MEDICAL INFORMATICS DRIVEN BY INTELLIGENT MULTI-AGENTS

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By

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Certificate

This is to certify that project report entitled "MEDICAL INFORMATICS DRIVEN BY INTELLIGENT MULTI-AGENTS", submitted by Neha Tyagi in partial fulfilment for the award of degree of Master of Technology in Computer Science Engineering to Jaypee University of Information Technology, Waknaghat; Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date:

Supervisor's Name

Designation

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Date: Name of the student:

Table of Contents

Table of Figures

Table of Figures

Abstract

To start with, as we all are aware of the fact that over a time period of more than two decades software agent technology represents one of the rapidly developing areas of research. The highlighted achievement of this trend of research was the creation and development of new programming models that address both the basic features of agent-hood (autonomy, reactivity, pro-activity and social abilities) in addition to more advanced, human-like features usually collectively devise in the agent literature as ―mental attitudes‖ (beliefs, desires, intentions, commitments). Agent oriented technologies, artful engineering of agent systems, agent languages, development tools, and methodologies are an active and progressing research area. In this study the contributions of multi-agent systems in medical or health care domain have been reflected. The intent of this research is to do the comparative study of techniques being used in telemedicine with agent. Multi-agent system is most fitting for healthcare hypothesis; it is so because the properties of agent based systems takes care of heterogeneous multiple agents. Data distribution and data management in a vibrant and distributed environment with multi-user cooperation has made multi-agents system even more significant in this arena. This research also provides a hybrid approach which deals with diagnosis and monitoring. This thesis gives the proposed approach for monitoring and regulating observations of the patients who are staying at home. It also gives the diagnosis technique for the patients who belong to unreachable remote areas. An advanced scheme of agent-based healthcare and medical diagnosis system can take care of every stage of patient‘s progress such as initial check up, treatment and reports of the patient. A user friendly interface is also required to provide rapid, high performance, reliability and smooth functionality in this regard. Using the knowledge base, collaborative as well as co-operative intelligence agents and residing on a multi-agent platform, that facilitates a communicative task-sharing environment.

Signature of student	Signature of Supervisor
Name: Neha Tyagi	Name: Prof. Deepak Dahiya
DATE:	DATE:

CHAPTER 1: INTRODUCTION

The traditional medical and healthcare system of our country has failed to provide even the minimum of required services. Struggling with the poor economy and overpopulation has become a threat in this issue [18]. Besides these critical problems, a major portion of the total population of India resides in underdeveloped remote areas, where proper health care and community medical services are almost beyond the reach of the native people [17].

The predicament is due to acute scarcity of medical practitioners as well as strong infrastructure [19]. Keeping the medical diagnosis system in mind, we notice that the whole system depends on some primary factors like proper medical healthcare infrastructure, stable economic condition, global awareness and user friendly environment. This leads to the introduction of the concept of telemedicine in the scenario of India.

Telemedicine is a field of medical science where there is a collaboration of telecommunication and computer technology with medicines. Telemedicine is all the time more being used as shorthand for remote electronic clinical consultation [16]. Depending on one's viewpoint, telemedicine may be seen as a valuable tool for providing crucially needed specialty care services to backward areas, more sincere use of existing medical resources, and a tactic to attract patients living outside the hospital‘s regular service areas.

The central aspect of telemedicine is the use of electronic signals to carry information and observations from one site to another. These highly advanced telemedicine systems can be distinguished by the type of information sent (such as clinical findings or radiographs) and by the means used to transmit it.

Many areas of medical practice have potential telemedicine applications. Clinically disposed specialties can capture and tenuous display of physical findings, transmit specialized data from tests for example electrocardiograms and electroencephalograms and carry out psychiatric interviews or interactive examinations.

Telemedicine can be useful for situations in which:-

(1) Physical barriers prevent the prepared transfer of information between patients and health care providers and

(2) The availability of information is key to proper medical-care.

Table 1 : The Spectrum of Clinical Telemedicine Interactions [16]

Purpose	Mode of interaction	Types of information	Minimum	Typical application
Diagnostic or therapeutic consultation	Real-time, one-way or two-way interactive motion video	Voice, sound, motion video images, text, and documents	Moderate To high	Tele-psychiatry and mental health applications, remote surgery, interactive examinations
Diagnostic or therapeutic consultation	Still images or video clips with real-time telephone voice Interaction	Voice, sound, still video images or short video clips, text	Low To moderate	Multiple medical applications, including dermatology, cardiology, orthopaedics
Diagnostic or therapeutic consultation	Still images or video clips with text information; "store- and-forward," with data acquired and transmitted for review at a later date	Sound, still video images or short video clips, text	Low	Multiple medical applications, including dermatology, cardiology, otolaryngology, orthopedics
Case management or documentation	Transfer of Electronic text, image, or other data	Text, images, documents, and related data	Low to high	Community health information networks, medical record management

While telemedicine is often displayed in terms of dynamic, interactive video consultations, "store and forward" technologies are at least equally promising. In these systems, static images or audio video clips are transmitted to data storage device at remote side, from where they can be later retrieved by a medical practitioner for review, consultation and procedure of treatment. The benefit of store-and-forward methodology is that it avoids the need for instantaneous accessibility of the referring parties.

The adaptation and implementation of telemedicine programs gives birth to important questions like, how much do we really know about the appropriate use of telemedicine and how should it be incorporated into the nation's health care system [16].

In our programmed research, we have tried to throw light on that technical infrastructure difficulty. 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 centres situated at vaguely remote villages as well as at other places. Lack of efficient user friendly environment also becomes a barrier against proper treatment and diagnosis. These mentioned above are not the only limitations; there persist many other problems that affect 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 practitioner, this is really a threat for our health care system and the current situation demands a new system. A system which will work beyond the limitations stated above. Research work on Community healthcare System is going on, but those systems are highly expensive to implement [17].

Common telemedicine system is a good option obviously, but it is not better for future expansion of the existing system [17] [18]. Agent oriented intelligent diagnosis system came into being which 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.

1.1. Motivation of research work

- Problems concerned with the quality of health information.
- A breakdown of the relationship between health professional and patient.
- A breakdown of the relationship between health professionals

1.2. Objectives of research work

The primitive and most important goal of this research work is to develop and highlight the progress of the telemedicine mechanism in dynamic multi-agent system. The mechanism must possess following requirements:

- To develop a knowledge base for patient information managed by intelligent agents.
- To provide constant accessibility to the patient and health official by utilizing the mobility attribute of intelligent multi agent system.
- To provide agent‘s embedded procedures and its data to perform tasks and exchange information within the architecture at various operational level.

1.3. Thesis scope

This thesis aims to develop a multi-agent paradigm which is intelligent enough to handle a complex telemedicine infrastructure. The system can be utilized to manage the reach of medical aids to the remote areas of any country.

The thesis will implement only a prototype of the same assuming various conditions as will be specified.

1.4. Thesis Outline

The remainder of the thesis is as follows. Chapter 3 deals with the various literatures which are present in this field and related fields. It discusses the amount of work which is currently being carried out in the scientific community. Chapter 4 proposes our problem statement and gives a mathematical shape to it so that various algorithms could be applied on it. Chapter 5 introduces our methodology and discuses the implementation proposal for various algorithms and our own algorithm. Chapter 6 concludes the report with a discussion on the various pros and cons of the methods. Finally Chapter 7 provides the future possibilities of the research.

CHAPTER 2: THEORETICAL BACKGROUND

2.1. Software Agents

“An agent is a computer program that is placed in some surroundings, and that has the ability of autonomous action in these surroundings in order to meet its design perspectives” [Wooldridge and Jennings 1995]."Autonomous agents are computational systems that occupy some compound dynamic surroundings, sense and work in those surroundings automatically, and by doing this comprehend a series of tasks they are designed for" [Maes 1995, page 108]. From the above statements of two definitions we can infer that an agent is an intelligent computer program which works responsibly, according to the different environment parameters.

In Table2, the properties of intelligent agents are being discussed. We can design our agent with the combination of following properties in accordance to the requirement of our environment.

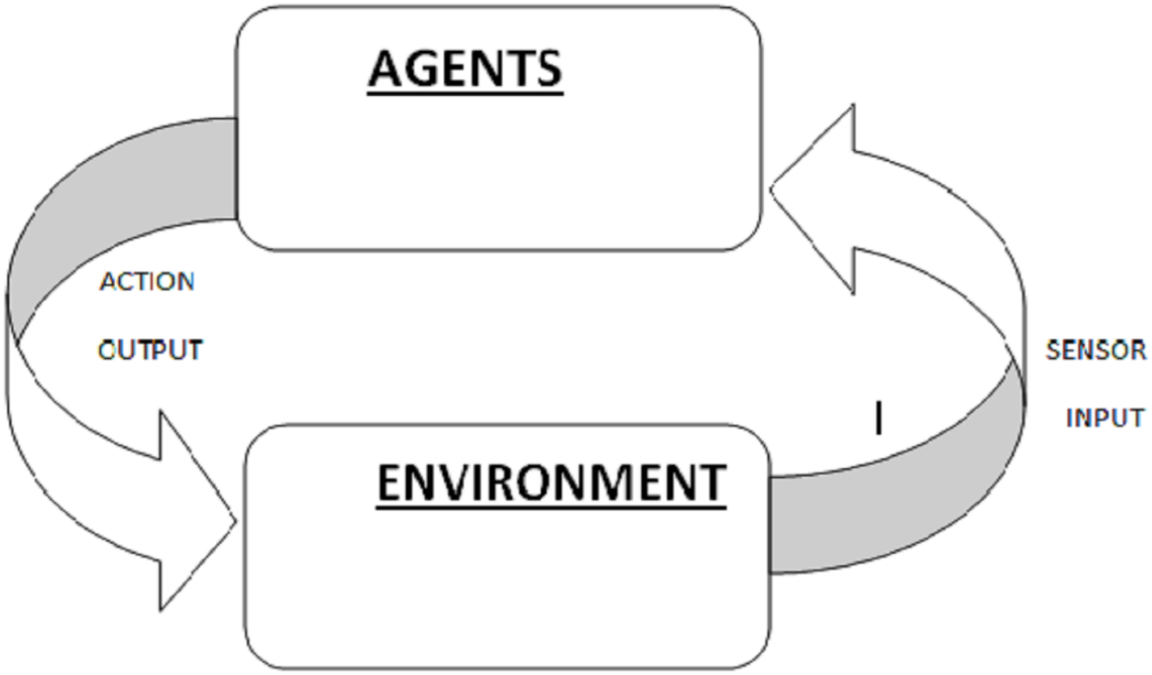

Figure 1: software agent

Table 2: Agent properties

1. Autonomy	Agent can act without the interference of humans or other agents and that it has manage over its own actions and inner state (Sycara, 1998).
2. Reactivity	Agent gets some type of sensory input from its surroundings, and it performs some action that changes its surrounding in some way (Chira, 2003; Sycara, 1998).
3. Pro-activeness	agent is able to exhibit goal-oriented nature by taking the initiative. (Chira, 2003; Wooldridge & Jennings, 1995; Odell, 2000).
4. Social ability	agent interacts and this interaction is noticeable by affability or (Odell, 2000).
5. Coordination	agent is able to perform some activity in a shared environment with other agents (Odell, 2000).
6. Cooperation	agent is able to synchronize with other (Odell, 2000).
7. Flexibility	system is pro-active and social (Jennings et al., 1998).
8. Learning	agent is capable of:- i) amenably to changes in its surrounding; ii) taking goal-directed plan; iii) Gaining knowledge from its own incident, its surroundings, and exchanges with others (Chira, 2003; Sycara, 1998).
9. Mobility	agent has the ability to move itself from one machine to another (Etzioni & Weld, 1995).
10.Temporal continuity	Agent is continuously running process, (Etzioni & Weld, 1995).
11. Personality	Each agent has the unique trait (Etzioni & Weld, 1995).
12. Reusability	requires to keep instances of the class 'agent' for an information handover results (Horn et al., 1999).
13. Resource limitation	An agent can perform as long as it has resources in its control (Horn et al., 1999).
14. Veracity	an agent will never provide wrong information intentionally (Wooldridge & Jennings, 1995; Wooldridge 1998).

