Implementation of SMART APP Service Using HL7_FHIR

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Abstract—The present paper aims to develop a server that can search and exchange the medical information of patients by utilizing HL7_FHIR, which is a next-generation framework of medical service-related standardization. Furthermore, it aims to implement an interface that can show specific medical information analysis utilizing the server. To configure the above user system, two types of servers, FHIR API Server and App Server, were employed. The data model of the medical information of patients was composed with HL7_FHIR Resources, and PostgreSQL, an object-relational database management system, was used for the database management system. To approach the medical information services (Transport, Search), a Representational State Transfer (REST) RESTful API was used. A website was made using HTML5 based on a source that can analyze heart diseases provided by Smart Corporation to provide web services to show specific medical information analysis results through the configured system.

Keywords—HL7 FHIR, Restful, Medical Service

I. INTRODUCTION

Due to the rapid advancement of information and communication technology (ICT) in recent years, medical environments have increasingly become an information and knowledge-based paradigm. There has been increasing integration between modules inside hospital systems and more medical institutions have increased the use of electronic medical records. Accordingly, great effort has been made to implement good-quality medical services with low cost worldwide. The exchange of medical information for good-quality medical services is one of the most important elements for the systems of hospital task procedures and activities. However, this issue has not been solved fully despite recent technological advancement due to the heterogeneous and diverse characteristics of hospital task-related data and patient clinical medical data. The lack of information caused by the difficulties in information exchange can lead to inefficient treatment as well as incur substantial medical costs to national and individual economies. To solve this problem, Health Level Seven (HL7) has provided a series of frameworks for the exchange, integration, and search of medical health information and has developed standards to resolve interoperability between systems. Other organizations, such as the Integrating the Healthcare Enterprise (IHE), have also defined guidelines for the integration of medical information management systems and health device medical information [1], [2].

V2 Message, V3 Rim, and CDA are some of the main standards developed by HL7. HL7 V2 Message was a standard developed in the early 1990s that is now widely used. Although it is based on characters and delimit symbols, it takes a lot of time to develop various services based on HL7 V2 Message. It also lacks an information transfer that ensures semantic interoperability [3]. HL7 V3 Rim was developed in 2005 to solve the drawbacks of V2, which ensured interoperability and used XML technology and object-oriented approaches. However, development using this standard was not easy due to the complexity of medical information and difficulties in modeling complete services of engineers without professional knowledge [4], [5]. To overcome these drawbacks, HL7 introduced Fast Healthcare Interoperability Resources (FHIR) as the next generational standard. FHIR is a new standard framework that is based on previous data format standards and utilizes the beneficial elements of V2 and V3 [6]. Furthermore, the FHIR is based on the Representational State Transfer (REST) architecture style so that it can be extended to mobile devices and other light-weight devices. As a result, the interface can provide services that can be accessible to all doctors, pharmacists, and patients. To extend developer-friendly systems and medical service-related fields overall, the FHIR Connectathon is held regularly and feedback collected through the conference is reflected in the FHIR standard [7].

In this paper, a system is developed and implemented to facilitate medical information exchange between medical institutions using FHIR. To achieve this goal, a FHIR-based web server was configured to perform the collection, exchange, and searching of medical information. In addition, a web user interface to utilize the system was developed to analyze specific medical information rather than merely displaying patient information through the web. The visualization is implemented by using the analysis sources of heart diseases provided by the SMART Corporation.
II. RELATED WORK

A. HL7_FHIR

HL7 FHIR has been adopted as a draft standard for trial use (DSTU)-2 and is now under development and will be adopted as the formal standard of HL7 and released as a complete product soon. In FHIR, medical and medicine-related concepts are segmented to resource units to define them as a set. The resource specification defines a resource section type and foundational structure to deal with resources. To develop a solution by utilizing the resources, the resources are mapped to project content accordingly. The resource section mainly consists of clinical record content, process entities required for treatment procedures, medical process management, billing and payment-related finance information, the general functions of the FHIR requirements, the development and tests of FHIR solutions, and resource management. The recycling capability has been increased by the combination of segmented resources, and various combinations can be achieved by enabling references between resources. Resources that are available through various external systems can also be utilized through links using the Universal Resource Identifier (URI) by referring to various resources via a single resource. When exchanging resource units, it utilizes XML and JSON, which are the RESTful protocol based on the HTTP. Based on the simplified technology, existing medical documents and messages can be employed. By providing the new standard method, the scalability of information and simplification of expression can be achieved. The improved functions in the FHIR compared with the existing standards are as follows: [6, 8].

