A model of Distributed Ayurvedic Diagnosis and Therapy System for Hridroga Using Agents

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Abstract— **Diagnosis of Hridroga (cardiac disorders) in Ayurveda requires the combination of many different types of data, including personal details, patient symptoms, patient histories, general examination results, Ashtavidha pareeksha results etc. Computer-assisted decision support systems must be able to combine these data types into a seamless system. Intelligent agents, an approach that has been used chiefly in business applications, is used in medical diagnosis in this case. This paper is about a multi-agent system named "Distributed Ayurvedic Diagnosis and Therapy System for Hridroga using Agents" (DADTSHUA). It describes the architecture of the DADTSHUA model .This system is using mobile agents and ontology for passing data through the network. Due to this, transport delay can be minimized. It is a system which will be very helpful for the beginning physicians to eliminate his ambiguity in diagnosis and therapy. The system is implemented using Java Agent DEvelopment framework (JADE), which is a java-complaint mobile agent platform from TILab.**

Keywords- Hridroga; Mobile Agent; diagnosis; treatment; Ayurveda; Ontology.

I. INTRODUCTION

A lot of medical diagnosis and therapy system has developed. But they are all based on modern medicines and they lack the collaborative ability [1]. There is no system available which is based on Ayurveda. Ayurveda is first and foremost a 'spiritual science' - offering scientific insights how to live in harmony with nature and to grow toward the realization of one's true nature or Soul. Medicine is only one aspect of this science of compassion [4]. The heart is one of the most important organs in the entire human body. It is really nothing more than a pump, composed of muscle which pumps blood throughout the body, beating approximately 72 times per minute of our lives[8]. The heart pumps the blood, which carries all the vital materials which help our bodies function and removes the waste products that we do not need. Heart disease or cardiopathy is an umbrella term for a variety of different diseases affecting the heart [10]. As of 2007, it is the leading cause of death in the United States, England, Canada and Wales, killing one person every 34 seconds in the United States alone. It is quite disheartening that the highly technological approach of the modern medicine literally bypasses the underlying causes of the heart disease. Ayurveda, on the other hand, aims at striking at the very root of the disease. A real cure for this disease is only possible if we adopt a holistic approach as the one advocated in Ayurveda and address the problem at its very root [9].

This paper aims to put forward a model of intelligent Ayurvedic diagnosis and therapy system which combine the functions provided by multiple heterogeneous systems via Local Area Network (LAN). In this model, these different Ayurvedic diagnosis and therapy systems can collaborate with each other via LAN. In our DADTSHUA model, the mobile agent can travel to remote ayurvedic diagnosis and therapy system via LAN as the delegate of local medical diagnosis and therapy system.

The rest of the paper is organized as follows. Section 2 describes the advantages of using agents in this system. Section 3 describes the application model of DADTSHUA. In section 4, the architecture of the system is described. Section 5 briefs about the functions of agents in the system. In the section 6, the agent interactions in the system are explained. Section 7 describes the ontology used in the system. Section 8 discusses how the diagnosis and therapy are done in the system. Section 9 concludes the paper.

II. WHY AGENTS?

The existing systems in this field do not have collaboration ability. In this model, agent technology is used because of its ability to provide collaboration. The decision making is done with the help of collaboration between agents in this system. And another factor for selecting agents is that it provides higher efficiency and safety. In this model, Patients' data can be encapsulated in mobile agent object which can be serialized as binary data and sent it to remote site. When reaching at the remote site, these binary data can be un-serialized to rebuild mobile agent quickly, so higher efficiency and safety are able to be insured [1].

III. THE APPLICATION MODEL

The system composed of many Ayurvedic Hridroga Diagnosis and Therapy System (AHDTS) and one Ayurvedic Treatment Service Register Server (ATSRS). The AHDTSs and ATSRS can communicate through the LAN.