15. Benevolence	Agents do not have contradictory goals (Wooldridge & Jennings, 1995; Wooldridge 1998).
16. Rationality	agent will work in the direction to achieve the task, (Wooldridge & Jennings, 1995; Wooldridge 1998).
17. Inferential capability	Agent act on random task requirement using prior knowledge (Bradshow, 1997).
18. "Knowledge-level" communicationabi-lity	The capacity to converse with people and other agents with language similar to human. (Bradshow, 1997).

2.2. Multi agent systems

Software agents are intelligent and efficient software which work on behalf of a user. Moreover, its highly developed in built programming and settings allow it to work as a human and make responsible decisions. Their properties to cooperate, coordinate and socialize allow them to work in a group.

This network of software agent is known as Multi Agent System. The computing paradigm of multi-agent systems (MAS) has its origin in both distributed artificial intelligence (DAI) and object-oriented distributed systems. In this sense, agent systems can be viewed as a generalization of the client-server model in that each agent can be both a client and a server and can provide and request services to and from others as conveniently as there could be.

A multi-agent system (MAS) is one that consists of a number of agents, which interact with one another, typically by exchanging messages through a shared computer network infrastructure and programming.

In the most general case, the agents in a multi agent system will be representing or acting on behalf of users or owners with varied specification to achieve all possible goals and motivations [19].

The best way to depict the distributed computing systems is Multi-agent systems. There are several characteristics of multi-agent systems given [3]:

- An infrastructure with communication and interaction protocol is provided by the Multi-agent environment
- Multi-agent environment doesn't require any centralized or controlled designer.
- Multi-agent systems are open, dynamic and efficient in nature.
- The agents that constitute of the multi-agent systems are autonomous and distributed in nature.

There are numerous concerns in the multi-agent execution environment that can be reckoned as the possible characteristics of multi-agent system.

There are various industrial and commercial applications for multi-agent systems. Such applications are:

- E-Commerce, where “buyer” and “seller” agents are used to purchase and sell the products on the behalf of users
- Student-scheduling system, here three agents namely student agent, lecture agent and scheduling agent communicate for schedule decision
- Anti-phishing, in this system, the agent warns the user to enter their sensitive information on a phishing site or any unauthentic web site that has a corrupt viewing certificate.
- Automatic- target recognition, the agents sense the target and communicate with each other for the computation and structural procedure.
- Traffic-monitoring, agents are used for traffic-monitoring. The traffic agents sense the traffic and commotion then further communicate with driver agent.
- Disaster-rescue operation, various agents communicate and coordinate with other to perform the rescue operations in order to make possible complete evacuations from location of disaster.

2.3. When is an agent based solution appropriate?

1. Environment has challenging means - highly dynamic, unpredictable ,reliable and complex
2. Complex distributed systems: Distributed and differently allocated data base systems where finding a centralized solution is difficult or impossible
3. Environment consists of open systems: software systems in which different parts are designed and written by different authors.
4. Legacy systems: a software that is technically archaic but functionally essential for an organization to wrap the legacy component, providing with an ’agent layer’ functionality.

Table 3 : Comparison of Traditional and MAS

Traditional systems	Multi-agent systems
•Hierarchies of large programs	•Large networks of small agents
• Sequential execution of operations	• Parallel execution of operations
•Instruction from top to bottom	• Negotiations
•Centralized decision	• Distributed decisions
• Data drive	• Knowledge driven
• Predictability	• Self-organization
• Stability	• Evolution
• Striving to reduce the complexity	• Striving to thrive with the complexity
• Total control	• Support for growth

Table 3 shows the comparison between the traditional systems and multi agent systems. It shows why we prefer the multi agent systems and its performance characteristics.

2.4. Agent Communication

2.4.1. Agent Coordination

Agent has ability to draw the inferences from its represented knowledge. Agent also has social ability thus can communicate and coordinate with other agents. Agents communicate with each other in order to achieve the goals which can't be achieved individually and complete tasks in a more faster and efficient manner.

For more coherent systems, the communication enables the agents to coordinate with their actions and behaviour. The coordination enables the agents to perform some activities in shared environment. The three factors coordination, cooperation and negotiations are interlinked with each other.

As [3] explained that the coordination among non-antagonistic agents is cooperation and coordination among self-interested or competitive agents is negotiation

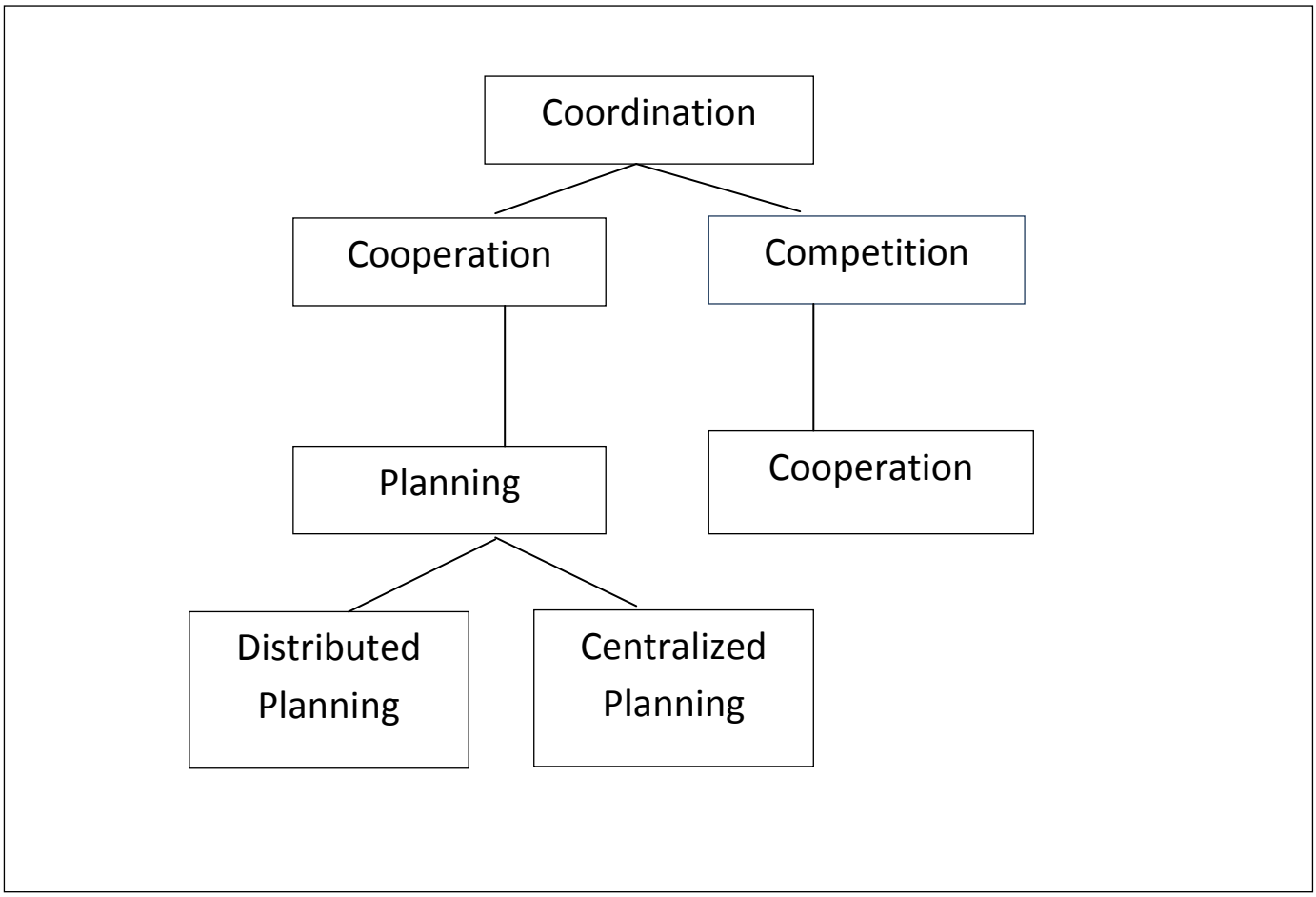

Figure 2 : Agent Coordination [3]

2.4.2. Message Types

Heterogeneous agents communicate with each other via message passing. There are two basic types of messages: Assertion and queries [3].

Assertions are the simple instructions or statement messages that are communicated within the system. Queries are request-reply message types. They characterize agents in three categories namely active, passive and peer.

The active agents send and receive queries from the environment. The passive agents can make assertions and send queries. The peer agents can send and receive queries and assertion both.

2.4.3. Agent communication language

2.4.3.1. Speech Acts

The communication among the computational agents can be done by modeling spoken human communication in a universally understandable language. Speech Act Theory is a basis for analyzing human communication.

In Speech Act Theory [3], the natural human language is considered as actions which can be a request, suggestions, commitments and replies. Speech Act theory has three main aspects namely, location (speaker's physical utterance), illocution (speaker's utterance meaning) and per locution (locution's result action).

2.4.3.2. Knowledge Query Manipulation Language (KQML)

KQML is a protocol that exchanges information and knowledge [3][2]. The beauty of KQML is that the information to perceive and understand the content of message is included in the communication itself.

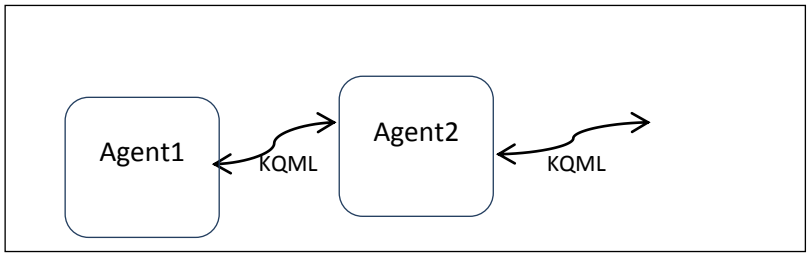

Figure 3 : KQML Working

Basic structure of KQML is:

(KQML-per formative

:sender <word>
:receiver <word>
:language <word>
:ontology <word>
:content <expression>

…)

KQML "wraps" the message in such a format that can be understood by any type of any agent.

2.4.4. Agent interaction protocol

To send a string or series of messages, interaction protocols play an important role. The agents communicate the messages in order to accomplish the desired goals. The self-interested agents try to maximize their own utility but in case of common goal for all the agents, the aim is to maximize the overall system utility.

The important aspects involved during the interaction are determining the shared goals and common tasks, avoiding the conflicts those are unnecessary and collect knowledge and evidence.

2.4.4.1. Coordination Protocol

The coordination among the agents is required in order to meet the global constraints or hurdles, or there exist some dependencies among agents or to achieve system goals, no one agent has sufficient competence, resources, or information.

Thus coordination protocols allow the coordination among the agents so that the desired system goals can be accomplished successfully. The actions of agents are designed in terms of AND/OR goal graph [3].

2.4.4.2 Cooperation Protocol

The Cooperation protocols follow the strategy of Divide-and-Conquer. The task is to first decompose and then distribute to multiple agents for its completion. There are various methodologies to decompose and distribute the task such as contract-net protocol, game theory approach, Markov-decision based approaches, negotiation, auction-based market approach, Swarm-intelligence based methods and so on. This ensures quick and efficient functioning as no one system in particular is overworked.

