A Medical Treatment System based on Traditional Korean Medicine Ontology

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Abstract. The objective of this study was to provide a way to share knowledge of traditional Korean medical ontology in a machine-readable form and to use this method to build a treatment system based on traditional Korean medical knowledge. The treatment system constructed in this study is an ontology-based application that can be used for treatment. This system has been constructed to increase the applicability of an ontology that systematically models traditional Korean medical knowledge. In particular, the ontological knowledge in this system was used to determine the diagnosis and the treatment, to implement functions that support the diagnosis and the treatment and to provide the basis for sharing treatment information among many doctors. However, the immediate clinical use is problematic because the clinical data are currently not included in the ontology, and only the basic treatment functions are implemented. Thus, a study on the additional clinical knowledge and various treatment support methods is deemed necessary in the future.

1 Introduction

Recently, there has been great interest in LOD (Linked Open Data), which connects different data sources with standard protocols, such as URIs (Uniform Resource Identifiers) and RDFs (Resource Description Frameworks), to link and share data on the web. Datasets from various domains, including biology and medicine, and many institutions and researchers are currently shared using LOD, which is managed by the CKAN (Comprehensive Knowledge Archive Network).

In the field of traditional Korean medicine, a study that modeled traditional Korean medical knowledge and constructed an ontology using OWL (Web Ontology Language) has recently been proposed [1]. The ontology constructed in this paper is currently linked to a webpage [2] in the form of an OWL file, and therefore version management and links to other ontologies are difficult.

The objective of this study was to develop a method for sharing an existing traditional Korean medicine ontology in a machine-readable form and to use this method to construct a treatment system based on traditional Korean medical knowledge.

To do so, a traditional Korean medicine ontology server was first constructed using Jena TDB [3], which is an RDF databases. This server uses Open API and SPARQL endpoint service, which can query the ontology database.

Based on the service constructed in this way, a traditional Korean medicine treatment system was constructed. This system was an application that utilized the traditional Korean medical knowledge of the traditional Korean medicine ontology. The traditional Korean medicine treatment system implemented in this study was created to aid patient treatment by suggesting diseases or patterns based on patient symptoms and by recommending the formula for the suggested diseases or patterns. The recommendations offered by this system are obtained using the inherent knowledge of the traditional Korean medicine ontology; physicians can refer to the recommendations and use them for treatments, or they can modify and save them if necessary, in which case the recommendation reflects the modified information for the next treatment.

In reality, hospitals use hospital information systems, such as OCS (Order Communication System), PACS (Picture Archiving and Communication System), and EMR (Electronic Medical Record). These systems are commercial products created by specialized companies and provide convenient and diverse features that are necessary for diagnosing and treating patients. In particular, an EMR system provides a way to electronically record and preserve the personal information and medical history of patients, which previously were written on paper by hand. Nevertheless, hospital information systems, including EMRs, are systems to manage patient information electronically inside the hospital and not to manage publicly available data on the web. Furthermore, it is difficult to interpret and utilize these data for diagnostic purposes because the data are not standardized. To solve these problems, studies of CDSS (Clinical Decision Support Systems) [4] have been conducted by artificial intelligence researchers.

The traditional Korean medicine treatment system constructed in this study is fundamentally different in that it concerns traditional Korean Medicine, rather than modern medicine. In addition, this system does not implement actual clinical data and complex diagnostic processes, as is the case with CDSS; rather, it is a system that recommends a diagnosis and formula based on the traditional Korean medical knowledge included in the traditional Korean medicine ontology. Therefore, the system can be used for information searches on traditional Korean Medical treatments and for education in traditional Korean medicine.

2 Ontology Open Services

The traditional Korean medicine ontology is managed with Jena TDB, which is one of the RDF databases. Among the free RDF databases, Jena TDB is known to have excellent query performance for full-text data [5]. In this study, Open API and SPARQL endpoints were constructed to allow a machine, rather than humans, easily to access and query the traditional Korean Medicine ontology knowledge stored in the Jena TDB.

