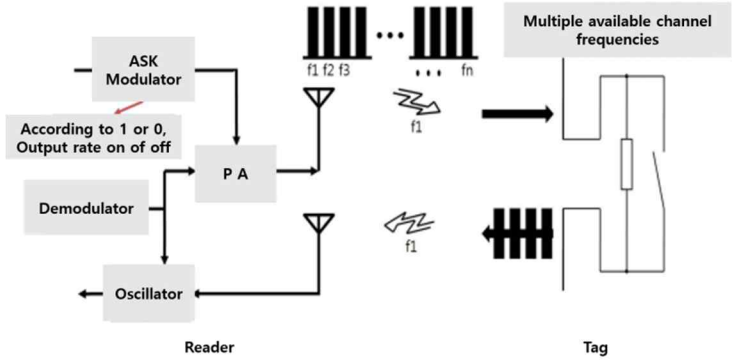

Figure 6. Passive RFID transmission and reception process

$$P_{r\cdot Reader} = \left(P_{r\cdot xp\cdot bss}\right) C\frac{(\eta D)_{Tag}(\eta D)_{Reader}\lambda^2}{(4\pi r)^2} \quad (1)$$

$$= P_\tau \times \left(1 - I\frac{Z_{\gamma p} - Z_{out}}{Z_{\gamma p} - Z_{out}}I^2\right) \times \left(\frac{(\eta D)_{Tag}(\eta D)_{Reader}\lambda^2}{(4\pi r)^2} - P_{r\cdot xp\cdot bss}\right) \times \frac{(\eta D)_{Tag}(\eta D)_{Reader}\lambda^2}{(4\pi r)^2}$$

2.4 Recognition distance of passive UHF band RFID tag

Generally, the passive UHF band RFID is determined by the smaller of the forward recognition distance and the reverse recognition distance. If the free space is assumed, the forward link's recognition distance can be up to several km, and the reverse link's recognition distance can be forwarded a few m. That is, the reverse difference between the forward link and the reverse link is not established. Therefore, the signal transmitted from one RFID reader is inter-reader interference that may cause interference in communication between the other reader and tag, and tag interference due to multiple reader that may occur when the tag is located in a place where the reader's recognition area overlaps (Tanaka et al, 2009).

Table 3 shows the results of calculating PCR indices for interference tolerance per tag for three tag products. As a result, LTE signal interference is larger than WCDMA signal interference (Kwon et al., 2014).

In other words, in this paper, since the service was provided through smartphone, in order to provide good quality service, it was necessary to consider a tag product with relatively low LTE signal interference.

Table 3. PCR index

Division	After electromagnetic interference (WCDMA)			After electromagnetic interference (LTE)		
	917 MHz	920 MHz	924 MHz	917 MHz	920 MHz	924 MHz
LID-L9	0.16	0.171	0.183	0.33	0.338	0.357
ALN-9640	0.186	0.19	0.202	0.7	0.707	0.68
XCODE-95000082	0.171	0.185	0.2	0.648	0.645	0.633

3. Experiment Result

3.1 Ontology Construction

The ontology development process is based on Noy and McGuinness's 'Ontology Development 101: A Guide to Creating Your First Ontology' (Noy, 2001), which is most commonly used in business. This method is divided into 7 steps as follows. Step 1: Start developing the ontology from determining the target field and scope. Step 2, consider reusing existing ontologies. If the system you are developing needs to interact with

other applications that contain a specific ontology or control vocabulary, reusing existing ontologies is a prerequisite. Step 3, list important terms in the ontology. In the beginning, it is important to create a comprehensive list of terms, regardless of whether the concepts represented by the terms overlap with the terms, the attributes that the terms have, and whether the concepts are classes or slots. Step 4 Define class and class hierarchy. There are several approaches that can be used to develop a class hierarchically. The top-down approach starts with a definition of the most general concept belonging to the field of interest and then sequentially embodies the concept. Bottom-up development starts with the definition of the most concrete concept at the bottom of the hierarchy, and then sequentially bundles it into a more general concept. Combined development approaches combine top-down and bottom-up approaches. Step 5 Define class attributes and slots. In general, the properties of objects that can be slots in ontologies include implicit properties, external properties, and physical and abstract parts, if the objects are assembled, with other individual members. Step 6 Define the facets of the slot. A slot may have multiple facets describing the type of value, the allowed value, the number of values (cardinality), and other characteristics of the values that the slot may have. Step 7, Create an individual case.

