Ontology for Patient Medical Record in Healthcare Organizations

Kambiz Houshiaryan[a], Il Kon Kim[b], YunSik Kwak[b], Hune Cho[b]

[a] *Daegu, Computer Science, Intelligent Information Laboratory, Kyungbook National University South Korea*
[b] *Daegu, Computer Science, Intelligent Health Information Sharing System Development Center, South Korea*

Abstract

Many steps in the right direction have been made to help the promotion of healthcare. However, lake of agreement among physicians to use the same medical record has arisen problems for integrating information system within healthcare organizations, which is seldom supported by the technology. This paper introduces ontology for patient medical record in healthcare organizations that includes a language structure adoptable to any kind of Agent applications in Multi-Agent platforms, stand alone medical systems or independent applications that have followed by standards of HL7 [1] and FIPA [2]. This ontology has been constructed with a patient medical record formatted in HL7 message and has enveloped according to standards of FIPA message structure. Total message structure has ability to be summarized according to the provider's request by sender's made user Interface.

Keywords:

Patient Medical Record, Ontology for Medical Information in Healthcare System, FIPA and HL7.

Introduction

In the last few years there has been a shift in healthcare practice towards healthcare promotion, shared patient-provider decision-making and managed care, creating an increased demand for information and online services [3, 4]. The shared decisions and actions of all concerned need to be coordinated to make sure that the care is efficient and effective. To facilitate this, software systems are needed to reduce error in diagnosis and treatments, deliver healthcare to remote locations, improve medical training and education, and make healthcare information more accessible to patients. In this concern we intend to develop ontology for patient medical record in healthcare organizations and share information through the web to be used in different departments, healthcares, clinics or hospitals of a city, town or a remote area abroad and help to have a better treatment and efficient care system. Growing interest in the applications of agent-based techniques to solve problems in the medical domain are also more steps forward [5, 6, 7, 8]. Multi-Agent systems are indeed an interesting tool to solve problems in medical area since the usual properties of intelligent agents match quite precisely with necessitate in this field. In this paper we shall explain the way that we adopt communication of Multi-Agent systems into our ontology.

Materials and Methods

Ontology is currently perceived as the solution of first resort for all problems related to biomedical terminology. Most ontology-based systems in healthcare accordingly conceive an ontology as a mere knowledge representation tool and thus they adhere to the computer science understanding of the term, tracing over the more venerable philosophical understanding of ontology as a science of the types of entities and relations in reality. Ontological engineering without ontological theory may, certainly, suffice for developing terminologies for data-entry systems under which users need simply to select terms while browsing through a hierarchy. But such an approach is far from meeting the requirements imposed by information systems that need to deal with grammatically complex patient records and other documents in natural language. Constructing our ontology with standards of FIPA and HL7 will lead us to have a powerful ontological theory. We shall argue some of the characteristic of FIPA and HL7 to patient medical record in healthcare organizations.

Using Multi-Agent systems offers an appropriate tool to tackle problems in healthcare systems. The components of Multi-Agent may be running in different machines, located in many different places. Each of the agents may keep part of the knowledge required to solve the problem; therefore, distributed information are solutions to the complexity of healthcare. Wooldridge states that any agent in a Multi-Agent system is necessarily social [9] and Moulin and Chaib-draa [10] take an agent to be social if it can model others. A social agent therefore views its environment as containing a collection of entities with engagements, engagement chains and cooperation between them. Social agents are able to communicate between themselves, using some kind of agent communication language, in order to exchange any kind of information. In that way they can engage in complex negotiation and collaborate to solve a problem. When a problem is too complex to be solved in a single system, it is usual to decompose it in subprograms (which will probably not be totally independent of each other). In Multi-Agent systems there are techniques of distributed problem solving [6], in which a group of agents may dynamically discuss how to partition a problem, how to distribute the different subtasks to be solved among them, how to exchange information to solve possible dependence between partial solutions, and how to combine the partial results into the solution of the original problem. Agents can also be used to provide information to doctors and patients. There are information agents [7], that are specialized in retrieving information from different sources, analyzing the obtained data, selecting the information in which a user is

especially interested, filtering redundant or irrelevant information, and presenting it to the user with an interface adapted to the user's preferences.