2.1 Open API

In general, Open API refers to a method used to search and share information on Web 2.0 applications. The following four types of Open API were designed and implemented to search the ontology knowledge in this paper. The servlet call address for

all of the APIs is http://tkm.kiom.re.kr/ontology/openapi, and a separate authorization is not required when calling. The GET method is used for the calls, and two output methods, JSON and XML, are supported.

Open API 1: Search all instance lists

This API searches and returns all instance lists in a class. Table 1 explains the API input parameters. The "target" is the name of the open API, the "query" is the input query, and the "form" is either the XML or JSON output formats. The "level" specifies how many link levels will be shown starting from the searched instance. For example, when the level value is one, the properties of the MM 人蔘 (the Chinese characters mean "ginseng") node and the values for each of the properties are shown. When the level value is two, the properties of the MM 人蔘 node and the values for each of the properties are shown. When the value of a property is an instance, the properties of each of the instances and the values of the properties are shown. Because the default value of "level" is one, the search will be performed at level one if it is not specified at the time of API call.

Table 1 Input parameters of Open API 1

Parameter	Required?	Value	Description
target	O	instances	search all instance lists
query	O		class name
form	O	xml, json	data output format
level	X		level of searching link (default value is one)

For example, when calling an address, such as http://tkm.kiom.re.kr/ontology/openapi?target=instances&query=Medicinal_Material &form=xml, all instances of medicinal material class are returned in XML form. The returned results become a list of instances, and each instance in the list has the basic parameters shown in Table 2. The parameters specified in this table are the common parameters from all instances, although they can have the class properties from each of the classes as additional parameters.

Table 2 Output parameters of Open API 1

Parameter	Description
id	instance id
type	class name of an instance
koreanName	Korean name of an instance
chineseName	Chinese name of an instance
englishName	English name of an instance
koreanDescription	Korean description
englishDescription	English description

Open API 2: View the detailed information of an instance

This API call result for one instance returns detailed information consisting of all properties of the instance and the values of the properties. For example, when

http://tkm.kiom.re.kr/ontology/openapi?target=instance&query=MM 人蔘&form=xml is called, all of the properties for MM 人蔘 and their values are returned.

Open API 3: Search the reference instance list

When this API is called with one instance as the input value, the API searches all instance lists that reference the instance. For example, when http://tkm.kiom.re.kr/ontology/openapi?target=references&query=MM 人蔘&form=xml is called, all instance lists with MM 人蔘 as the property values are returned.

Open API 4: Search the parent class and child class lists

This API returns a parent and the list of child classes of the input class. For example, when http://tkm.kiom.re.kr/ontology/openapi?target=hierarchy&query=Medicinal_Material&form=xml is called, a parent and the list of child classes for medicinal material are returned.

2.2 SPARQL Endpoint

The SPARQL endpoint is an SPARQL protocol service that is provided in accordance with the definition from the SPARQL protocol for RDF specification. A SPARQL endpoint enables humans or machines to query a knowledge base via the SPARQL language. To provide the SPARQL endpoints for this study, a SPARQL server for Jena known as Jena Joseki [6] was installed and linked with Jena TDB. The SPARQL endpoint address for the traditional Korean medicine ontology is http://tkm.kiom.re.kr/ontology/sparql/, where SPARQL can be entered to query ontology using the SPARQL web form.

Currently, the SPARQL endpoint for traditional Korean medicine ontology is registered on the Data Hub [7] site, an LOD registry managed by CKAN, and searching and sharing is available using the Traditional Korean Medicine Ontology dataset name.

3 Medical Treatment System

The treatment system implemented in this study provides traditional Korean medicine with ontology treatment support. This system was implemented using the Smart GWT (Google Web Toolkit) v2.5 [8] user interface. GWT is a Google development toolkit for building and optimizing complex browser-based applications, and the Smart GWT is an Isomorphic Software toolkit that extends GWT. Communication with the server involves calling the open API described in the previous section and receiving the results in JSON form.