2.5. Telemedicine

We can see telemedicine as a special type of "virtual hospital" where the patient can have the benefit of a complete medical team where they are geographically separated in one go.

When the patient logs into the system with a medical complaint, by the assistance of the advice nurse, each of the medical team members who is being assigned to the patient can be contacted at that very moment.

The patient can also be linked, whenever there is a need for call, to other specialists all through the Internet-based network of medical care.

Benefits of telemedicine include:

1. Flexibly organization infrastructure.
2. Greater access to healthcare and nutrition techniques.
3. Improved quality of healthcare due to quick availability of the best facilities regardless of geographical boundaries and separations.
4. Reduced costs of healthcare, thanks to economies of scale.

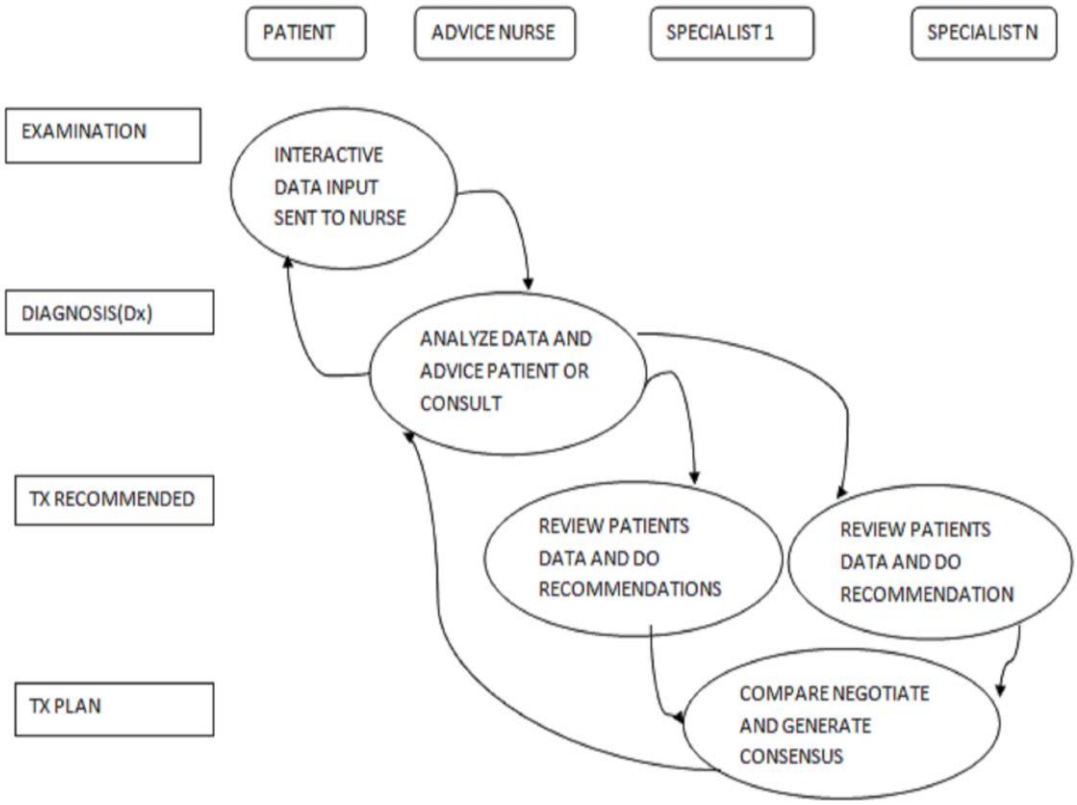

Figure 4 : Telemedicine

CHAPTER 3: LITERATURE SURVEY

In this thesis [1], Henkemans proposed the concept of eHealth using Information Communication Technology in health sector that prolongs today's health care environment. In specific, the Multi Agent System technology has an aspect of ICT contribution to the improvement of health care.

The exceptional integration of technology needs a Cognitive Engineering method. Implying the design and implementation of architecture is completed incrementally with the use of distributed agents that are provided by easy management, verification and data entry by involved actors. Conversely, design hybrid agent architecture, including the several distributed agents or Virtual Personal Assistant which supervises to the patients' self-care of their chronic illness, and checked it in a laboratory according to Cognitive Engineering method. Its results are displayed the designed architecture meets with requirements and functionalities are completed by involved users.

The incremental character of generated hybrid architecture makes able further development and applicable for supervision of several chronic diseases in the eHealth setting.

In this thesis [2], Bellifemine proposed the JADE which is framework software to create the easy development of several multi-agent applications in the compliance with FIPA specifications. Java Agent Development Framework is considered as a middle implement in efficient agent platform that compatible with the development of multi agent systems. Java Agent Development Framework agent platform try to take high performance of distributed agent system which is implemented with Java language.

In specific, its communication architecture has also tried to offer efficient and flexible messaging, transparently opting the good transport available and prolongs state-of-the-art object distributed technology embedded with Java runtime environment. Java Agent Development Framework uses an agent model and Java implementation which lets best runtime efficiency, agent mobility, software reuse and realization of individual agent architectures

In this thesis [3], H.S. Nwana proposed the huge development of Java agent systems offering library components of agent, keeping a visual environment for taking user

specifications, an agent generating environment which involves an automatic code generator with set of classes which form to the building blocks different agents. Agents are combination of 5 layers: API layer, organizational layer, definition layer, communication layer and coordination layer. API layer makes an interaction with non-agent world.

The organizational layer is used to manage the knowledge to other agents. The definition layer is used to manage the task of agent has perform. The coordination layer manages negotiation and coordination with agents. At the end, the communication layer makes the communication with the other agents.

In this thesis [4], Sycara, Katia P proposed the agent-based technology systems to generate the lots of excitement in later years because of newest paradigm for implementing, designing, conceptualizing software systems. It is specifically attractive for generating software which operates in the environments which are open and distributed, like internet. Presently, the majority of agent-based systems include of a single agent.

Although, the technology addresses and matures increasingly complex applications, requirement for these systems consists of several agents which communicate in peer-to peer fashion. Central to design and effective operation of multi-agent systems are a base set of issues and questions have been studied by the distributed AI community. In this, some of the critical notions in MASs are research work that has addressed them. These notions works around the concept of problem-solving coherence that is one of the most difficult characteristics that MAS should exhibit.

In this thesis [5], Cao, Fang proposed the dramatic prolong to use the information technology for the healthcare which is resulted in innovative research on eHealth applications. But it is hugely acknowledged that unlocking the dynamic value in clinical records which is largely dependent on the standards of health information which lets interoperability between several clinical systems, supports to easy exchange records with stakeholders in patient circle of care.

This software agent has been based on the virtual integration of framework to interact the multiple electronic health record systems from the distributed databases, features three properties. First one, a loose coupling of EHR formats and software engineering of application which allows to the agent based framework to flexible for the on-line deployment and reconfiguration. Second one; framework has been designed with

knowledge base that supports to the both consumers and medical practitioners, to manage the healthcare information of a higher knowledge-based level. Third one, the framework has been integrate with distributed databases with adaptive user interfaces to support the customized health information systems that used by a range of some users with their differing requirements.

This agent-based framework demonstrates a newest direction to handle other eHealth interoperability issues like development of personal health record systems and providing a technical foundation for developing the clinical decision support systems.

In this thesis [6], Chakraborty, Sou proposed the involvement of multi-agent system in health care or medical domain. The main objective is to provide the future researchers much focused and resourceful review of several researches in domain. The multi-agent is suitable system for healthcare paradigm with agent based systems properties deals with heterogeneous multiple agents.

Data management or data distribution are concerned in dynamic and distributed environment with multi-user cooperation which makes by multi-agent system with significant field. The classified disposition is deployed on the basis of theoretical approach or application.

In this thesis [7], Vicari, Rosa proposed the multi-agent intelligent environment to support of diagnostic modeling and reasoning of domains with the uncertain and complex knowledge. It is a simple system which deals with the uncertain network approach, where learner-modeling tasks have been consisted of developing a Bayesian network for a problem of system. The construction of a network involves quantitative and qualitative aspects.

The qualitative part concerns to network topology with normal relations among domain variables. When it is ready, then the quantitative part is occupied. It composed the distribution of conditional probability of represented variables.

Moreover, a negotiation process has been managed by an intelligent topology and probability distribution between models of built learner. This mediation procedure follows

among the agents which signifies the expert knowledge domain and the agent which signifies the learner knowledge.

In this paper [8], Yang, Qiao proposed a model in which multi-agent diagnosis helping system is given, where various knowledge-based systems has been used as a cooperative agents in medical diagnoses. Uncertainty and Fuzziness have been used in decision trees to make the mechanism of reasoning in agents.

Moreover, a mechanism called novel coordination has described that enable to reach the destination diagnosis compatible with both existing medical principles and patient's anamnesis. The reasoning mechanisms have been implemented with the use of Java Agent Development Framework, Java, NRC FuzzyJ Toolkit and Java Expert System Shell, and tested by traditional western and Chinese and medical diagnosis examples.

It proposed the system and technologies which will be broadly used in applicative areas, like medical helping, multi-agent medical diagnosis, and many other decision-making systems and automatic diagnosis.

In this paper [9], Koutkias, Vassilios G. proposed a multi-agent system that is integrated in home care telemedicine system which was developed in context of Citizen Health System works as a congestive heart failure patients and contact center for diabetic.

The main objective of system is to give a set of notification mechanisms for clinicians, help to classify clinical condition of an each patient. Thus, the large amount of data can be managed by system, causing the daily use of contact center's services. More so, these alerts give the clinician overview of cases that are needed examine further and save her time from trivial cases.

These multi-agent systems include the distinct types of agents in which specific tasks are assigned to communicate with each other to share knowledge.

In this paper [10], Zambonelli, proposed several Systems which are composed of interaction autonomous agents provide a systematic software engineering method to develop the applications in complex domains. Although multiagent system paradigm

introduces several new abstractions or development/design issues which is compared with many traditional methods to the software development.

According to the newest design and analysis methodologies with multiple new tools are required to effective engineer systems. Firstly, clarify and synthesizes the main abstractions of agent-based computing to the agent-oriented software engineering.

In specific, multi-agent system can be viewed naturally and architected with a computational organization. It identifies the organizational abstractions which are central to analysis and design of such these systems. Second one, extends and detail the Gaia methodology for design and analysis of multi-agent systems. Gaia expresses aforementioned abstractions of organizational to provide the guidelines for design and analysis of complex and open source software systems.

In this paper [11], Gill, Kaveri evaluates the quality of service and quantity of delivery in the rural public health merits under the NRHM. On feasible measures, the former process has been assessed on dynamic or static condition of the physical infrastructure; by some numbers of technician, paramedical and employed of medical staff that figures the gender breakdown and attendance; by the quality, supply and some range of drugs; with the usage of decentralized untied and availability and maintain the funding of centre; and real availability of laboratory, service facilities and diagnostic.

Quality has been defined in the relation of condition above tangibles, which can be provided by subjective information on intangibles, like as patient satisfaction whose are collected from exit interviews.

These micro-findings across the four states that are resulted in individual ranking sections of study, suggests many disparate situations at several centres on the individual components, reflects to the context-specific driving factors, complexes by nature. These findings are based on the ranking of states on the ‘entire performance of delivery service under the NRHM’, but it would be meaningless, irresponsible and defeats with the purpose evaluation that highlights the micro-components of numerous features which are crucial to the Mission’s capacity to deliver the services, how states have been fare to implement the

several strands factors which may be cause the problems where the implementation has been less than desirable.