FIPA [2] stands for *Foundation of Intelligent Physical Agent* and it is formed to produce software standards for heterogeneous and interacting agents and agent-based systems. FIPA specifications represent a collection of standards, which are intended to promote the interoperation of heterogeneous agents and the services that they can represent. Thus, properties of intelligent agents (autonomy, social ability, relationship) and the features of Multi-Agent systems (management of distributed information, communication and coordination between separate autonomous entities) can be though of a good options to be considered to solve problems in healthcare domains.

HL7 stands for *Health Level Seven* and it is used to denote both a data messaging standard for the exchange for healthcare information and is an ANSI accredited standards body which has focused extensively on data formats for exchange within organizations.

A typical healthcare organization uses a multitude of separately developed IT applications. The exchange of healthcare related data between these systems is required both for administrative as well as clinical reasons. The problems associated with systems integration in healthcare IT have been well known for years, and have lead to the development of messaging standards such as HL7. Message Oriented Middleware (MOM, a.k.a. message broker or communication server) are being used to deal with some of the integration issues, e.g. the reformatting of encoding layers (ITS), code translations, event mappings and message routing. This paper won't address these well-known issues. The publication of the HL7 version 3 (HL7 v3) standard also has given rise to some new aspects of systems integration issues. There is a serious effort underway with the HL7 version 3.0 Reference Information Model (RIM) to use object-oriented techniques [11].

The reason for using HL7 [1] as a standard is that HL7 focuses on the interface requirements of the entire health care organization, while most other efforts focus on the requirements of a particular department. The real cost of HL7 compliance is in the integration of back-end systems across heterogeneous platforms, databases, and transaction processing systems. One need is for standardized patient medical record so that participants can recognize the format and transmitted message.

Since many applications, Multi-Agent platforms, Web based technologies in the medical area have been developed to improve healthcare technology we have to construct a framework not only to meet requirement of common standards but also to distribute information among clinical healthcare which has been scattered and arisen problems of sharing medical record.

Ontology for Patient Medical Record

The development of ontology for patient medical record has guided by the following requirements in 3 steps:

- The language format must have HL7 [1] structure to be understood by parsers used in dependent or independent healthcare systems. This language also must allow for an easy integration with current structure of message communication system.
- The language should be integrated in a common logical framework and should reduce the complexity of complicated messages.
- The language format must have FIPA [2] structure for being recognized by agents on Multi-Agent platforms.

Part of the Figure 1 illustrates the use of HL7 message structure to construct ontology for patient medical record. This message has designed to be updated by different departments of health organization or departments in different organizations. Each segment of this message consists of fields that have assigned to a specific provider to be updated with necessary information. For example SCH [1] refers to a schedule for patient, IN1 refers to insurance department, DG1 shows the diagnosis of a patient by physicians, etc.

In this concern Symphonia [12] as a toolkit has been used for designing message definitions. Symphonia creates a message and validate it according to standards of HL7. We are in the middle of developing an Interface Engine (IE) to work similar as Symphonia. By using Interface Engine, users can define the structure of composites, segments and messages according to the standards of HL7, which is the first step of requirements for developing ontology of patient medical record.

HL7 Version 3.0 will utilize Extensible Markup Language to increase interoperability between systems also it takes advantage of the intrinsic structuring capabilities of XML [13] documents. The representational messaging format is implemented as a hierarchy of items together with their identifiers and descriptions, whereby each item corresponds to a node of the document tree. HL7 has developed the Patient Record Architecture (PRA), an XML based clinical document architecture that provides an exchange model for documents of varying levels of complexity. Using the PRA, Version 3.0 will enable systems to create XML documents that incorporate HL7 message content, to generate messages from document content, and exchange and process messages and documents between disparate systems. Thus, along with adopting HL7 version 3.0, the second step of requirements for language format is met.