The treatment system implemented in this study has the following functions: search and enter the patient symptoms, recommend the list of diseases (including patterns) that accompany these symptoms, recommend the formula list for a specific disease, and add or delete component medicinal material for formulas.

The figure below shows the user interface of the treatment system implemented in this study. The screen is principally divided into the symptoms section on the left side

and the diseases and formulas section on the right side. After searching and entering the patient's symptoms on the left side and clicking the "diagnosis" button, a recommended list of diseases or patterns with these accompanying symptoms is shown in a table at the top of the right side. When a disease is selected, a list of formulas to treat that disease is available immediately below. Moreover, after the formula is selected, a list of the medicinal materials that comprise the formula and their amounts appears on the right side. Summary information, including the names of the diseases, formulas, and medicinal materials, is shown on the screen, but detailed information can be obtained by moving the mouse over the items or by clicking on the icon located at the right side of each field and opening the popup window.
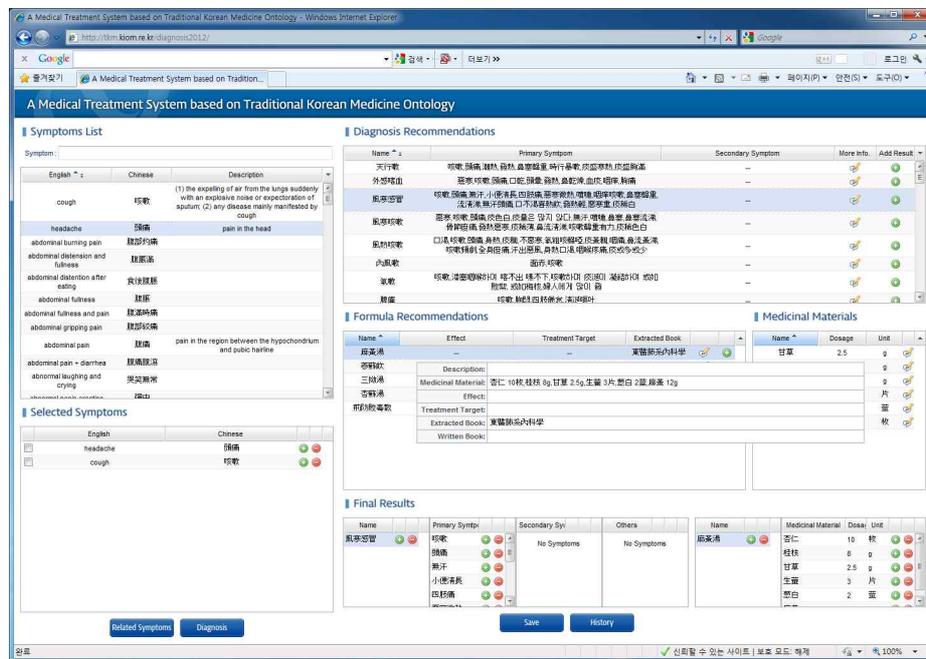

Figure 1 A Screenshot of the Medical Treatment System

4 Conclusion and Future Work

This study provided a method for sharing traditional Korean medicine ontology knowledge in a machine-readable format and created a treatment support system using this knowledge.

The objective of our treatment system was to increase the applicability of a systematic traditional Korean medical ontology by building an ontology-based application that can be used for treatment. In particular, ontological knowledge was used to suggest the disease and treatment, to support the diagnosis and treatment, and to provide a means of sharing the treatment knowledge among many users.

However, the current traditional Korean Medicine ontology does not include the data that would actually be used in a clinical setting. Moreover, the current treatment system implements only basic diagnostic and treatment processes, and there is a lack of additional functions, such as user and history management. Thus, it is difficult to use directly the treatment system created by this study in an actual clinical practice.

To make our treatment system more easily accessible in the future, there are plans to conduct a study to strengthen the treatment supporting functions and link them with other services that utilize ontology. Furthermore, a study to construct a system that can help practicing physicians by including clinical knowledge in the ontology is also necessary.

Acknowledgements

References

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