Information Retrieval System Based on Multi-agent for Healthcare

Mya Mya Khaing[#1], Shwe Sin Thein[*2]
Faculty of Information Science, University of Computer Studies (Pakokku)
University of Computer Studies (Pakokku), Myanmar
[1]*joice.028@gmail.com*
[2]*shweshwe@gmail.com*

Abstract

The hospital staff serve as patient registration and appointment scheduling in today's healthcare domain. It makes time consuming and somehow hectic. Usually, patients have to come to the hospital and have to fill out patient registration forms and have to wait appointment. Over the past, most of works have been done by using online healthcare appointment system like m-commerce, e-commerce, telemedicine etc. Multi-agent system is most suitable for healthcare paradigm, as the properties of agent based systems deals with heterogeneous multiple agents. This information retrieval system based on multi-agent contains agents that have information about the personal medical history, the hospital, departments of each hospital and doctors of each department. This system provides as an agent that gives the patient by selecting desired hospital, desired date and desired time, etc. This multi-agent based system collaborates with the agents of hospital, department and doctor for that appointment. The personal agent allows the access the offered services for appointment and view medical history. The visited user can search and view doctor information with time and date, hospital information and health news. This system is implemented with PHP programming language, for providing a robust, user friendly appointment for the patient.

Keywords - *agent, multi-agent, information retrieval system, m-commerce, e-commerce, telemedicine*

1.INTRODUCTION

So people need more and more healthcare services and options. The current population of Myanmar is 53.37 million it will increase to 54.81 million by 2020. Most of patients expect to get comfortable and care for medical facilities, hospitals, wellness centers, physicians' practices and holistic groups.

As shown above, if it gives all facilities for patient, it can pass new challenges for facility administrators.

Online application system is an important role over the world when the patients want to apply and request their suffering disease or accident. For that, cooperation in the Agent Technology can provide better healthcare than the traditional medical system. In fact, Intelligent Agents properties (sociability, proactivity, autonomy) and the features of Multi Agent Systems (management of distributed information, communication and cooperation between different entities) are a good option to solve several problems in the hospital organization. As examples of problems, which appear in the hospital, collaboration between hospital wards, elaborations of medical diagnostics, coordination among medical entities and the collection of information about patients, etc.

In today's world, where the current scenario in the healthcare domain requires to avoid patients' satisfaction, the numbers of missed appointments and unnecessary waste of patients' appointment time that have led to a tremendous problem for healthcare institutions. Hence, there is a need for an efficient healthcare system that will provide doctor information, hospital information and latest Health News for both registered user and visited user. This system saves effort, time and money of patients from waiting in the queue to book appointment. And this system develops for doctor appointment to ensure smooth, safe and quicker appointment service based multi-agent technology. In this paper we observe and collect the data as required from there hospitals such as City, Asia Royal and Nyein.

2. THEORETICAL FRAMEWORK

A concise theoretical framework as an introduction for those that the essential concepts in the field of MAS.

A. Agent

Traditional software used to be made up of hard-coded entities whose behavior is completely defined beforehand by its coder. Every possible input to the system and every possible internal state have to be taken in account by the programmer and a custom action command have to be provided for each single different case. If some case is not foreseen by the programmer, the results are unpredictable.

This system can manage the situations of the healthcare and instruct the user want to do in order to achieve goals. The piece of software that acts in this way is called an agent [1]. In this sense, pieces of software like control systems or most software daemons are examples of agents.

For simplicity in this paper we use the definition given by Wooldridge in [1] that is adapted from [2] where he refers to an agent:

An agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives.

The agent does not have to possess full control or knowledge about the complete environment. The agent may know only a part of the system, perhaps only its neighborhood and it only can take several actions to influence the system to achieve the goal. Since the system might be populated by other agents, the results of the actions of every one depend on the actions of the others, so the system is non-deterministic from the point of view of a single agent [1].

B. An Intelligent Agent

Although there is no universally accepted definition for an intelligent agent [1], most of the researches agree with that an intelligent agent is a piece of software that has a set of properties. Most common properties are: reactivity, autonomy, learning, cooperation, reasoning, communication and mobility [6], [13], [7].

Defining *Intelligent Agent* should require a description of intelligence, but there is no consensus about what intelligence means when referring to computer software. Getting rid of this question Wooldridge defines an *Intelligent Agent* in[1] as follows:

> An intelligent agent is one that is capable of flexible autonomous action in order to meet its design objectives.