Results

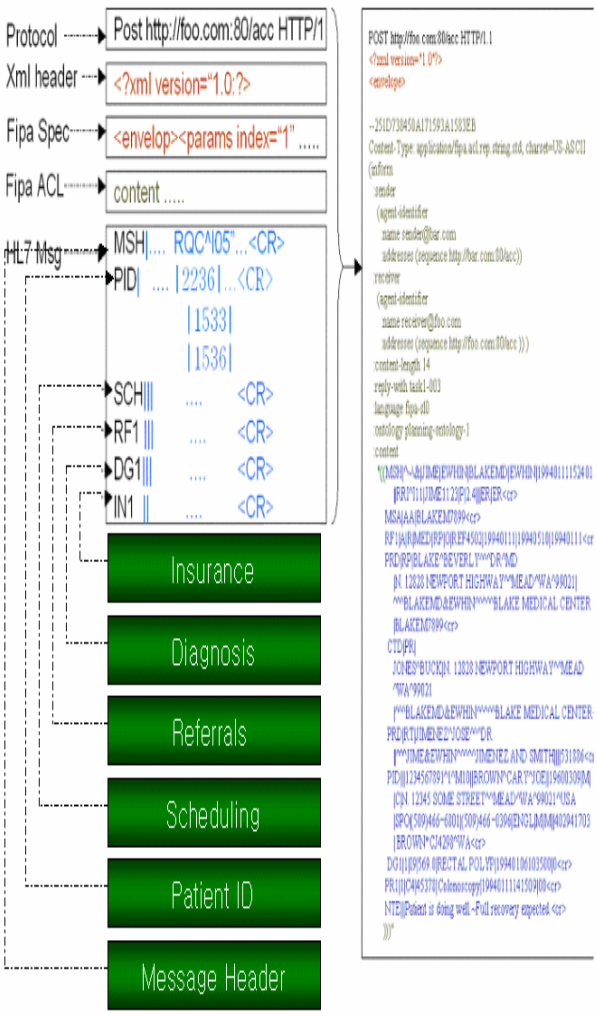

Figure 1- This figure illustrates the structure of a patient medical record in an envelop of FIPA message structure.

As shown in Figure 1 we have adopted the standards of FIPA message structure to our ontology for patient medical record. According to FIPA, for using http protocol a message needs a request line, request headers, request body, response line, response headers and response body. The header of this message represents the usage of HTTP protocol. The body of the message contains an envelope, which includes requesting or replying to a request. Content of this message includes HL7 structure. The envelop of this message has constructed with XML [13] language to be in harmony with HL7 version 3.0. Reasons to use this kind of structure for ontology of patient medical record is not only to follow the same standard used in communication among agents in Multi-Agent platforms (e.g.Fipa-Os), but also to extend ways of communication among stand alone applications in healthcare domain and Multi-Agent platforms. This will lead us to integrate medical knowledge and share medical information among stand alone application in healthcare organizations and agents in Multi-Agent platforms. Follow by this structure third step of requirements for language format is met.

Our purpose to share the medical record takes place by linking patient medical record to a web server for more accessibility by authorized users.

Security of health organizations while dealing with medical information stored in a medical center is clearly a very sensitive issue. One solution to this matter is by adding XML digital signature [14] to our formatted message. It is obvious that the research on secure access to data such as authentication of users, delivery and use of certificates, cryptographic methods or security in communications, will be the fundamental to ensure that applications may safely deal with medical data and by authorized users may access or update.