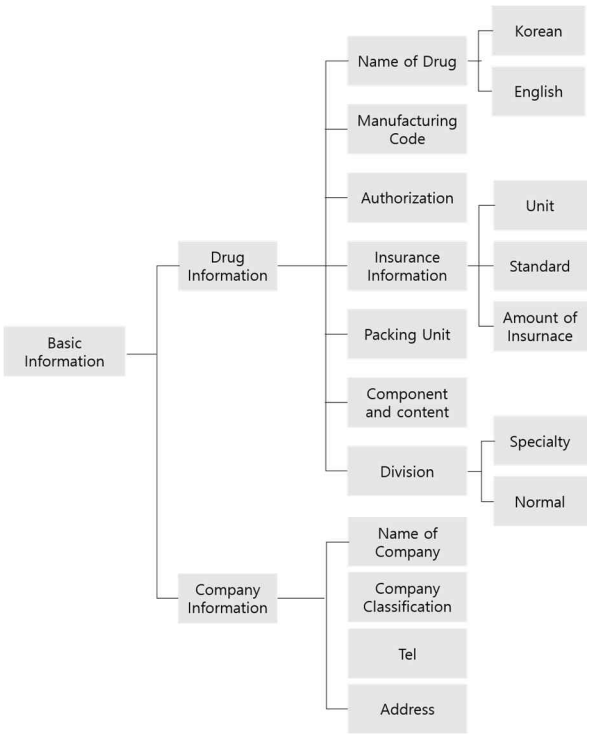

Figure 7. Basic information classification of drugs

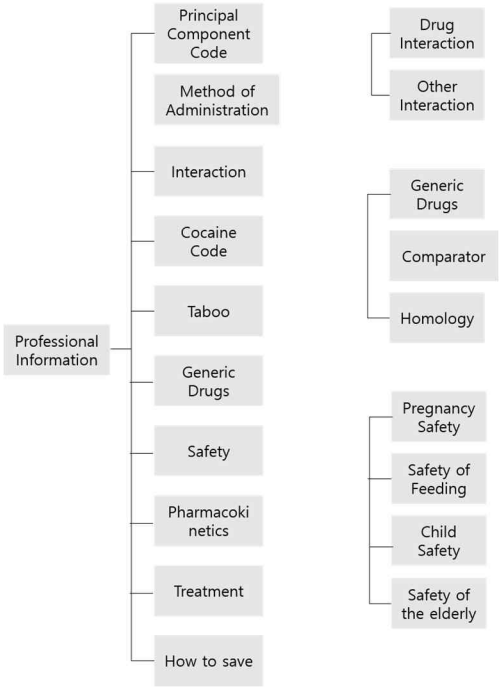

Figure 8. Classification of medical specialty information

In this study, we modified it and proceeded through 4 steps in total. First, it defines the scope and scope of the ontology. Since the scope of the ontology may be limited depending on the purpose of use and the user, the scope of research on ontology development should be limited at this stage. In this study, 23 kinds of medicines on the market are provided by KIMS even within the scope of ontology related to drug information. In Step 2, important terms were listed and categorized in the collected data. KIMS lists the information on the drugs provided by KIMS, including name, efficacy, usage, precautions, and storage methods, and bundles them using the bottom-up method. Step 3, class and class hierarchy are defined. In the top class, the main category was classified as basic information about medicines, professional information that medical staff should know, and general information that users should know.