In the previous definition the word *flexible* means three things [2]:

- Reactivity: The intelligent agents perceive the environment and they take actions depending on the perceived state.
- Pro-activeness: The intelligent agents are able to initiate actions to achieve their goals. This means that the agents are goal-directed. Achieving a good balance between the first and the second properties can be difficult.
- Social ability: The intelligent agents are able to communicate among themselves, with other systems and with the users to achieve their goals. The communication is supposed to provide cooperation and negotiation mechanisms to allow the agents to fulfill their own goals and the global ones.

A common view of agents based on Bratman [8] and Rao and Georgeff [3] isthe DBI model that makes up an agent of a set of *desires*, *beliefs* and *intentions* meaning the following:

- *desires* describe the final goals to achieve.
- *beliefs* compose the information that the agent has about its environment.
- *intentions* are a set of goals that the agent has decided to achieve forming a plan.

3. MULTI AGENT IN HEALTH CARE DOMAIN

In recent years agent based systems has become growing approach to solve the limitations in the medical health care domain. Medical domain is a huge environment distinguished by its common and distributed decisional characteristics and its management of care, which requires a communication and a complex management between the various medical departments, doctors and patients. The introduction of multi-agent systems into the medical domain make it easy for the management to take its decisions and the actions, and ensures the communication and coordination by minimizing the errors of analysis and treatment, and by improve time required to look for the medical resources, and other medical departments.

Multi-agent systems have been importantly contributing to the development of the theory and the practice of complex distributed systems and, in particular, have shown the potential to meet critical needs in high-speed, mission-critical content-rich and distributed information applications where mutual interdependencies, dynamic environments, uncertainty, and sophisticated control play a role. Therefore, multi-agent systems can be considered a suitable technology for the realization of applications

for providing healthcare and social services where the use of loosely coupled and heterogeneous components, the dynamic and distributed management of data and the remote collaboration among users are often the most relevant requirements.

Multi-agent systems are one of the most interesting areas in software research and they have been importantly contributing to the development of the theory and the practice of complex distributed systems [9], [10]and, in particular, have shown the potential to meet critical needs in high-speed, mission-critical content-rich and distributed information systems where mutual interdependencies, dynamic environments, uncertainty, and sophisticated control play a role [12]. Application for healthcare and for providing social services can take outstanding advantage of the intrinsic characteristics of multi-agent systems because of notable features that most healthcare applications share: *(i)* they are composed of loosely coupled (complex) systems; *(ii)* they are realized in terms of heterogeneous components and legacy systems; *(iii)* they dynamically manage distributed data and resources; and *(iv)* they are often accessed by remote users in (synchronous) collaboration[4],[11]. The goal of this chapter is to describe the main reasons why multi-agent systems are considered one of the most interesting technologies for the development of applications for healthcare and social services. It provides some guidelines intended to help identifying the kinds of applications that can truly take advantage of the features of multi-agent systems, and it presents some of the most important international projects that used multi-agent systems in the healthcare and social services domain.

4. ARCHITECTURE OF MULTI-AGENT HEALTHCARE

The main aim of the system is to build a worldwide network of agent based platforms that provide interesting services to the all online user. (e.g. appointment and information about hospital). The basic architecture of the MAS which has been developed in this system is shown in Figure. 1.

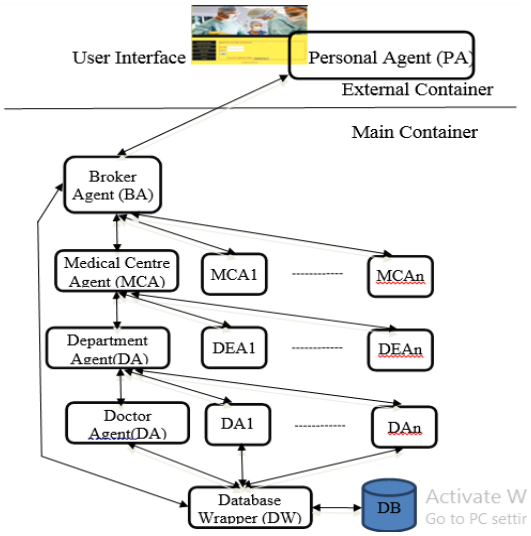

Figure 1. Architecture of Information Retrieval System Based on Multi-agent for Healthcare

This multi-agent system contains the following agents:

- The user's personal agent (PA), that provides a graphical interface of the MAS to the user, allowing the access to the offered services (queries, appointment, history).
- The broker agent (BA) is an agent that provides a gateway between personal agents (PA) and the rest of the agents in the system. It controls the access of users that are properly authenticated.
- The information of a medical centre is divided into three levels. For each medical centre there is one medical centre agent (MCA), several department agents (DEPs, one for each department of the centre) and many doctor agents (DAs, one for each doctor of each department). The MCA has the general information of the centre (e.g. its address and phone number, department). Each DA maintains the free times and busy times of a doctor.
- The database wrapper (DW) is the agent that controls the access to a database that contains the medical records of the users.