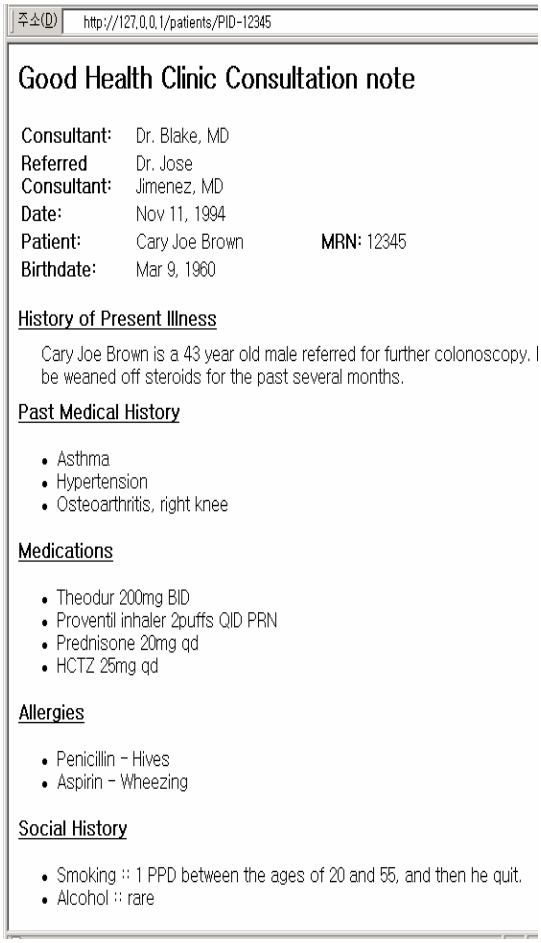

Figure 2- This figure demonstrates a medical record for Cary Joe Brown, which has summarized from content message of patient medical record in figure 1.

With the structure explained above, we have developed a repository of electronically maintained information about patient's lifetime health status and healthcare, stored such that it can serve the multiple legitimate users of the record. Consequently, the record must integrate elements regarding a patient's health and illness acquired by multiple providers across diverse settings. In addition, the data should be stored such that different views of those data can be presented to serve the many users.

Developers in each departments, healthcare, clinical care or even insurance companies can cut down unnecessary parts of a total medical record related to a specific patient and

parse it into a documentary format or suitable applications for physicians, nurses or any other health providers. An example has shown in figure 2.

Discussions

There are quite a number of related approaches to ontology definition languages. Nevertheless, the presented approach follows its own conception. Distributed artificial intelligence is study and creation of systems in which two or more autonomous agents interact intelligently. The shared meaning problem arises when cooperating intelligent agents do not share a common ontology, and therefore cannot communicate. Solving the shared meaning problem requires the ability to learn new symbols and associated meanings, which in turn requires a shared physical environment upon which the "ground" shared symbols [15]. In order to solve this problem and follow a unique ontology to be acceptable, adoptable and recognizable for all applications, software or agents, we have adopted the structure of HL7 messages into an envelop according to standards of FIPA. This approach gives us ability to communicate with Multi-Agents systems.

Health care involves several healthcare professionals, with different roles. The patient meets general practitioners, specialists of many branches, nurses, administrative employees, each one with his/her own expertise and with the need of accessing specific patient data, graded to their knowledge; such group have continues contacts.

The use of FIPA recommendation allows to exploit the ongoing industrial effect towards agent-based interoperability. However, adopting the Multi-Agent paradigm will involve a through analysis of the medical domain, in order to identify actors to be agentified, and relationships to be put forward as explicit communication acts.

Conclusions and Future works

Disagreement among physicians to use the same medical record have caused a variety of individual and expensive software to be made in the way that none of them has ability to be integrated with other healthcare systems. Disintegrate software and unshared information in healthcare system has a direct influence on patient care and treatments. Sharing clinical patient record may reduce the possible risk of mistreatments or human mistakes made by healthcare personals. This paper introduces ontology adoptable to any kind of Multi-Agent platforms or independent applications that have followed standards of FIPA and HL7. Significant conclusions are as follows:

- Following ontology with its unique structure is understandable for present software, platforms and other dependent or independent systems that have adopted standards of HL7 or communicate according to FIPA message structure.
- Patient medical record can be accessible form remote area through a web server. All it need is a web browser and a connected line to the internet.
- This ontology is a solution also a step forward for integration of information among healthcare organizations. Information system my help both citizens and healthcare professionals to obtain up-to-date and relevant healthcare information.

Security issues are extremely important in this field, where sensitive medical information is transmitted between agents. Appropriate measures have to be taken to guarantee the confidentiality of medical information. Placing security into our ontology has left to be worked on in the near future.

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