In this thesis [12], Nabeth T. proposed architecture of cognitive multi-agents that are called Intelligent Cognitive Agents elaborated for design of Intelligent Adaptive Learning Systems. InCA architecture rely to the personal agent which is aware to the characteristics of user, that coordinates intervention to a number of expert cognitive agents. This InCA architecture is applied to design the K-InCA, where e-learning systems are aimed to help the people adopt and learn practices of knowledge-sharing management.

In this paper [13], Béhé, Florian k proposed a new approach of combination the 3D elements to compose the environment of agents with the semantic descriptors taking the Models of Building Information. IFC standard is based on the field of Civil Engineering to construct the digital models of building while designing the phase. The IFC semantic objects composes 3D environment which has been used to choose set the 3D elements and objects of simulation scenarios.

The main result of dynamically process generates the input files for JaSIM environment which works on the simulation. These files represent the virtual environment in that the simulation is working. It is displayed by two different files: a RDF file for semantics and a COLLADA file for geometry. Both files can be created according to extracted data and selected from IFC file by user.

In this paper [14], Cowling, Peter proposed the use of multi-agents in the integrated dynamic scheduling of steel casting and milling. The process of Steel production is a complex problem that needs to the consideration of various distinct objectives and constraints of some of processes in dynamic environment.

Multiple research processes in steel production has been scheduled to consider the static process of scheduling in isolation. In the contrast of previous schemes, the multi-agent architecture consists of heterogeneous agents that integrate.

In this thesis [15], Huin, S. F. proposed the several merits of Enterprise Resources Planning systems which do not represent successful and clear management tool to SMEs, or it is not easily implementable by small and medium sized enterprises. This share aimed to identify the operational and strategic requirements of Small and medium-sized enterprises in South East Asia region.

It gives a set of operational, organizational and supply chain interdependencies in Small and medium-sized enterprises that in several aspects influence project management methodologies located in ERP systems in Small and medium-sized enterprises. An agent-based model coordinates with management of enterprise resource in Small and medium-sized enterprises.

This model expresses the several enterprise resources in Small and medium-sized enterprise can be interfaced, managed and organized. To draw the model, relate to Small and medium-sized enterprises can better project which is managed the ERP systems in informal systems.

In this thesis [16], Pépin, Nicolas proposed to pave indoor floors with "communicating" tiles in order to express perception and communication of mobile agents and more commonly to implement environment-based multi-agent models. Each tile supports a real-time process which ensures communication with neighbors and any agent laid on it.

An algorithm required for tiles to interact with mobile agents and to carry out distributed processes. Then apply the approach to a behavior-based model, by dividing the model into the tiles and a simple agent. In this, displays a new version which is equivalent to the original one and so discuss its advantages.

In this thesis [17], Yang proposed the healthcare system which undergoes on the transformation of reactive care to preventive and proactive care. Patients or health consumers are actively needs knowledge to manage their health and seeking supports from their peers in addition to receiving healthcare support from healthcare professionals. 74%

of American adults use the internet, of which 80% have looked online for healthcare information.

With the popularity of social media, several health consumers are exchanging informational and emotional support with peers who have similar health diseases or conditions. The large volume of health consumer contributed content provides valuable resources for healthcare informatics research.

It is worth to note that the information in health consumer contributed content is timelier than traditional resources such as electronic health records, centralized reporting systems, and pharmaceutical databases because health consumers often discuss their concerns with peers before any of them are reported in the traditional resources. In this article, we review a few important healthcare informatics research issues that are centered on the patient contributed content and concerns.

In this paper [18], Rozenblum proposed the patient satisfaction is important component of quality. The extension of health technologies information has an impact on the patient satisfaction – either negatively or positively. In this, explores the impact of technologies on the patient satisfaction.

Some methods are provided: The PubMed database was searched from the inception on May 2010, while using the terms “Patient Satisfaction” and “Medical Informatics”. We involved all genuine studies regarding of their design which was published in English and evaluating HIT impact on the patient satisfaction. These studies were separated by the type of technology according to American Medical Informatics framework and design. The main outcome of interest is to HIT the impact on patient satisfaction.

In this paper [19], Dogra, inderjeet singh proposed the clinical guidelines on standard procedures for diagnosis and treatment of several diseases that should be followed by medical practitioners around the world. But the adherence to guidelines becomes much difficult of task considering their frequent versioning, changes required in them to cater to particular health conditions of patients, their deceptive management etc.

Added to this is the increasing cost of medical services, in the healthcare domain, due to increasing aging population, which calls for optimizing the use of medical resources. This survey summarizes research work on computerizing clinical guidelines using multi-agent technology, to enable their compliance in medical processes and to provide a decision support system that assists profession- also in taking decisions through various situations.

This survey contains detailed annotations of research publications describing different approaches used to computerize clinical guidelines, their effective management, modification, verification and usage in remote monitoring.

In this paper [20], Xiangjun, Zeng proposed the distributed generation, deregulation systems using the distributed generators installed in middle or less voltage networks that becomes well-known in the distribution systems.

The protections are developed in radial systems, which are difficult in the coordination and protect against to the high impedance fault, sometimes it cause nuisance tripping in DG systems. A multi-agent based decentralized protection with the capability of HIF detection, load shedding, fault location for DG systems.

Digital relay has been designed as relay agent that is capable to search the information from relay agents, interacts with relay agents that perform tasks of protection with cooperating and autonomy. EMTP simulation conclusion display the proposed agent based on the protection approach can delete the influence of load operations of switching, protects against to the HIF, electric shock.

In this paper [21], Yu, Ren proposed a challenge of product manufacturer is to maintain the consumer, the service of the supplied product while the entire product life cycle, no matter the product has been located.

The modern information is a combination of communication tools and processing, referred to the Tele-service, provides the technical support to implement the remote service maintenance. Although, technical support is used to face the newest remote decision-makings maintenance that needs not only exchanges between suppliers and customers but also negotiation and co-operation based on sharing of individual contradictory and

complementary knowledge. It needs an evolution from Tele-service to E-service and maintain in specific where the decision-making maintenance results from the collaboration of processes and experts to Distributed Artificial Intelligence environment.

In this paper [22], Acampora, Giovanni proposed the last decades including academic and industrial organizations which are used in individual learning schemes to prolong humans' consequence and capabilities, the overall competitiveness and performance in newest economy context.

Although, the huge change in modern knowledge causing the exponential growth of the information sources which is complicated learners' activity. In this same time, newest technologies are offered, if it used in right way, number of possibilities for efficient design to learn the scenario. For this reason, novel schemes are vital to attain the suitable learning solutions that enable to generate personalized, efficient and flexible to the learning experiences.

To this point of view, computational methodologies can be expressed to give intelligent and efficient tools to analyze the learner's needs and consequently, customize its knowledge acquirement. In specific, a group of agents analyzes preferences and create high-quality learning to execute in parallel way with individual cooperating optimization strategies. This cooperation method has been performed by exploiting the data mining through fuzzy decision trees, along with a decision-making framework expressing fuzzy methodologies.

In this paper [23], Campbell, Adam, proposed a cooperative multi-agent system to role a design concept when large systems can be created, these systems are facilitate to the specialization of agents, and help to decrease the interference in the multi-robot domains. These tasks of agents are used to solve the communicative capabilities of significantly agents affected by the roles in cooperative multi-agent systems.

These discussions of issues are roles in multi-agent systems to compare the computational models of role allocation, display the notion of explicitly versus implicitly defined roles,

give a survey of techniques used to scheme role allocation problems, and conclude with a list of open research questions correlated to roles in multi-agent systems.

In this thesis [24], Bhat, Srividya, et al. proposed the healthcare organizations those faced the challenge of high-quality delivery services with efficient process management of regionally, levels-locally, nationally, or internationally.

Patient scheduling has become an important part of daily work for all the healthcare professionals. The work is used to build an agent based services of information for mobile users. Multi-Agent systems can be crucial in many medical domains, due to features of problems in area and basis on the emerging technology which promises to create it much easier to implement.

It integrates the accessing distributed health service in the multi-agent environment to get better QoS by using java platform. It generates a framework to make a schedule of meeting between the relevant doctors and the patients meeting in an effective way for emergency services and routine.

In this thesis [25], Mistry, Mijal, et al. proposed a business scenario to display how the web services can be used in multi agents for communication purpose. Web Services are augmented in formal descriptions of capabilities that can be utilized by the applications or services without the human assistance or hugely constrained agreements on the interfaces.

Healthcare is one of the domains where various complex issues required to be addressed. Multi agents are useful to solve the complex scenario where the less human interaction is needed. To test the usefulness of Web Services in the health care domain can develop an application.

In this paper [26], Rosaci, Domenico proposed the various models to represent the both reputation and reliability. However, remarks an important in practical to use the two measures which are represented by the suitably to combine them with the support of agent's decision.

In the earlier, a reliability-reputation model, known as RRAF, that lets the user to select how much crucial to give to reliability with the respect to reputation. In this paper, we propose an extension of RRAF, aiming at facing the limitations above. In specific, introduced newest reputation model, called TRR, which consider from the mathematical viewpoint, the interdependence with all trust measures which is computed in systems.

More so, this model dynamically computes a measuring the vial of reliability with the respect to reputation. Some are popular ART platform display the significant merits in the terms of effectiveness which is introduced by TRR respect to the RRAF.

In this thesis [27], Xie, Dongmei proposed the consensus of multi-agent systems with specific topology. Firstly, define the problem and provide some preliminaries. Then follow the matrix theory and algebraic graph theory, the system matrix convergence has been analyzed.

Main results indicates to the second-order system can be taken if and only if topology graph has been directed to the spanning tree and values of scaling parameters are satisfy to the range. The eigenvalues has been corresponded to the Laplacian matrix that plays a key role in arriving consensus. At the last, numerical simulations can be provided to illustrate the results.

In this paper [28], Chen, Yao, et al. proposed the e multiagent system with switching topology that is transformed into convergence problem of infinite products of the stochastic matrices that can be situated by the Wolfowitz theorem.

However, a transformation is much difficult or impossible for particular MASs, like as discrete-time second-order MASs, whose consensus are transformed into convergence problem of infinite products of the general stochastic matrices. These common stochastic matrices can be organized with row sum 1 but elements are not vitally nonnegative.

Since Moreover, it points out on method for DTSO MASs which can easily expressed to deal with a huge class of discrete-time of MASs, involving high-order MASs with taking switching topology and discrete the time without MASs velocity measurements.

In this thesis [29], HUANG, Qin-Zhen proposed the consensus of problem in discrete-time large-dimensional linear systems without or with delays. The system can be considered as a multi-agent system including of several agents, each one possesses the dynamics different from others and influenced by states of all other agents. The effectiveness of attained results can be verified by a numerical.

In this paper [30], Devlin, Sam proposed the Potential-based reward that has been proven to either Q-table initialization or equivalent which guarantees to the policy invariance in the single-agent reinforcement learning.

This scheme has been used in the multi-agent reinforcement without learning the consideration of whether theoretical guarantees and equivalence hold. It expresses the current proofs to results in the multi-agent systems, giving the background to express the success of earlier empirical studies.

In this paper [31], Bogdanovych, Anton, et al. proposed the majority of virtual applications which are focused on the detailed 3D reconstruction. Presently crowd simulation algorithm has not compatible for complex modeling of individual behaviors and role of dependent agent interactions with some other participants in World.

To notify this problem treating the 3D Virtual Worlds as a Normative Multi-agent Systems and the Virtual Institutions of Methodology to be examined for deployment and design of Virtual Worlds that needs complex interactions including both autonomous and human agents.

