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Multi Agent System Based Clinical Diagnosis System: An Algorithmic Approach

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ABSTRACT

Modernization of medical health care system using agent technology has become an important research direction today. It is a true fact that agent based health care system can provide better healthcare than the traditional medical system. An advanced scheme of agent-based healthcare and medical diagnosis system can take care of every stage of patient such as initial check up, treatment and report for the patient. A user friendly interface is also required to provide high performance, reliability and functionality in this regard. In this paper we have tried to propose an operational algorithm to describe the individual working operations of a hybrid multi agent system based intelligent medical diagnosis system called Clinical Diagnosis System(CDS). Using the knowledge base and collaborative as well as co-operative intelligent agents and residing on a multi-agent platform, that CDS provides a communicative task-sharing environment.

Keywords – Agent Technology, Health Care, Multi Agent System, Knowledge Base,

I. INTRODUCTION

Now a days it is became a true fact that health care problem is the major problem in many poor country. In our country a large number of people live under the poverty level. Conventional medical and healthcare system of our country failed to provide the minimum service. Poor economy and rapid growth in the population [1] has become a threat in this issue. Beside these issues a major portion of the total population of our country resides in the remote areas [2], where proper health care and community medical services are almost beyond the reach of the native people. The problem is due to acute scarcity of medical practitioners as well as proper infrastructure. Keeping the medical diagnosis system in mind, we notice that the whole system depends on some basic factors like proper medical healthcare infrastructure, healthy economic condition, global awareness and user friendly environment or setup. In our research we have tried to give focus on that technical infrastructure problem. Generally technical infrastructure means the practitioners, tools, medicines and modern technology based platform. And it's a fact that the factors are quite indispensable, mainly for those community health centers situated at remote villages as well as at other places. Lack of proper user friendly environment also stands against the proper treatment and diagnosis. Not only those limitations, there persists many other problems that affects the overall situation of our social environment and health situation. Due to the lack of proper medical system, many people go to some local unqualified practitioners. This is really a threat for our health care system.So the current situation demands a new system. A system which will work beyond the limitations stated above. Research work on Community healthcare System [3] is going on, but those systems are highly expensive to implement. Common telemedicine system [4] [5] is a good option obviously, but it is not better for future expansion of the existing system.In our previous research paper we have proposed an intelligent and agent-based medical diagnosis system called Clinical Diagnosis System or CDS [6].This model is agent oriented, much better to say, multi agent system (MAS) oriented intelligent diagnosis system which system can take care of the initial check up of the patient, do the treatment and generate the solution or report for the patient very easily. In this paper we have analyzed the working concept of CDS first, and then we have analyzed the individual system operations of that scheme and proposed the working algorithm of that above mentioned model.

II. IMPORTANCE OF MULTI AGENT SYSTEM IN HEALTH CARE

The capacity of individual agents is limited by its knowledge, computing resources and its perspective. The most powerful tool for handling complexity are abstraction and modularity which are definitely offered by a system where a number of or a group of agents work together to perform a task. Such a system is said to be a Multi Agent System (MAS)[7]. A multi-agent system (MAS) is one that consists of a number of agents, which interact with one another, typically by exchanging messages through some computer network infrastructure. In the most general case, the agents in a multi agent system will be representing or acting on behalf of users [8] or owners with very different goals and motivations. In order to

successfully interact, these agents will thus require the ability to cooperate, coordinate, and negotiate with each other, in much the same way that we cooperate, coordinate, and negotiate with other people in our everyday lives. Multi Agent Systems offer modularity. Thus, in an attempt to solve more complex real-life problems, the concept of MAS [9] was developed which uses a number of agents working together interactively and solving complex problems successfully.

It has been said that the Multi Agent System acts as the latest Software Engineering paradigm . The Multi Agent Systems can be used specifically when following domains are encountered:

- The domain contains problem that can be decomposed into several sub-problems, which may have some kind of inter-dependencies.[10]
- The knowledge is administered in various places.
- A number of entities need to join their problem-solving abilities, keeping their autonomous nature intact to solve a complex problem.

Keeping all the above in mind we can feel that applying agent-based techniques to the problems in the medical domain can be beneficiary for the civilization. And we think that is the main reasons why Multi Agent Systems are opted as one of the most interesting and effective technologies to solve various health related problems to revolutionize the medical paradigm.