The agents are stored in several containers [5]. The MCAs (with DEPs and DAs) and the DW are internal to the system and only the BA is accessible by external agents. The PAs are running in the user's machine in an external container. The internal agents could be deployed physically around several machines in a real setting, e.g. each MCA (with its hierarchy of associated agents) could be running in a separate machine. Concretely, through our tests, we recommend not to run more than 100 agents on the

same machine because the overhead produced by each one agent decreases the global performance.

4.1 How to interact with agents in Multi-agent system

In Personal Agent stage, the user may request information about the medical centers or hospital a particular city. In Doctor Agent state, visit to be examined by a doctor. The user can access to his medical record. It must be made sure that nobody can access the private medical information of the user of the system without proper authorization. In a Broker Agent state, the doctor can manage his working hours and patient's appointments. After checking, he is able to access the patient's medical history and to update it with the result of the visit. In database wrapper stage, the user can manage his own timetable and to select the most appropriate information. The authorized person can only see the private medical information of the user of the system.

5. DESCRIPTION OF THE SYSTEM FLOW FOR PROVIDING HEALTH CARE SERVICE

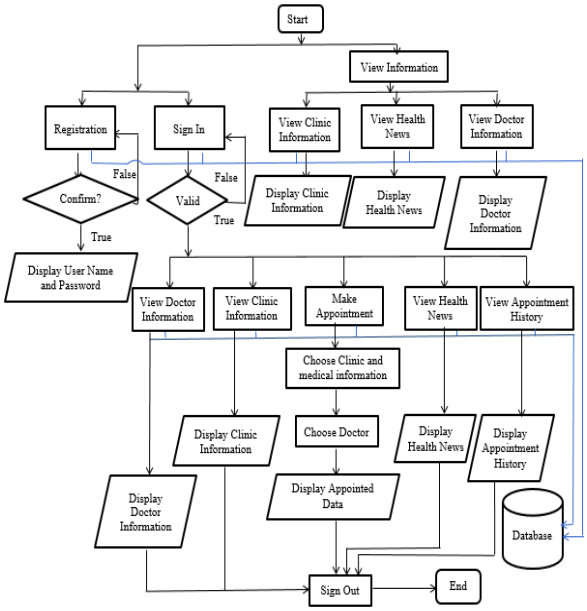

Figure 2. System Flow Diagrams for Providing Healthcare Service

Figure.2. shows the system flow diagram for providing healthcare service, based on multi-agent for healthcare. In this system, there are two user levels – registered user and visited user. The visited user can view clinic information, doctor information, and health news, contact us, about us and do registration. For making appointment and viewing his/her appointment history, the user must register and sign in. The registered user can also view clinic information, doctor information, health news, contact us, about us and his/her appointment history and make an appointment. All registered users can search doctor information with hospital name, doctor name, department name and appointed date and time.

6. IMPLEMENTATION

The proposed system is implemented as an information retrieval system based on multi-agent for healthcare. This multi-agent system contains agents that have information about the medical centres, departments and doctors of a region. The system has two modules as registered user and visited user. The system allows registered user to do appointment and to view his/her appointment history and visited user to search the specific doctor by name, hospital name, department name. Some system features with respect to user interfaces are shown in the following figures.

6.1 Home page

Figure 3. Home Page Design of the system

Figure.3 is the home page design of the system. In the home page, there are five left sub-menu; Hospital Information, Doctor Information, Health news, About us and Contact. If the user want to know the hospital Information to view the hospital information, Doctor Information to view and search doctor information, Health News to view updated health News, to view vision, mission and quality policy of web page and Contact to view contact.