- A strong focus on implementation – fast and easy to implement (multiple developers have had simple interfaces working in a single day)
- Multiple implementation libraries, many examples available to kick-start development
- Specification is free to use with no restrictions
- Interoperability out-of-the-box – base resources can be used as is, but can also be adapted for local requirements
- Evolutionary development path from HL7 Version 2 and CDA – standards can co-exist and leverage each other
- Strong foundation in Web standards – XML, JSON, HTTP, OAuth, etc.
- Support for RESTful architectures and also seamless exchange of information using messages or documents
- Concise and easily understood specifications
- A human-readable wire format for ease of use of developers
- Solid ontology-based analysis with rigorous formal mapping for correctness

B. RESTful

RESTful web services have been employed by Internet service providers to supply data conveniently to developers. It is a web architecture style model used on the web as a distributed application. RESTful web services search requirements independently, and due to their characteristics of resource-oriented representation, transfer, and approach, they can process data more rapidly than other existing protocols. All resources are also characterized by their own unique URI so that they can be represented by addresses and expressed using links in general web pages in which one resource is interlinked with other referred or related resources. Furthermore, they are characterized so that the client status is not managed by the server; all requests are one-off and not affected by previous requests. According to the CRUD method, which is a basic request type of HTTP for resources, the functions of query, update, addition, and deletion of resources are performed using GET, PUT, POST, and DELETE, respectively, and resources delivered as the basic request type of HTTP are represented and transferred with various methods, such as XML, JSON, or RSS [9], [10].

FHIR employs the RESTful API to create, read, modify, delete, and search data. As a result, FHIR is needed to implement basic operations and request methods over the REST. Fig. 1 shows the HTML interaction and REST mapping according to request.

Fig. 1. FHIR interaction with RESTful API

III. DESIGN OF THE SERVICE MODEL

The present study provides a web application that can improve patient treatment based on the medical information of patients by utilizing the FHIR resources in HL7. The structure of the system is shown in Fig. 2, including the design of the service model. The service model consists of three parts. First, the FHIR API server was implemented via the open source provided by the FHIR, in which a low-level FHIR parser, serial, and object model are utilized [11]. The server supports the creation, read, update, and deletion tasks according to HTTP request using RESTful to implement the FHIR search API and FHIR DSTU 1 resources. The server also includes a chain search and path basis. Since the server is implemented to query the internal FHIR data structure, it does not support complex parameters. Through the server, medical information in the electronic medical record system can be accessed using mobile devices and the web. The data type used during the exchange of patient information is JSON or XML. The implemented web service provides an environment, such as an electronic health record, which is composed via HTML5 and Java scripts [12]. The user interface (UI) screen is developed
using the analysis sources of heart diseases provided by SMART Corporation [13].

Fig. 2. System Architecture.

IV. IMPLEMENTATION SERVICE MODEL

A. Data Modeling

The resource used in the present study was a resource type consisting of patient data among a number of resource types provided by FHIR. Each resource plays a different role from that of others. For example, Bundle plays a role in combining many sets of resources, Patient plays a role in managing information about patients, and Condition takes care of the patient’s condition and record of previous medical examination results. Observation takes care of patient medical examination results, and MedicationOrder plays a role in displaying prescription-related information. Each resource has sub-categories, such as value, path, and type, to segment a resource in more detail, thereby displaying the diversity of information expression. TABLE I presents the sub-categories of three resources as an example. Patient data consisting of the above resources are registered in the database (DB) in the server. The data type follows the XML and JSON protocol, and data registration is conducted using upload and download via Curl, which is a data transfer tool for the command line that supports major protocols, such as HTTP and HTTPS.

TABLE I. FHIR RESOURCES FOR PATIENT INFORMATION MODELING

<table>
<thead>
<tr>
<th>FHIM Resource</th>
<th>Resource Content</th>
<th>Name</th>
<th>Path</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundle</td>
<td>Type</td>
<td>.type</td>
<td>Token</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Composition, message</td>
<td>.Entry.resource(0)</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Patient</td>
<td>Identifier</td>
<td>.active</td>
<td>Token</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Address</td>
<td>.address.(city, state)</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gender</td>
<td>.gender</td>
<td>Token</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Name</td>
<td>.name.(family, …)</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Code</td>
<td>.code</td>
<td>Token</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Onset</td>
<td>.onset</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
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REFERENCES