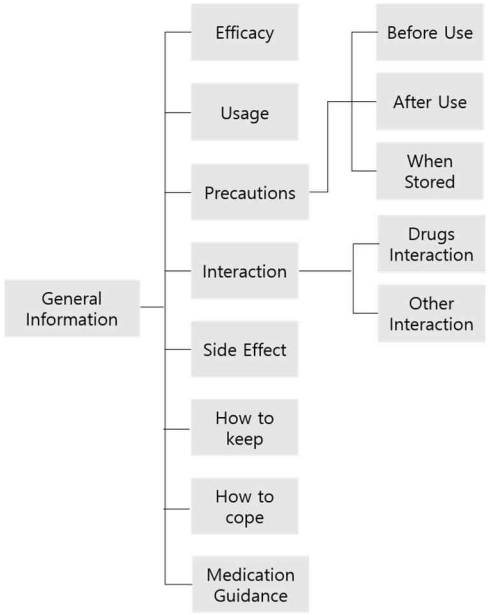

Figure 9. General information classification of drugs

Step 4, We set the relationship between class and attribute. The national and English names classified in the basic information of pharmaceuticals, the attributes of insurance information, and the division of specialty and general are considered to be in the property relation rather than the class relationship. In addition, drugs can be classified into generic drugs, reference drugs, and generic drugs, which are generic drugs for counterparts. Therefore, Daejo and generic drugs are set as subclasses of drugs. In addition, the duplicated content of drug information was transferred from the basic information in the class of professional information and general information Figure 10.

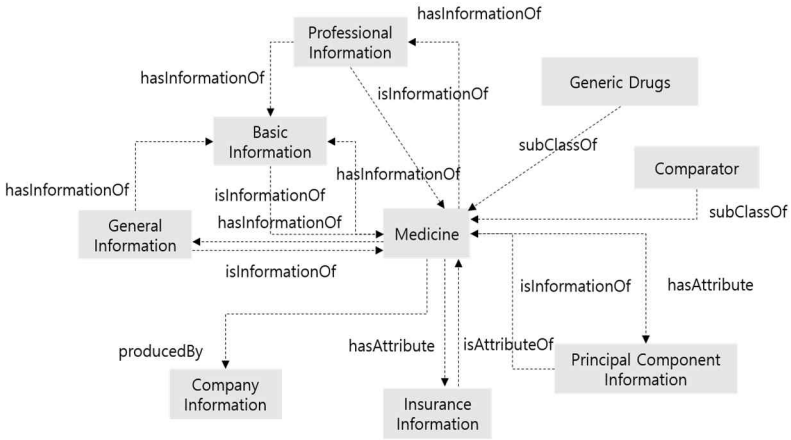

Figure 10. Representation of attribute relations

3.2. System configuration diagram

The system configuration diagram in this study is shown in Figure 11. In the ontology DB, medical professionals build and manage basic information for pharmaceuticals, general information for providing

accurate information to patients, appropriate information for proper prescription. When the RFID reader reads the RFID tag, the information is transmitted to the device through Bluno, and the appropriate information is fetched from the device connected to the DB and the voice is output.

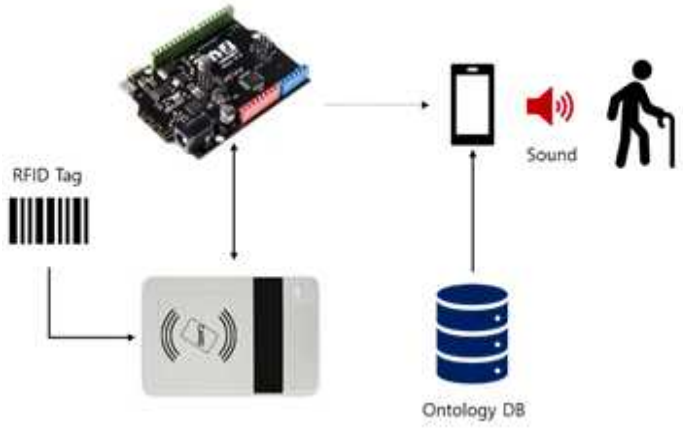

Figure 11. System configuration diagram

4. Result

The system of this study is currently in the development process, and it has read the Tag information of RFID, transmitted it through Bluetooth, and finished the step of outputting the drug information according to the serial number of Tag by voice. Read Tag's serial number information through RFID Reader. This information is transmitted via Bluetooth to the application of the device connected to Bluno.

When the serial number is transmitted to the corresponding application, the application identifies it and outputs the medical information corresponding to the serial number by voice. Figure 12 is the currently developed application screen, and it can get information of RFID Tag by interworking with Bluno via Bluetooth. Medical information, which is output by voice in the application, is provided from the ontology-based drug database. Future research will focus on building an ontology database and linking it with devices.

Figure 12. Application Screen

The implementation of ontology was developed using Protege. Protege is an ontology development tool developed by Stanford University in the USA. It provides not only ontology but also SparQL, DLQuery and other ontology query language.

The results of this study are meaningful in that medical information is divided into professional information

that experts should know and general information that user should know. We have constructed ontology of the nature suitable for the system of this study, which is expected to contribute to efficient management and use of medical information.