To measure the usefulness of this method illustrated the Virtual Institutions are worked in the development of Uruk prototype that correlates with Artificial Intelligence and 3D Virtual Worlds in domain of cultural heritage.

In [3] meticulously addresses the subject of indicating in the model that is object oriented of the system's diverse features including: the material world of in-house bio-signal sensors, the computational scenario of software agents and Internet-associated methodologies, and social worlds of patients and the medical, medical officers and care-givers.

In the model, the principal flow of information moves to the socio-medical world of carers' from the biophysical world of patients at home to through a sequence of devices including in-house sensors, local area network, personal computers, remote servers, and carers' computers. Each component hosts software agents with varied levels of knowledge and complexity. Web and Java technologies provide the constructional blocks of the Telemonitoring software. Laboratory investigation have been realized using a fully equipped 'smart' demonstration home for telecare.

In [4], an efficient healthcare arrangement which is based on multi-agent system is analysed, which is formed of medical sensor module along with technology based on wireless sensor communication. The proposed system aids a wide range of services, mobile Telemedicine, patient monitoring, emergency assistance and information transfer between medical professionals and patients.

A systematic computing environment between the Body Area Network and the subsystem within the hospital is provided by the system. Information within the hospital is shared within the MAS environment. This MAS environment is developed by JADE and FIPA. The ultimate goal of our arrangement is to manage and record the patient's medical data and to support efficient medical services through medical staff's cooperation.

There have been a quick advancement in methodologies comprising wireless communication particularly the software agent,healthcare devices,third generation network (3G) and internet in terms of mobility, speed and communication [5].

However the current engagements are restricted in terms of flexibility, mobility and have some privacy issues. In the paper [5], a broad mobile health observing system based on software-agent and 3G mobile network which includes a bunch of intelligent agents is

presented. These software agents will work homologous to human agents in co-operating between different health care professionals for presenting group-based medical services.

The proposed model is designed with the possible healthcare scenarios as follows:-

1. General Web-Based E-Medicine and remote treatment
2. Home Monitoring
3. Community Care/Rural Health Centres
4. Pre-hospital Emergency Ambulance Service
5. ICU Patient Care

An advanced 3G network and agent-oriented modus operandi in developing automatic architecture for a generic telemedicine arrangement to address the ever inflating complexity in next-generation telehealth systems.

The proposed system would provide versatile way of furnishing healthcare to patients than is currently available in various kinds of healthcare frameworks or service platforms in rural, remote and emergency settings as well as in remote areas and ambulance. Further works are in progression to unfold a prototype and to test the arrangement underpractical scenarios.

Peer-to-peer (P2P) networking has lately emerged as one of the utmost current applications used in the internet because of its comfort in easy-to-manage resources and because it stabilizes workloads. Therefore, There is an immediate desideratum for setting up a platform that is telemedicine platform for an agent-based system based on P2P networking architecture.

The main intention of this paper [1] is to construct a secure platform that is agent-based telemedicine which is based on P2P networking architecture. A Mobile Agent can be attacked when it migrates from one position to other containing the information. The suggested architecture is supported by the JXTA protocol.Here a two-layer safety mechanism is used so that secure solution is being provided for agent dependednt telemedicine services.

To provide high performance, reliability and functionality in this regard a user friendly interface is also required. In [19] Clinical Diagnosis System (CDS) is introduced where an operational algorithm to depict the individual working function of an intelligent medical diagnosis system which depends upon multi agent system.

With the assistence of knowledge base and intelligent agent who works colallaboratively and co-operatively CDS cater a communicative task-sharing environment.This new agent oriented clinical diagnosis system(CDS) provides assistance to the patients on every level.

In [8] provides a probabilistic approach for decision making that is diagnosis of disease. AMPLIA is a multiagent environment which supports the Byzantine and changeable domains to construct the informative frameworks. AMPLIA focuses on the medical area.The system consists of the application of Baysien networks, it will create a Baysien Network for the problem being proposed to the system.

This construction demands qualitative and quantitative analysis. The qualitative part take care of the network topology.The quantitative part is is consisted of the dispersal of conditional probability of the variables which are used to represent the system.

A negotiation process which is being managed by an intelligent Mediator Agent, will address the differences of topology and probability distribution between the model the learner have built and the one built within the system. That negotiation procedure carried out between the agents that typify the expert knowledge domain (Domain Agent) and the agent that symbolises the learner knowledge (Learner Agent).

In [7], authors provide a novel approach for multi-agent diagnosis known as MADHS Multi-Agent Diagnosis Helping System. To make a diagnosis for a patient, Coordination and negotiation among multiple agents are necessary. In this approach, knowledge-based systems are used as cooperative agents for medical diagnoses.

Decision trees are used to form the reasoning mechanism of agents. In decision trees fuzziness and uncertainty have been incorporated. Then, a novel coordination mechanism is defined, which is used to reach the final diagnosis that is well-matched with both existing medical principles and patient's anamnesis.

The execution is done by using Java Agent Development Framework (JADE), NRC Fuzzy Toolkit, Java and Java Expert System Shell (JESS).The author tested this system by using both western medical diagnosis examples and traditional Chinese. The proposed system and technologies can be used in many applicative areas like multi-agent medical diagnosis, medical helping and decision making systems.

CHAPTER 4: PROBLEM FORMULATION

This Chapter explains the problem of our thesis and gives light to the objectives we want to achieve in this chapter. The aim of this chapter is to provide a detailed explanation of our problem and give a mathematical shape to it.

4.1 Problem Statement

The aim of our thesis is to design an automated system of telemedicine using intelligent multi-agents. The multi-agents are used to interact between the various routing tables which are maintained to create a robust database. Various databases need to be maintained in order to use this multi-agent paradigm.

The information technology area was looked upon by multi-agent paradigm. It proposed a novel way to look software programs as autonomous, social, reactive and proactive entities, being sometimes also mobile. Every agent has a design which aims at fulfilling by operation independently or working in collaboration with other agents. The behavior of a multi –agent system can be deduced by resulting complex reaction among agents.

Telemedicine cannot be described as a single workstation able to intercommunicate but as communities of different interacting entities which aims at providing collaboration and sharing resources in medical field. While incorporating this, a set of telemedicine facilities can be described using multi–agent paradigm and can be analyzed. It is mainly for telemedicine systems, which is quite complex, the multi-agent paradigm is compared to the distributed objects paradigms as both involves entities having a internal state with a interface based on passing of message . . However, there are some differences that make agents unique: first of all, their autonomy means also that they maintain a complete control over their actions, while objects‘ remote method invocation does not allow the same level of control. There occur some requests for action against method invocation.

Many initiatives show devotion towards multi agent paradigm. KSE is one of them which provides means for knowledge interchange and includes a knowledge representation language.

Past years show rapid development in agent based application in medical field. Introduction and implementation of GUARDIAN system brought revolution in medical field. It was wholly dedicated to monitor patients in Surgical Intensive Care Unit. These systems provide a feature so that specialist having expertise in different domain can have a collaboration and also are committed to share data with others and the nurses who are dedicatedly monitoring the patient under physician‘s control. Lanzola et al. has presented a model which is devoted to diabetes care in which the agency supported cooperation among specialist ,even outside the medical field[22].A language named KQML has been incorporated for inter-agent communications.

Huang et al. presented system for collaboration among different practitioners and specialist about patient healthcare [21]. There is testing of architecture for telemedicine services through KQML based internet agents [20], where agents are organized into federations and each one serving a particular requirement to other agents. The best experimented application so far is Patient Management .It is because of inherently distributed nature of expertise required for the problem. Agents are not the panacea for all problems. In fact, they raise new security problems, which are even more crucial when using mobile agents. All these problems result in an increased need of control when approaching telemedicine, because of the involvement of sensible patient‘s information. However, security is present among the main research lines in the agent field, and both FIPA specifications and KQML provide for security and privacy solutions, although we did not test them yet.

Agent based systems have been developed for hospital service, which incorporates searching and fixing of appointment over mobile and provides reply by fixing appointment, rescheduling or cancelling. This system lacks prioritizing the appointments. Also emergency situations are ruled out such as accidents and so on and the scheduling reported is only for general patient appointment only. Keeping in mind all these important aspects we have developed an intelligent agent based system which is dedicated towards negotiating and collaborating with the agents of doctors and the hospital for providing appropriate appointment time for the patient keeping all the above points in consideration. The functionality of these agents would be based on the fuzzy preference rule in order to make proper decision for making an appointment, which is very unique and first of its kind.

The system has a developed and validated Intelligent Agent Based hospital appointment system which uses fuzzy preference to make appointment.

The agents gather all the information necessary for scheduling appointment with hospital based on fuzzy preference. The Agent works smartly and possesses intelligence to schedule appointment for patients.

4.2 Objectives

The Objective of this thesis is to design the system of multiagents which can intelligently manage the subsystems. The system has some subobjectives which are listed below:

- There should be a signin/sign up facility for patients
- There should be a facility for patients to provide symptoms which could predict there disease based on their symptoms and also suggests some test for them
- A test entry scheme should be developed which would tell the patients if they need a doctor's appointment or not
- A list of databases should be maintained for doctors
- Patients should be able to register using a unique id and a password
- The patients should be able to enter test results, book a slot etc.
- The multi-agents should be designed in such a way as to book appointments and manage their schedule based on availability
- The doctors should be able to write prescriptions to their patients

In the approach we are proposing three modules:-

- Diagnosis
- Appointment
- First-aid

To implement the above modules we are using a system of seven agents namely:-

A. Patient agent- which provides an interface between the patient and the whole system.
B. Diagnosis agent – this agent will handle the request of diagnosis of the disease.

C. Appointment agent –The appointment agent interfaces with the patient agent and main agent, with its main function being to provide confirmed appointment information to the appointment requesters
D. Main agent- The main agent is considered most critical agent that interfaces with the appointment agent and doctors schedule agent along with the hospital main database
E. Schedule agent-interfaces with the main agent and provides confirmation of doctor‘s schedule and confirmed appointments.
F. Doctor agent-core function is to receive doctor‘s schedule remotely or otherwise and interface with the doctor‘s appointment database and the schedule agent
G. First-aid- provides the first aid facilities for the patients in the emergency and informs the respective doctor.
H. Health care agent- provides an interface between the main agent and diagnosis agent.