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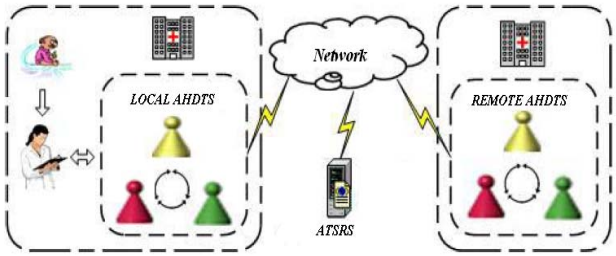

Figure 1. Application Model

The diagnosis and treatment task is completed in this system by the group collaborative work of Ayurvedic Diagnosis Agent (ADA) and Ayurvedic Treatment Agent (ATA) in different AHDTS. The Fig 1 shows the application model.

Through human-machine interface, physicians submit a new task by entering patient's information, including personal details, symptoms, history, personal history, examination details like general examination details and Ashtavidha pareeksha details into local AHDTS. The local AHDTS processes these data for getting a result and diagnosis is completed locally. Then it will search for the treatment. If it is available in the local AHDTS itself, then the system will give the diagnosis and treatment results to the user. If local AHDTS lacks to fulfill the task independently, it can expand the task to remote AHDTSs by getting a certain ayurvedic diagnosis and therapy services provided by a remote AHDTS. In the end, the results can be sent back to local AHDTS from remote AHDTS via Network.

IV. The Architecture of the System

In these system, there are two components as said earlier, AHDTS and ATSRS. Each AHDTS is itself a multi agents system. AHDTS is composed of six types of agents. They are

1. Human Machine Interface Agent (HMIA)
2. Ayurvedic Diagnosis Agent (ADA)
3. Ayurvedic Treatment Agent (ATA)
4. Ayurvedic Treatment Find Agent (ATFA)
5. Ayurvedic Treatment Register Agent (ATRA)

And

6. Messenger Agent (MA)

ATSRS consists of an agent and it is named as

7. Ayurvedic Treatment Server Agent (ATSA)

Fig 2 shows the architecture of the system.

V. Functions of Agents in the System

A. Human Machine Interface Agent (HMIA)

HMIA is considered as the main agent in the system. It has some important functions which are listed below.

1) Receiving patient's data from the naive user or administrator and stores these data in the database and then passes the details to the ADA.

2) Receiving the treatment details for registration from the administrator and forwards it to ATA.

3) Searching the treatment services in the local AHDTS.

4) Requesting the ATA for treatment.

5) Exciting ATFA for finding the address of the service providing agent from the ATSRS with the help of ATSA.

6) Displaying Results to the user.

7) User Management which involves the user creation, user deletion and changing password.

B. Ayurvedic Diagnosis Agent (ADA)

ADA is the agent where the diagnosis is done. The diagnosis process consists of 3 steps which are primary diagnosis, secondary diagnosis and confirmation of result. Primary diagnosis is done with the symptoms of the patient and Secondary diagnosis is done with the other details of the patient such as general characteristics, personal history, general examination results and Ashtavidha pareeksha results. Then ADA confirms the result according to the primary and secondary diagnosis results and the result is given back to the HMIA for displaying.

C. Ayurvedic Treatment Agent (ATA)

ATA is the agent which does the treatment. It takes the treatment details from the HMIA and stores it in the database. It then registers the service in the directory facilitator of the local AHDTS and then excites ATRA for registering the treatment services in the ATSRS with the help of ATSA. Whenever a user wants to get a treatment service from the ATA, he gives the details of the patient through the HMIA. Then the ATA retrieves the treatment details corresponding to the details given by the user and passes it to the HMIA for displaying it to the user.

D. Ayurvedic Treatment Find Agent (ATFA)

On receiving the disease details of the patient from the HMIA, ATFA sends a message containing the details from the HMIA, to the ATSA in the ATSRS for getting the address of the service providing agent. ATSA replies with the address. Then the ATFA forwards this message to the HMIA.