As we enter an aging society, medical technology and services are being addressed as important issues. Advanced medical technologies and services should be provided to anyone who needs them, but it is not. Among them, people with disabilities are the ones most in need of medical services, but the accessibility of people with disabilities is relatively low. This is because income levels are low, but medical services are provided according to the standards of the general public without taking into consideration their physical and mental conditions. In other words, it is necessary to provide convenient and accessible medical services considering the situation of each disabled person. For this reason, in this paper, considering the situation that the visually impaired could not read the printed information, we wanted to provide the necessary information by voice so that they could get more accurate medical information. This is expected to improve the accessibility of medical information to the visually impaired.

The development potential and expectation of the medical industry is getting bigger as technology develops. As a result, the importance and interest of medical information is increasing, and medical information is becoming more and more common. Therefore, it is difficult and troublesome to utilize such information. In order to utilize this, it is necessary to avoid redundancy and to organize and refine the necessary information appropriately and systematically.

In order to provide more accurate medical information, these problems had to be considered. In this paper, we tried to solve this problem by constructing a database through ontology. We intend to establish more effective and precise information by establishing the relationship between information resources related to pharmaceuticals through future research, and to improve accessibility to medical services.

Acknowledgement

This research was supported by the Bio & Medical Technology Development Program of the National Research Foundation (NRF) funded by the Korean government (MSIT) (No. 2016M3A9B694241).

Reference

[1] Bae, J. Y., & Cho, M. S. (2016). Ontology of Food Safety for the Social Big Data Analysis. *Journal of Health Informatics and Statistics, 41*(3), 278-289. DOI: https://doi.org/10.21032/jhis.2016.41.3.278

[2] Karthaus, U., & Fischer, M. (2003). Fully integrated passive UHF RFID transponder IC with 16.7-/spl mu/W minimum RF input power. *IEEE Journal of solid-state circuits, 38*(10), 1602-1608. **DOI:** 10.1109/JSSC.2003.817249

[3] Kwon, J., Song, T., & Cho, W. (2014). Read Range Reduction in Passive UHF RFID Tag by Smart Device Signal Interference. *The Journal of Korean Institute of Electromagnetic Engineering and Science, 25*(1), 83-91. DOI: 10.5515/KJKIEES.2014.25.1.83

[4] Noy, N. F. (2001). Ontology development 101: A guide to creating your first ontology: Knowledge systems laboratory, Stanford university. Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI-2001-0880.

[5] Tanaka, Y., Umeda, Y., Takyu, O., Nakayama, M., & Kodama, K. (2009). Change of read range for UHF passive RFID tags in close proximity. 2009 IEEE International Conference on RFID (pp. 338-345), IEEE. DOI**:** 10.1109/RFID.2009.4911202

[6] Villanueva-Rosales, N. & Dumontier, M. (2007). Describing Chemical Functional Groups in OWL-DL for the Classification of Chemical Compounds. In OWLED (Vol. 258).

[7] Kang Dae-hyun, Lee Jung-min, Kim Tae-yoon, Park Hansem, Kwang-Rak Kwon, Jung In-jeong (2015). A Study on the Historical Ontology Generation Method Using Metadata. Korean Institute of Communication Sciences, 801-802.

[8] Ko Young Man, Lee Seung Jun, Song Min Sun (2015). A Study on RDF Ontology Conversion Method of

Structural Academic Term Dictionary (STNet) based on Relational Database. Journal of Information Management, 32 (2), 131-152. DOI : 10.3743/KOSIM.2015.32.2.131

[9] Kim Jae Young and Lee Suk Won (2013). Movie Recommendation Technique Using Relation between Ontology Based Movie Metadata. Intelligent Information Research, 19 (3), 25-44.

[10] Park In Jeong, Park Deock Jea (2010). A Study on the Pedestrian Guide System for the Blind using RFID. Journal of the Institute of Electronics Engineers of Korea, 47, 124-130.

[11] Ministry of Health and Welfare (2014). Survey Report on the Status of Persons with Disabilities in accordance with Article 31 of the Welfare Act for the Disabled. Ministry of Health and Welfare.

[12] Son Jong-soo, Kim Do-hyung, and Jung In-jung (2010). A Case Study on the Knowledge of Drug Information Using Ontology. Korean Information Science Society, 37 (1C), 317-322.