4.3 Diagnosis

In the diagnosis module we help the patient in disease diagnosis; this will help to reduce the treatment time till the appointment with the specialist is fixed. This will assist to do all require formalities and test before hand which can reduce the wastage of time and money by reducing the consultation time and consultation fee atleast for one appointment. Following will be the scenario multi-agent system for diagnosis Procedural steps for Diagnosis:-

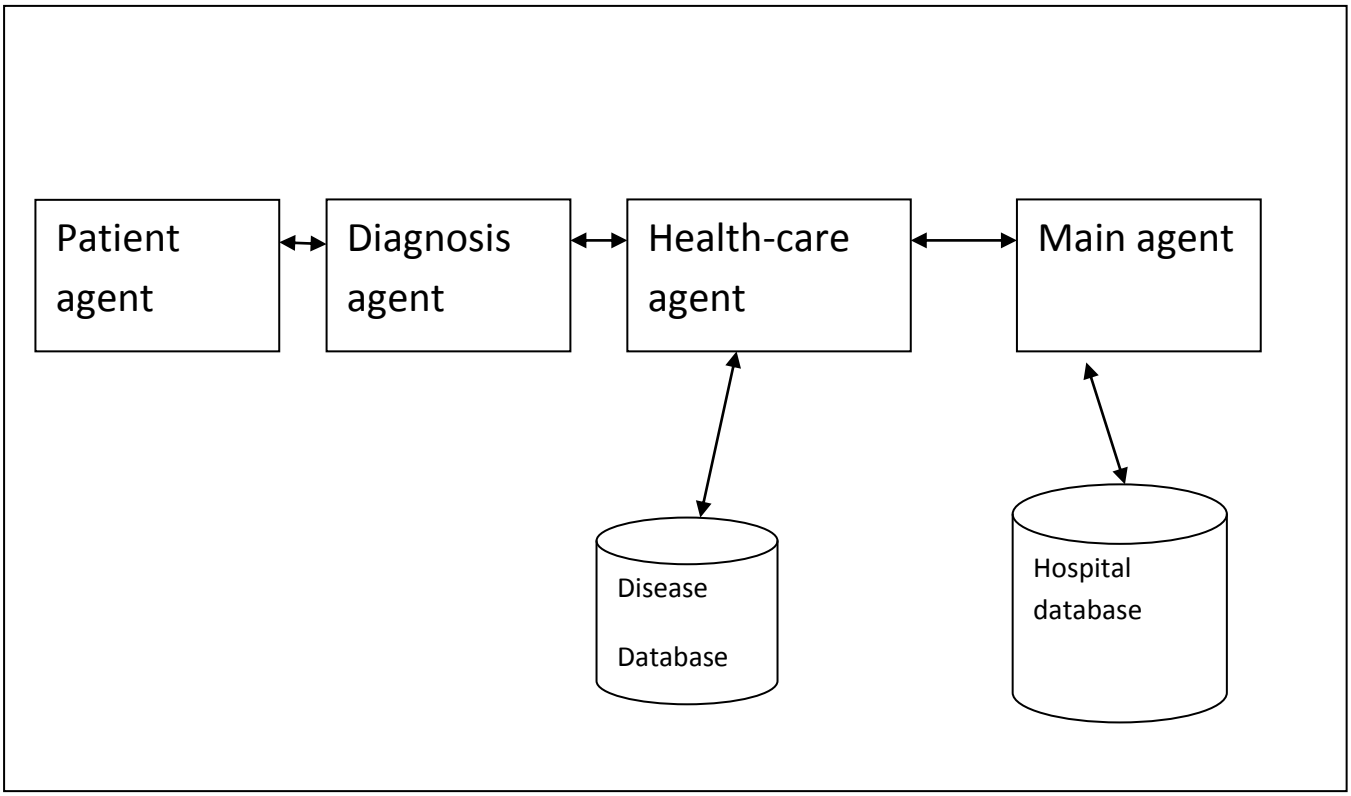

Figure 5 : Procedure of Diagnosis

1. As soon as patient login/register the patient agent will be invoked.
2. When the patient asks for diagnosis, patient agent will forward that query with the symptoms of the patient to the diagnosis agent.
3. The set of symptoms will then pass to the health-care agent which processes the data and provides the probable disease and recommend test for each of the disease.
4. Now this data will be provided to the patient agent.
5. If the patient returns with the test reports and submit the credentials accordingly.
6. This set of data is again passed to the health care agent through diagnosis agent.
7. Now the health care agent will negotiate with the main agent for the decision making.

8. Main agent will provide the interface to the hospital database, to help in the decision making and the specialist are also updated with the patient‘s record.
9. Final result will be provided to the patient agent.

4.4 Appointment

In our approach, we have imposed certain constraints towards patient/staff appointment such as:-

1. Registered patient will be required to make appointment at least 24 hours before their scheduled appointment date and time.
2. Non-registered patients will be required to make appointment at least 48-24 hours before scheduled appointment date and time, thereafter they will become a registered patient.
3. Senior Citizen/physically challenged/ Infants/pregnant woman/children be given highest priority irrespective they are registered or unregistered. And for them appointment can be made and confirmed latest 2-4 hours before the appointment time.
4. A registered patient making an appointment for a second visit after medication will be given the next priority and provided with a confirmed ticket of their appointment time, providing that the requested slot is available. Secondly, a registered patient making an appointment for medication will be the next level of priority, providing the requested time slot is available.
5. Regular check up and all other appointments by registered patient, such as request for consultation will be given a lower priority.
6. A non-registered patient making an appointment for medication will be given priority, providing their request was done during the stipulated 48-24 hours lead time.
7. All other appointments by registered patient, such as request for consultation will be given a lower priority.
8. In addition, all registered or unregistered patient will be provided with the option of the next available time slot, if the original requested time slot is unavailable. Staff and doctors appointment request will be flexible through agents using the fuzzy rules to schedule such an appointment.

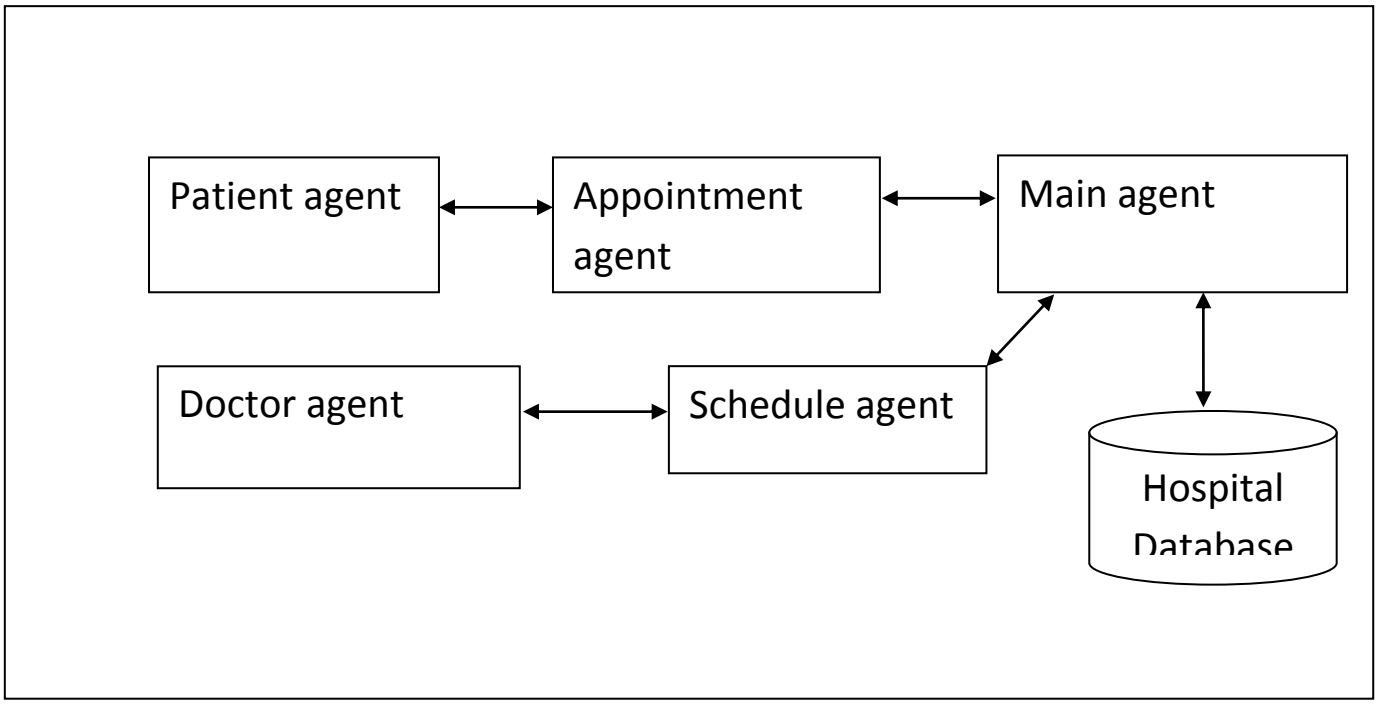

Figure 6: Procedure of Appointment

Procedural steps for appointment module are as follows:-

1. The patient using the patient agent provides the request for appointment, which invokes the Appointment agent.
2. The appointment agent interfaces with the patient agent and main agent, with its main function being to provide confirmed appointment information to the appointment requesters.
3. The main agent is considered most critical agent that interfaces with the appointment agent and doctors schedule agent along with the hospital main database.
4. The core function of the main agent is interrogate appoint request against the doctor schedule in an effort to provide available appointment slots.
5. The doctor agent core function is to receive doctor‘s schedule remotely or otherwise and interface with the doctor‘s appointment database and the schedule agent.

6. The schedule agent interfaces with the main agent and provides confirmation of doctor‘s schedule and confirmed appointments.

4.5 First aid

It is very critical for the patient to get immediate treatment for every injury, no matter how minor we think it is. Several cases have been reported where a small unimportant injury, such as a splinter wound or a puncture wound, which may lead to infection, intimidating the health and limb of the patient.

Even the smallest cut is large enough for dangerous micro-organisms to enter, and in large bruises or deep cuts, micro-organisms come by the rate of millions.

It is simply those things you can do for the victim before medical help arrives. The procedure is described below.

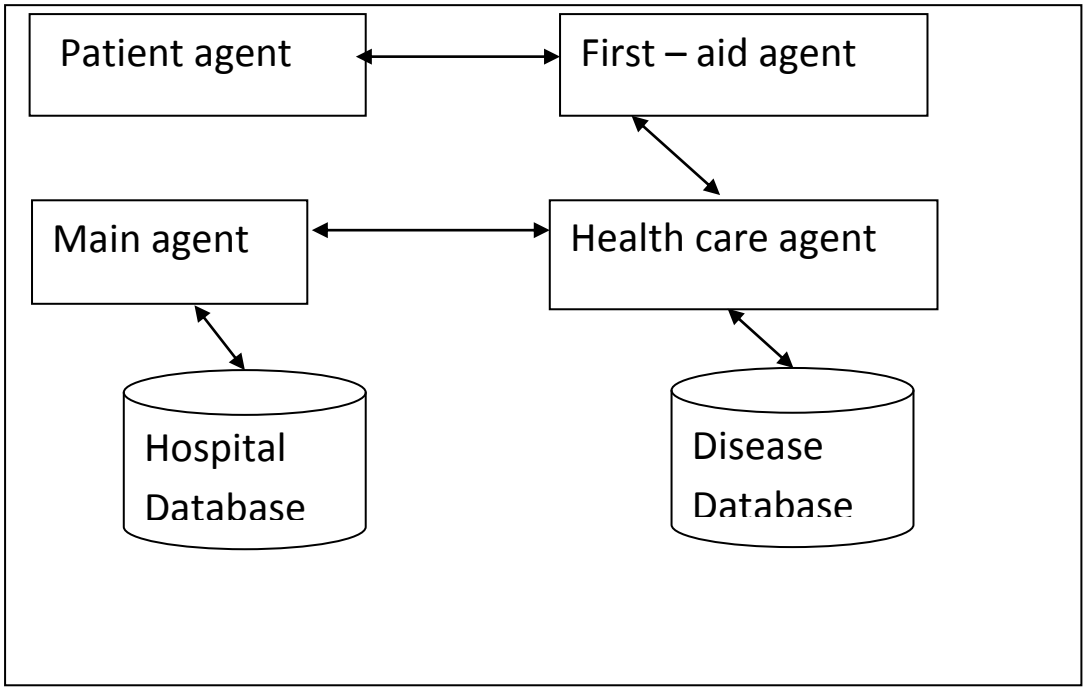

Figure 7 : Workflow of agents in first-aid

Procedural steps for the module:-

1. Patient agent will invoke the First-aid agent by querying for first- aid.
2. First-Aid agent will pass the query to the health care agent

3. This health care agent will refer to its database and provide the first aid assistant of the asked ailment.
4. Health care agent also informs the main agent which will provide the name of the specialist for that particular ailment.
5. This whole data will finally reach the patient.

4.6 Database Structure

Below is mentioned the database tables which are used in the proposed scheme. Along with the tables, the attributes are also mentioned.