E. Ayurvedic Treatment Register Agent (ATRA)

ATRA is the agent which is used for registering services in the ATSRS. When ATRA receives the request for registration, it sends a message containing the details of the

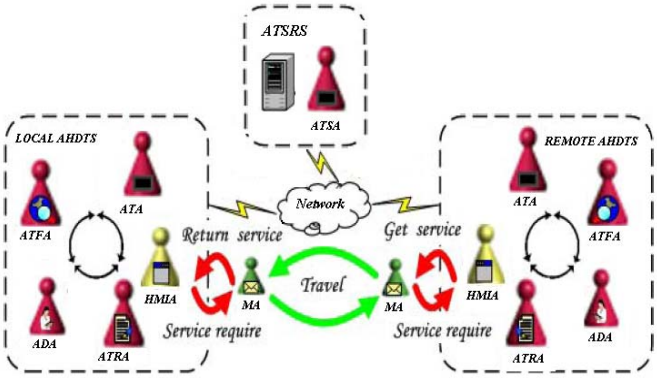

Figure 2. Architecture of the system

disease, id of the agent and address of the machine to the ATSA in the ATSRS. ATRA is also used for deregistering existing services in the ATSRS with the help of ATSA.

F. Messenger Agent (MA)

Messenger Agent is the only mobile agent in the system. After finding the machine address of the service providing agent, the HMIA creates Messenger agents for each address. Then it sends a message containing the patient details, diagnosis details and address of a service providing agent to each messenger agent. It migrates to the remote AHDTS with these details. Then it communicates with remote ADA and ATA for diagnosis and treatment respectively. It receives the result from the remote AHDTS and migrates back to local AHDTS. Then it sends the results to the local HMIA for displaying.

G. Ayurvedic Treatment Server Agent (ATSA)

ATSA is the only agent residing in the ATSRS. Its functions involve registering treatment services in the ATSRS on request from the ATRA. Another function of it is to discover service details from the database and sends back to the service requesting agent. The service details mean the identifier of the agent providing services and the addresses of the machine where the agent is residing. It is also responsible for deregistering existing services from the ATSRS.

VI. AGENT INTERACTIONS

A. Diagnosis And Therapy

Initially the HMIA displays a GUI for the user to enter the patient details. Then the HMIA takes the details and prepares a message containing these details and sends it to the ADA for diagnosis. The ADA diagnoses it locally and the diagnosis result is sent back to the HMIA. HMIA displays the results to the user. Then the HMIA checks the availability of the treatment in the local AHDTS and sends the diagnosis result and visit number to the ATA for getting treatment, if the treatment is locally available. If the local AHDTS lacks the treatment service, then the HMIA requests the ATFA to find service providing agents. The ATFA sends message to the ATSA in the ATSRS for getting addresses of the service providing agents. If there is no treatment service available in the ATSRS, it will give an error message. Otherwise ATSA sends reply with the addresses of the service providing agents to the ATFA and ATFA forwards this message to the HMIA. Then HMIA creates MA for each address given by the ATSA and prepares a message containing the patient details, diagnosis results and address of a service providing agent and sends it to each MA. Then each MA migrates to the address given in the message as the delegate of the local AHDTS. Upon reaching the remote AHDTS, the MA contacts with the remote ADA for diagnosis and the ADA gives result to the MA after diagnosis. The MA stores the diagnosis result in it. Then it contacts with the ATA for getting treatment measures according to the diagnosis result from the HMIA and the ATA replies with the treatment measures after processing. Then the MA stores the treatment measures in it and migrates back to the local AHDTS and gives back the result to HMIA. HMIA receives the diagnosis result from all the MAs and decides the type of hridroga. Then HMIA displays the diagnosis results and treatment measures to the user. Hence the diagnosis and therapy process completed.