III. CORE CONCEPT OF CDS

The In Clinical Diagnosis System[6], an agent called User Agent (UA) is responsible for taking the user inputs i.e. symptoms from the patients with the help of a user interface. The user interface helps the practitioner or any person engaged in taking the symptom to feed the input as measured form and observation. Duty of this UA is to take patient symptoms in the form of raw data. The UA takes the raw input, and to apply some analysis method upon those data with the help of Master Agent (MA) to convert it to knowledge. This analysis is done with the help of the user interface i.e. the patient symptom form. That knowledge is stored in the Global Knowledge base (G KB). Role of the Master Agent (MA) is to select a specialist doctor agent (SDA) for handling the particular case and handover the case to that specific specialist doctor agent (SDA). The MA has the responsibility to give the task and to provide the proper knowledge from the Global Knowledge base (G KB) to the specialist doctor agents. For each SDA, there is individual local knowledge bases (LKB) associated with them. After having the solution, SDA will give the solution to the Master Agent (MA) and that solution will be stored in the Solution knowledge base (S KB). A report agent will be responsible for generating the report after getting the final instruction from the master agent. For instance, if a patient will come with symptoms such as high fever with convulsion, headache and weakness etc, the person will take those symptoms with the help of the user interface i.e. the form. User agent will help the person to refine the queries. After getting the queries or symptoms in the measured way, those inputs will be converted to knowledge and will be kept to the Global knowledge base. That knowledge will tell the master agent that the symptoms are likely to be of malaria. Then on the basis of that knowledge, the master agent will select the proper doctor agent. MA will also help SDA to access the global knowledge base. That SDA will then give the proper solution. That solution will also be kept in the Local knowledge bases of each SDA. After getting the particular solution for a particular case, that solution will be stored in form of knowledge at a different knowledge base called Solution knowledge base (S KB). A Report Agent (RA) can access this knowledge base for generating report with the help of MA. After generating the report RA passes it to UA with proper tagging to broadcast the result to the user.

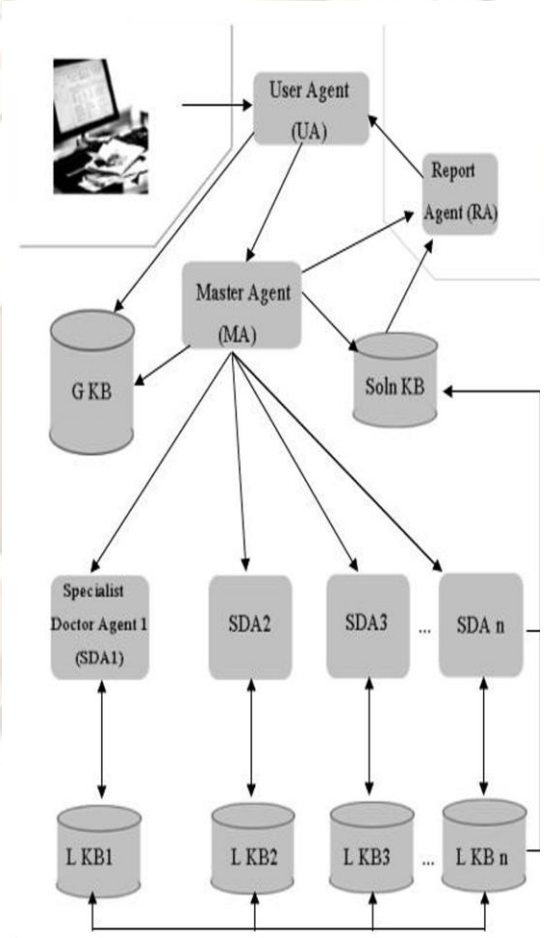

Fig.1. Architecture of CDS

IV. THE ANALYSIS OF CDS MEDICAL DIAGNOSIS SYSTEM

The CDS is composed from a set AD U SDA, the union of administrative agents and specialized doctor agent located in different medical sites. AD is the administration agent and it is heterogeneous in nature.AD is composed of master agent (MA) and user agent (UA) and report agent (RA).i.e. AD=MA U UA U RA and SDA is a homogeneous set and it includes all specialized doctor agents i.e. SDA= $\{SDA_1, SDA_2 \ldots\ldots SDA_n\}$. This homogeneous set of different doctor agents is capable to help the administration agent AD in the problem solving process. It is assumed that all the participated agents are knowledge based agents and posses the basic features of an agent like belief, desire, intension, task, capability, commitment etc. [11]. Belief means what an agent believes about itself and about its environment. Desire means the willingness to complete the task. Intension is the grade in which the agent wants to end up the task. Task is the mentioned work to be done by an agent. It consists of a set of atomic actions. Commitment means the agent's obligations towards the environment and to itself [11].The arrows used in the figure presents the type $T=\{T_a, T_{as}, T_{ss}\}$ of cooperation links between the agents.T_a presents the links between administration agents(UA and MA),T_{as} links master agent and specialized doctor agents(MA and SDA),T_{ss} is the cooperation link between different doctor agents.T_p is the diagnosis problem solving capability of the agents.