6.2 Doctor Information Page

Figure 4. Doctor Information for the visited user

In Figure.4, there are six left sub-menu at left side of page: Login, Registration, Hospital Information, Health News, About us and Contact. In this page, the user can view doctor information with doctor name, Hospital name, Department and Appointed Time and Date. And the user can also search doctor information by Doctor Name, Hospital Name, Department and Appointed Time & Date in search box.

6.3 Patient Registration Page

Figure 5. Patient Registration with validation format

In Figure 5, this form involves nine fields: name, password, confirm password, age, gender, marital status, current job, address and phone as in Figure. 5. Password field and confirm field is *required. Password field requires minimum 6 characters allowed*. *Invalid Phone Number* that validates the phone number format and *minimum 12 characters allowed.*

6.4 Registered User Home Page

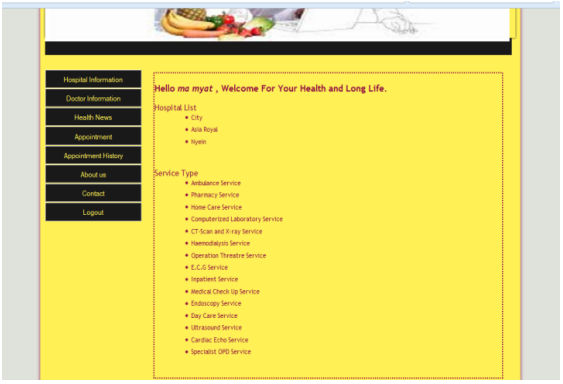

Figure 6. Home Page for the registered user

After login with user name and password, the home page will appear as shown in Figure. 6. In this page, there are eight left sub-menu, Hospital Information, Doctor Information, Health News, Appointment, Appointment History, About us, Contact and logout, Hospital Information, Doctor Information, Health News, about us and Contact page are all the same as visited user' pages except left menu. Registered user' pages contain appointment and appointment history sub-menu in left page. If the user chooses the logout, the login page will appear and exit the user account from entering. In this home page for register user, the hospital list in this web page and service type of hospitals are shown.

6.5 Appointment Page

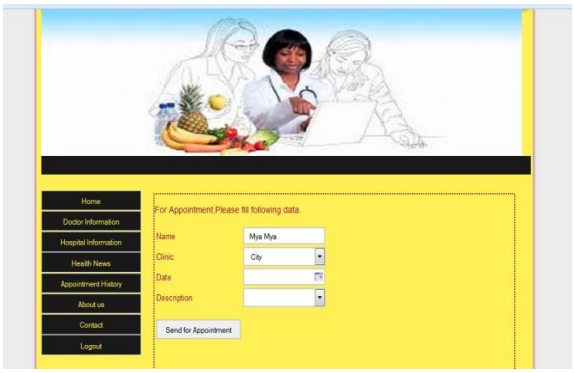

Figure 7. Appointment Page for the registered user

The proposed system is implemented as an information retrieval system based on multi-agent for online appointment. Firstly, the registered user must choose desired Hospital in *Clinic* drop down list (City, Nyein and Asia Royal), the appointed *Date* in *today and next calendar plug in* and disease *Description* (e.g. ill, kidney, neck, nose, sexual, pain

after accident, breast, pain after operation, movement problems, etc.).

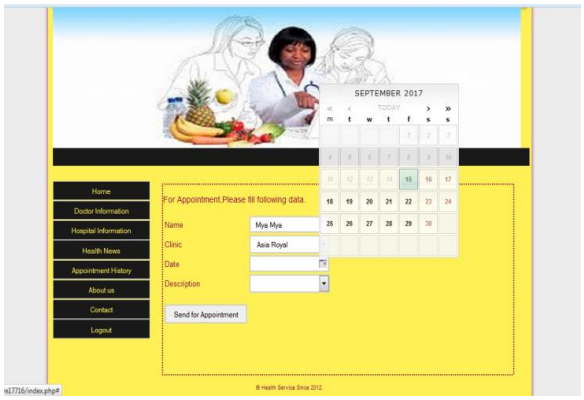

Figure 8. Appointment Page with today and future calendar

In Figure.8, the appointed date must be today and next day and not be past. So the calendar is implemented.