B. Treatment Registration And Deregistration

Only users having administrator privilege can register new treatment services in this system. Fig 3 shows the treatment service registration and service finding. The administrator can input details through a GUI provided by the HMIA. The HMIA takes the details (1) and prepares a message containing treatment details and pathya and sends this message to the ATA (2). The ATA registers the treatment service in the directory facilitator (3) and sends a message containing the identifier of ATA, address of the machine, treatment name and Boolean variable register to the ATRA (4). The value of register is true for registration and false for deregistration. The ATRA forwards the message to the ATSA (5). When ATSA receives the message, it makes a query for inserting the treatment details in the database (6) and the registration process completed.

For finding treatments, the HMIA displays a GUI for taking the name of the treatment to find, from the user (7). Then HMIA checks the availability of treatment service in the local AHDTS by checking in the Directory Facilitator (8). If it is available in the local AHDTS, the DF gives back the address of the agent providing service (9). Then the HMIA takes the treatment details from the ATA in the local AHDTS and displays to the user. Otherwise it prepares a message with treatment name and sends it to ATFA (10).The ATFA sends a message containing the treatment name and visit number to the ATSA (11). The ATSA retrieves the treatment details from the database ((12) and (13)) and sends a message containing identifier and addresses to the ATFA (14). The ATFA forwards the message to the HMIA (15). Hence the treatment finding process completed.

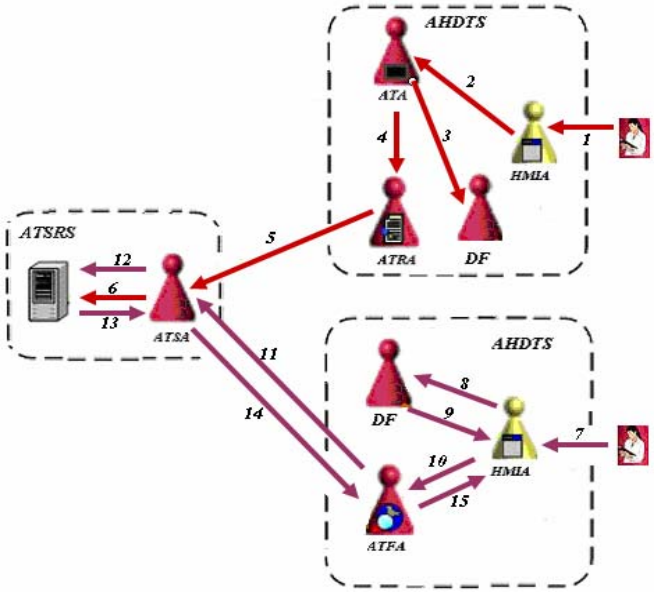

Figure 3. Treatment Service Registration and Service Finding

VII. AHDTS ONTOLOGY

AHDTSOntology is an ontology developed using JADE[3]. It describes the elements that are used as content of messages which are exchanged between different agents in the system. In it, there are 15 concepts and 4 agent actions[6][7]. The concepts are Patient Details, PatSymptoms, GenChara, Personal History, GenExam, AshtavidhaPareeksha, Patient Chara, Examinations, Patient, result, MsgFromATA, ResultInMsngr,ServCommMsg, ServMultiResult and HtoMMsg. The agentactions are ATACommMsg, ServRegMsg, Diagnose and TreatmentFindMsg.

The Patient Details, PatSymptoms, GenChara, Personal History, GenExam and AshtavidhaPareeksha are the details of the patient which are entered by the user. Patient Chara contains Personal History and GenChara. Examinations contain GenExam and AshtavidhaPareeksha. Patient contains PatientDetails, PatSymptoms, PatientChara and Examinations. Result is the diagnosis result send from the ADA to HMIA. MsgFromATA is the treatment result send from ATA. ResultInMsngr is the treatment result from the remote ADA and ATA which is stored in the MA and it is sent from MA to HMIA. ServMultiResult is the result from the ATSA which contains a list of ServCommMsg. ServCommMsg contains the identifier and address of the service providing agent. HtoMMsg is the content element of the message sent from HMIA to MA.