1. Doctors Data

This table maintains the following attributes:

- Doctor's id
- Doctor's name
- Doctor's location

The doctor's database is initialized in the beginning of creation of database. It is assumed that the entire available doctor's data is inserted in the start. Additional doctor's data cannot be inserted in real time without admin access to database.

A total of eight doctors have been considered.

2. Patient's data

This table maintains the following attributes:

- Patient's id
- Patient's name
- Patient's Password

This database is to be updated in real time and not in the beginning. The Patients can have multiple accounts but with different id. Although same password and name is allowed.

3. Doctor-Expertise

This table maintains the following attributes:

- Doctor’s id
- Expertise areas

4. Disease-Expertise

This table maintains the following attributes:

- Disease Name
- Expertise areas

5. Disease-Test

This table maintains the following attributes:

- Disease
- Tests needed for it

6. Disease-Symptoms

This table maintains the following attributes:

- Disease name
- Symptoms

7. Doctor-password

This table maintains the following attributes:

- Doctor’s id
- Password

8. Doctor-Patient

This table maintains the following attributes:

- Doctor’s id

- Corresponding Patient id

9. Patient-Test

This table maintains the following attributes:

- Patient’s id
- Test performed by the patient
- Status of test result

10. Doctor Schedule

This table maintains the following attributes:

- Doctor’s id
- Date of booking
- Slot number (1-4)
- Status
- Patient id

11. Patient Prescription

This table maintains the following attributes:

- Patient’s id
- Prescription given to him/her

4.7 Framework

The overall framework is written in python while MySql is used for database. The entries to the database are done through python. Pymysql is used for linking python script with myslq server. Tkinter module is used for GUI development

4.8 Tools Used

Programming Language: Python 3.4.2

Database: MySQL

Packages: Pymysql

GUI : Tkinter

Chapter 5: Results and Discussion

The proposed scheme has been implemented on a 1.7 GHz processor computer with 4 GB ram, Windows as OS.

The implementation has been done using python as language and tkinter module for GUI development. The various features of the system are given below.

Fig below represents the basic homepage.

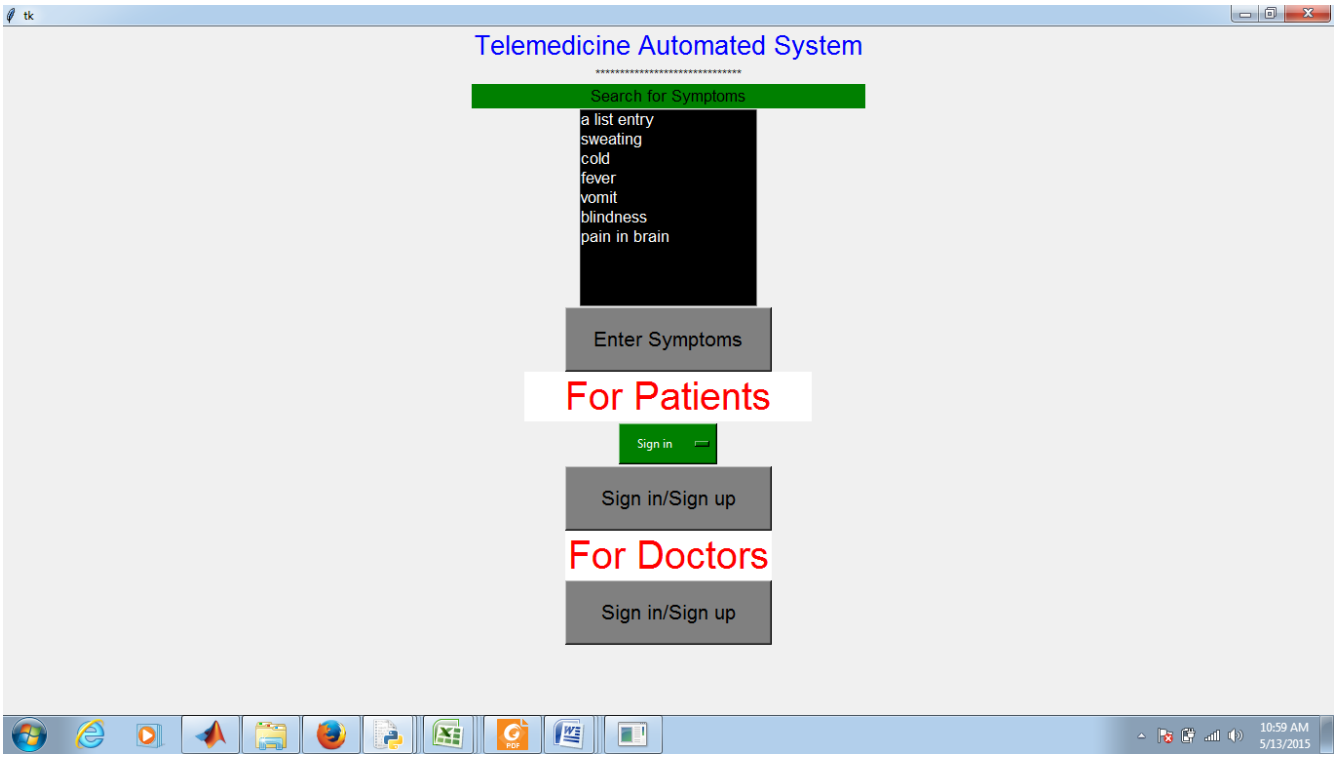

Figure 8: Homepage

This figure represents that multiple symptoms can be selected at times which are represented in blue.

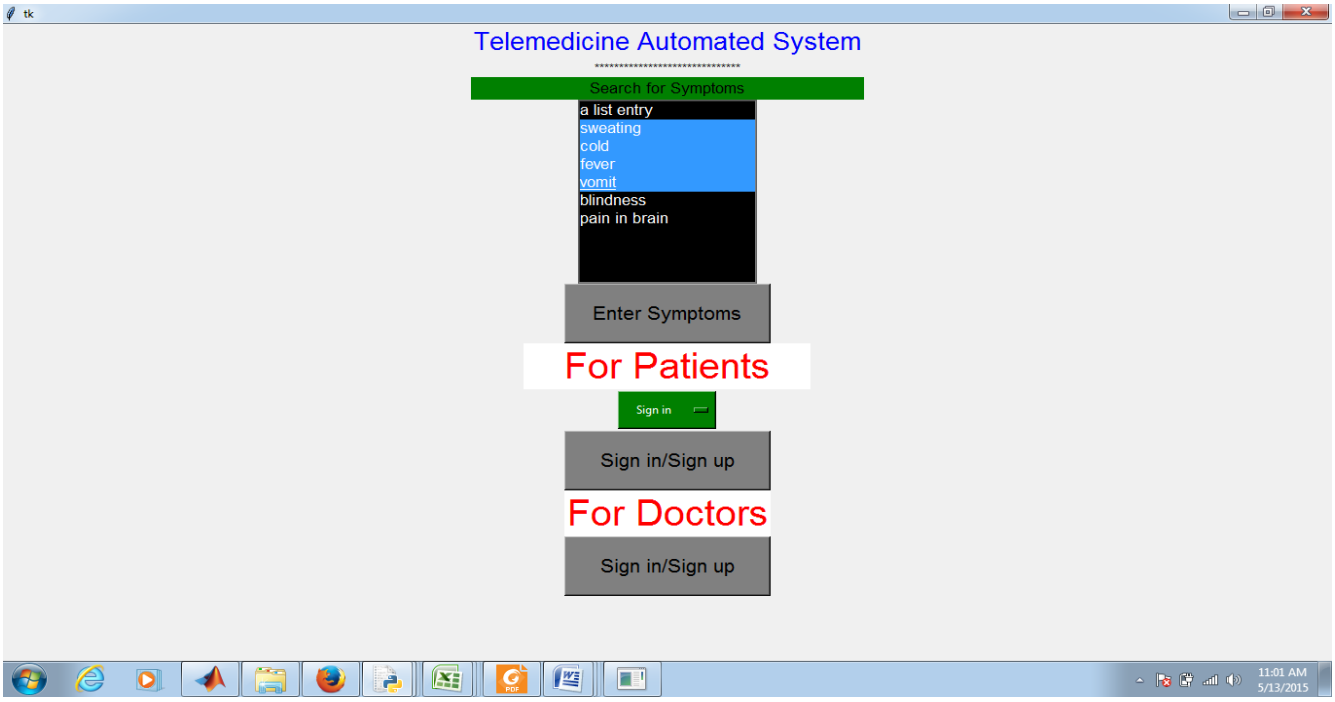

Figure 9: Symptoms Submission

This figure represents the test asked by the system to the patient once the symptoms are entered.

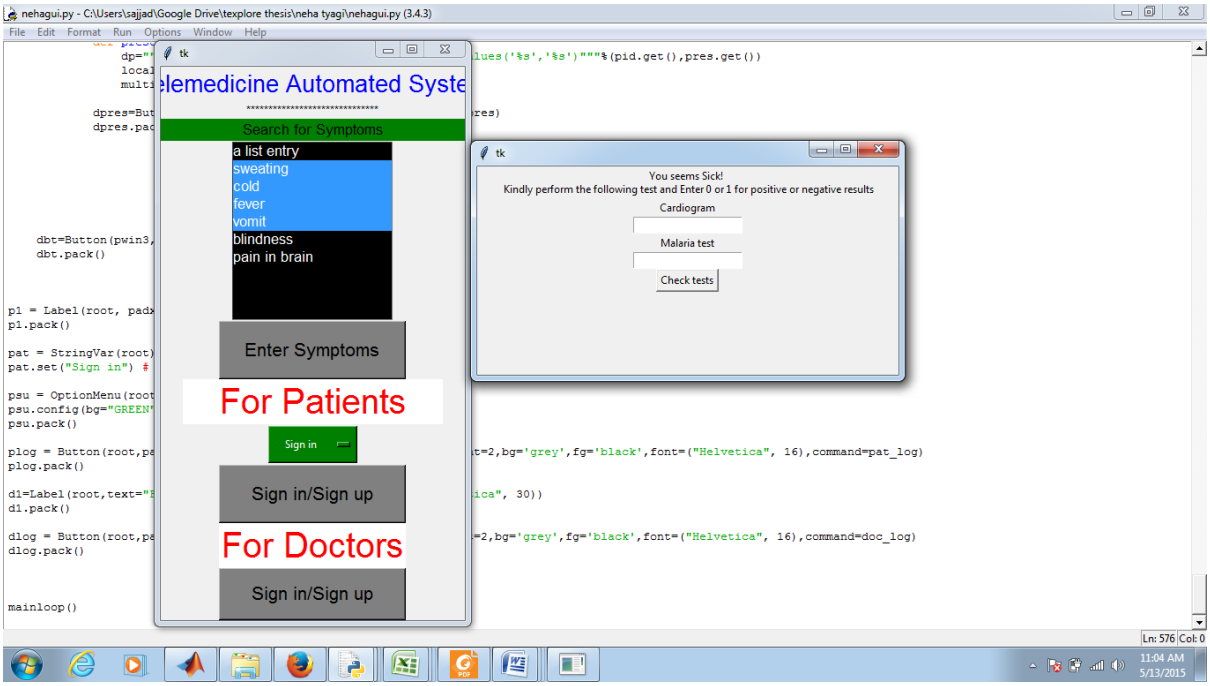

Figure 10 : Suggestion of Tests

The next figure shows the result of test in shell window and also how menu us available for signin and sign up.