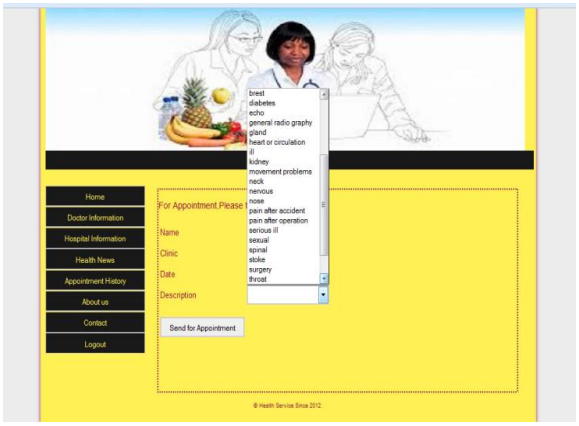

Figure 9. Description in Appointment page

The main design and objective of the system is to provide a decomposition of the problem as an information retrieval system that allows modelling the real entities of the medical domain as multi-agent, based on the structure of online appointment in City, Nyein and Asia Royal. Each hospital has a set of departments and each department has a set of doctors. If the registered user chooses the *City* hospital in *Clinic* drop down list, one medical centre agent (MCA) decompose other medical centre agents. If the registered user choose the one disease *Description* in *Description* drop down list, one department agent (DA) decompose other department agents based chosen hospital. In Figure.9, the system will change *Description* like user friendly usage to the related department.

Figure 10. Appropriate Doctor List for appointment

If the register user selects the *send for appointment* button in appointment page, doctor schedule based on user chosen data with their busy and free time will appeared as Figure. 10. The scheduled table contain doctor name with his/her hospital name, department name, busy time, free time and proposal button. The registered user can choose the one *Desired Time* in drop down list (9:00 A.M., 10:00 A.M, 11:00 A.M., 1:00 P.M. and 2:00 P.M.). If the registered user appoints the doctor in a table with one *Desired Time* by selecting *Accept* button, appointment successful page with appointment information will appear.

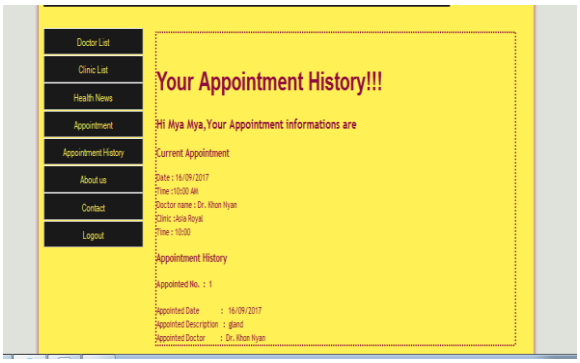

Figure 11. Description in Appointment page

The user's personal agent (PA) provides the graphical interface of the MAS to the user, allowing the access to the offered service as viewing his/her appointment history as shown in Figure. 11. The broker agent (BA) controls the access of users that are properly viewed their appointment history.

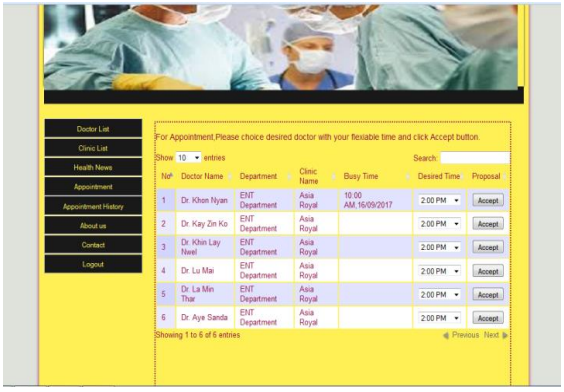

Figure 12. Doctor List for appointment

After appointment with one *Desired Time* by one registered user, this *Desired Time* will represent as *Busy Time* in that row of table shown in Figure. 12.

7. CONCLUSIONS

Intelligent Agents have a set of properties (sociability, proactivity, autonomy) that make them suitable to be used to solve many problems that appear in the healthcare domain. This basic property of Intelligent Agents and the features of Multi Agents Systems (management of distributed information, communication and cooperation between separate autonomous entities) suggest that they are a good option to solve the problems of coordination in the hospital organization. The system has been designed to benefit of users who need medical services, who could access the wanted hospital information from anywhere, make appointment with certain doctor based on doctor information, and obtain any kind of information related to the medical centres, departments and doctors. The application for modern healthcare is distributed by their nature. The main aim of information retrieval system based on multi-agent for healthcare is to provide multi-agent based services that improve the quality of the life of the people. The deployed application certainly contributes towards this objective, by giving to the users the possibility of accessing medical data in an easy and efficient way.

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