Agentactions are used as the content of the message for requesting an agent to perform an action[7][6]. ATACommMsg is the agentaction used for requesting ATA to perform service registration. ServRegMsg is the agentaction used for requesting ATSA to perform treatment service registration. Diagnose is the agentaction for performing Diagnosis and TreatmentFindMsg is the agentaction for taking treatment details from the ATSA and ATA.

VIII. OPERATIONS IN THE SYSTEM

A. Diagnosis

The input to the diagnosis function is patient details including personal details, symptoms, history of presenting complaints, general examination details and Ashtavidha pareeksha details. The output of the system is name of Hridroga.

In the system, the diagnosis process consists of three steps namely Primary diagnosis, Secondary diagnosis and Confirmation of result. In the primary diagnosis, the system compares the symptoms of the patient with the symptoms of each hridroga. For each symptom, the system has already given a weight according to the probability of that hridroga with that symptom. Finally the system takes the sum of the weights. If the sum is greater than a cutoff value of any hridroga, the system gives that Hridroga as the result.

The secondary diagnosis is done by using the patient details other than symptoms. The system has already stored all the information about which *dosha* is aggrevated corresponding to each possible value of details given by the user. Then checks whether which *dosha* is most aggrevated and the Hridroga caused by the aggrevation of that *dosha* is given as the result of secondary diagnosis.

Confirmation of result is done by checking whether the result of primary diagnosis and secondary diagnosis are same. If they are same, the result is displayed as the confirmed result. Otherwise it is displayed as non confirmed result.

B. Treatment

The inputs to the treatment operation are Hridroga details and visit number. The system stores the treatment details according to the visit number in the database when they are entered by the administrator. The output of this operation is treatment measures for each visit.

Upon receiving the hridroga details and visit number, the system retrieves the treatment measures corresponding to the entered details from the database. Finally the system outputs the details to the requested agent.

IX. CONCLUSION AND FUTURE WORKS

A multi-agent system named "Distributed Ayurvedic Diagnosis and Therapy System for Hridroga using Agents" was implemented. It was implemented in Local Area Network. Initially the system was implemented in such a way that Java Objects are used for sending details in ACLMessages. Then it was modified by using Ontology. It was implemented only for Hridroga. This system was implemented in JADE.

The system can extend to Internet using Web services. It can be extended to more diseases. Here diagnosis is done using simple weight calculation and comparison. It can be extended using more accurate methods. The values of details taking in this system are using predetermined values. It can be extended by using Fuzzy rules.

REFERENCES

[1] Wu Zhao, He Yanxiang and Jin Hui**.** "A Model of Intelligent Distributed Medical Diagnosis and Therapy System Based on Mobile Agent and Ontology". Proceedings of the Eighth International Conference on High-Performance Computing in Asia-Pacific Region (HPCASIA'05)0-7695-2486-9/05 $20.00 © 2005.

[2] DL Hudson and ME Cohen. "Use of Intelligent Agents in the Diagnosis of Cardiac Disorders". Computers in Cardiology 2002;29: 633−636.

[3] Natalya F. Noy and Deborah L. McGuinness. "Ontology Development 101: A Guide to Creating Your First Ontology".

[4] Swami Sadashiva Tirtha**.** 2005. "The Ayurveda Encyclopedia-Natural Secrets to Healing, Prevention & Longevity". Ayurveda Holistic Center Press.

[5] Alan Jovic, Marin Prcela, Dragan Gamberger. "Ontologies in Medical Knowledge Representation". Proceedings of the ITI 2007 29th Int. Conf. on Information Technology Interfaces, June 25-28, 2007, Cavtat, Croatia.A

[6] http://www.iro.umontreal.ca/~vaucher/Agents/Jade/JadePrimer.html

[7] Fabio Bellifemine, Giovanni Caire and Dominic Greenwood,"Developing multiagent systems with JADE," John Wiley & Sons Ltd.

[8] http://www.worldinvisible.com/apologet/humbody/heart.htm

[9] http://ayurveda-foryou.com/treat/ ayutreat4heart.html

[10] http://en.wikipedia.org/wiki/Heart_disease