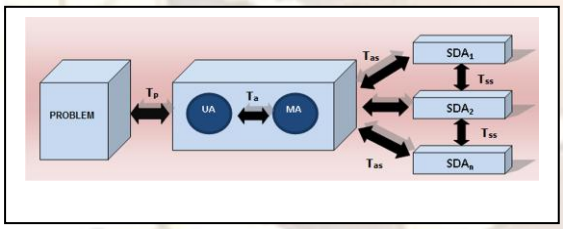

Figure 2. CDS medical diagnosis system

It is assumed that all the member agents has the problem solving capability [12] and in this problem solving aspect we also assumed that the system has the capability CA_{cds} and that CA_{cds} extends the highest grade (in ideal scenario), i.e. if CA_{cds} belongs to a specialization set S (CA_{cds})=$\{S_1, S_2, \ldots, S_n\}$ then the set should be able to solve all the problem with their own capability. The agents of AD set show the administrative specialization and the agents of SDA flourishes the specialization sets in medical diagnosis.

CDS Algorithm

Let P_f represents the specific problem, P_i refers to the analyzed and stored problem (with or without solution).SDA_f is the specific specialization against P_f and S_f is the exact solution of P_f.

Step 1: [Initial Handling or Processing of problems (health queries)]

UA takes the problem through user interface.

Step 2: UA checks the GKB

IF

(P_f matches with some problem P_i already analyzed and stored in GKB)

THEN

UA puts the problem P_f in GKB

ELSE

UA sends P_f to MA and goes to step 3.

Step 3: MA overtakes P_f and do the sub steps consequently.

3.1: MA analyzed P_f and places it in GKB for future purpose.

3.2: MA checks S (CA_{sda}) present in GKB and selects the most capable SDA (SDA_f) in respect of P_f .

3.3: MA sends analyzed P_f to the most capable SDA_f.

Step 4: Specialist doctor agent SDA_f overtakes the P_f.

4.1: It checks its own knowledge base LKB.IF

P_f is solved only with its own LKB THEN

i) SDA_f sends the solution S_f to the SKB.

ii) SDA_f puts a copy of S_f in its own LKB.

ELSE

i) SDA_f checks the S (CA_{sda}) in GKB.

ii) SDA_f sends P_f to one or many other capable/semi-capable SDA in the CDS to get the suggestion.

iii) SDA_f generates problem solution with that suggestion(s)

[N.B: it is assumed that all the agents have the highest problem solving capability in the CDS]

iv) SDA_f sends the solution S_f to the SKB.

iv) SDA_f puts a copy of S_f in its own LKB.

Step 5: After some time interval RA checks SKB.

5.1: If solution has come, then collects it.

5.2: RA sends the S_f to UA

Step 6: 6.1: UA makes an announcement of the solution through user interface.

5.3: UA puts the whole report in GKB with proper tagging [i.e: attached with the specific P_f]

Step 7: [END].

V. CONCLUSION

The proposed agent oriented clinical diagnosis system (CDS) can take care of every stage of patient such as initial check up, treatment, and report for the patient. And the CDS algorithm is capable to handle the system very efficiently. If the proposed CDS is implemented properly, it can bring a revolution in our clinical diagnosis system for Indian environment. In future correspondence development and implementation of the proposed scheme can be done to fulfill the situation demand.

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Acknowledgements

An acknowledgement section may be presented after the conclusion, if desired.

REFERENCES

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Note that the journal title, volume number and issue number are set in italics.

Books:

[2] R.E. Moore, *Interval analysis* (Englewood Cliffs, NJ: Prentice-Hall, 1966).
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Chapters in Books:

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Theses:

[4] D.S. Chan, *Theory and implementation of multidimensional discrete systems for signal processing,* doctoral diss., Massachusetts Institute of Technology, Cambridge, MA, 1978.
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