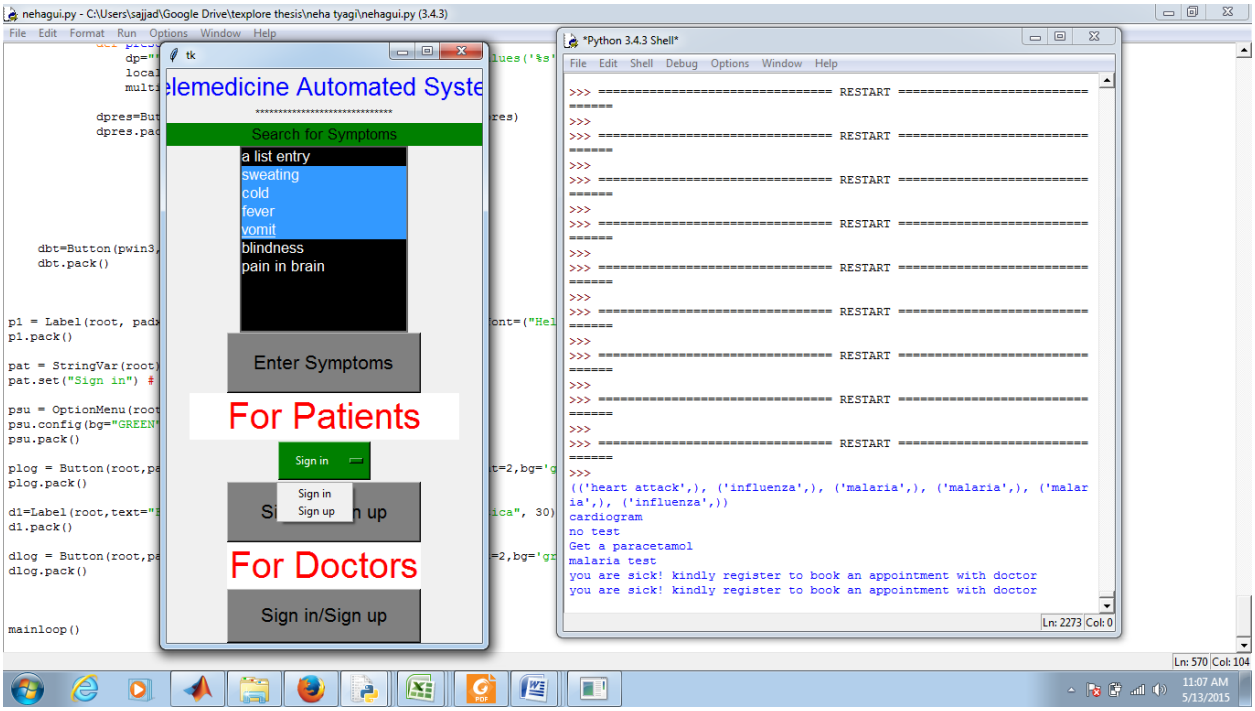

Figure 11: Results

The next figure represents the signup and sign in page for the patients.

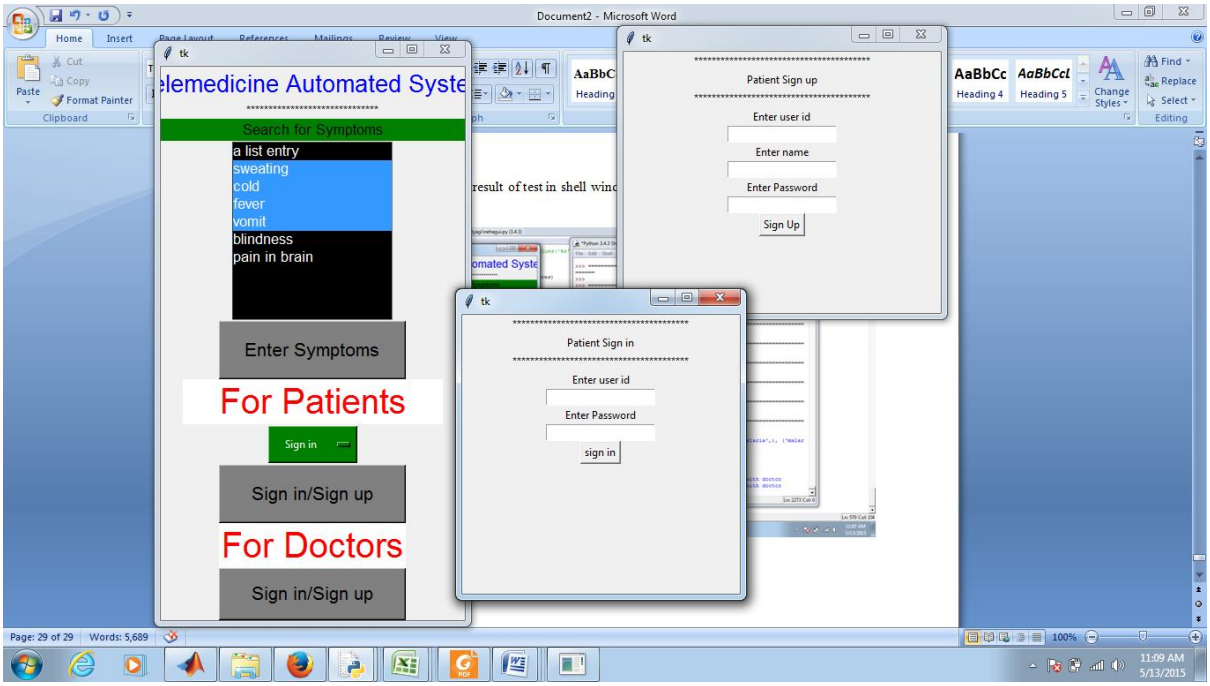

Figure 12 :Registration Page for patient

This figure shows the test entry by user after successful sign up and login

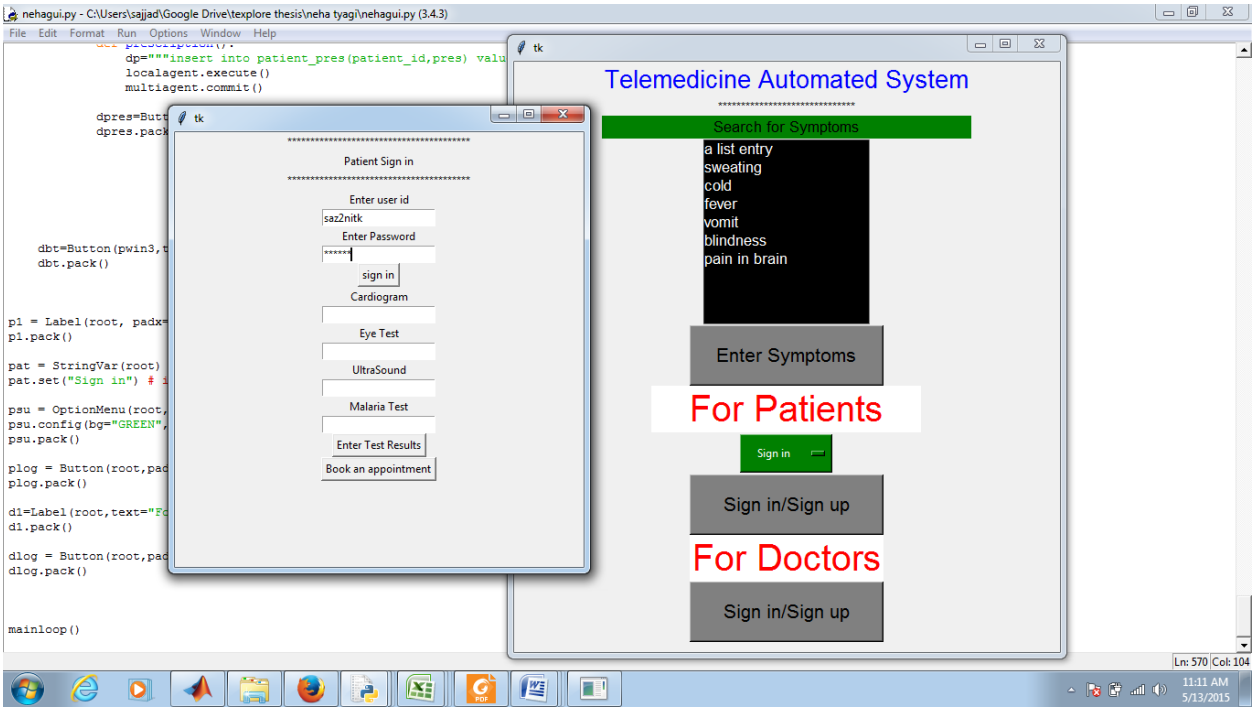

Figure 13: Test Entry

There is also an option of booking slots. The next figure represents the booking option.

The next figure shows the doctors login page and once they successfully sign in, they are allowed to give a prescription to their patients which will be updated in the patient's database.

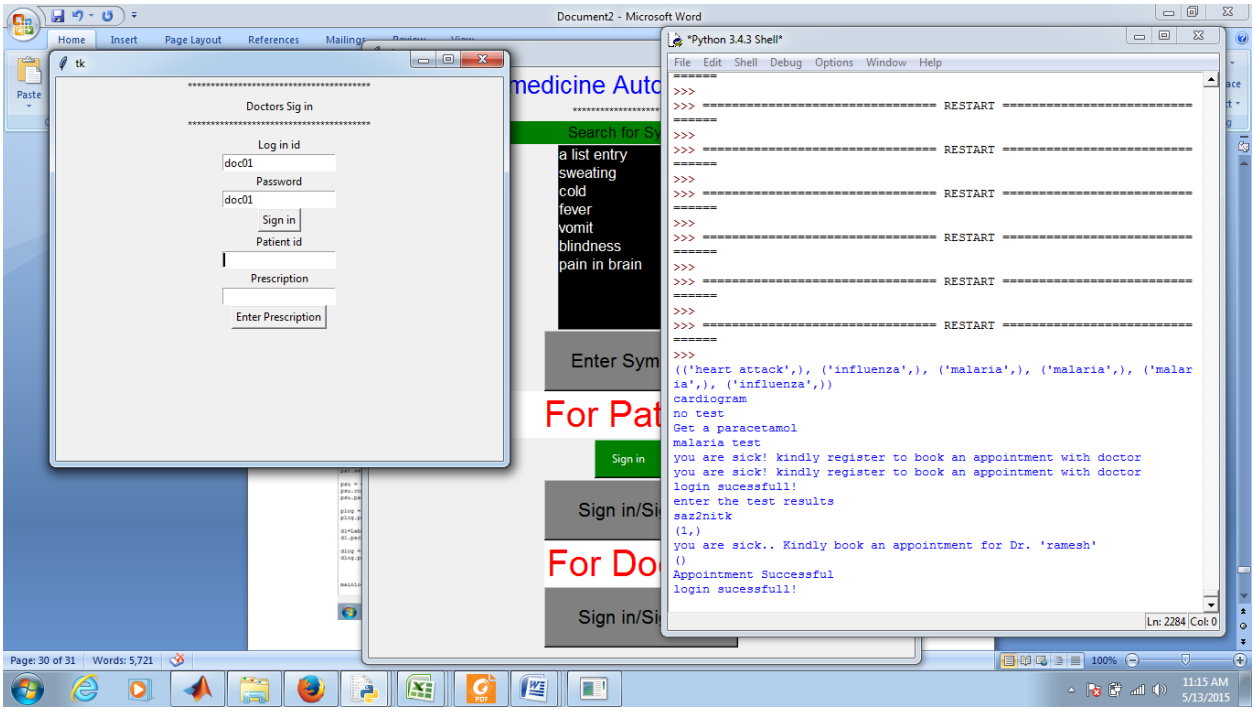

Figure 14: Doctors Login

This figure shows the various tables in MySQL database and their descriptions.

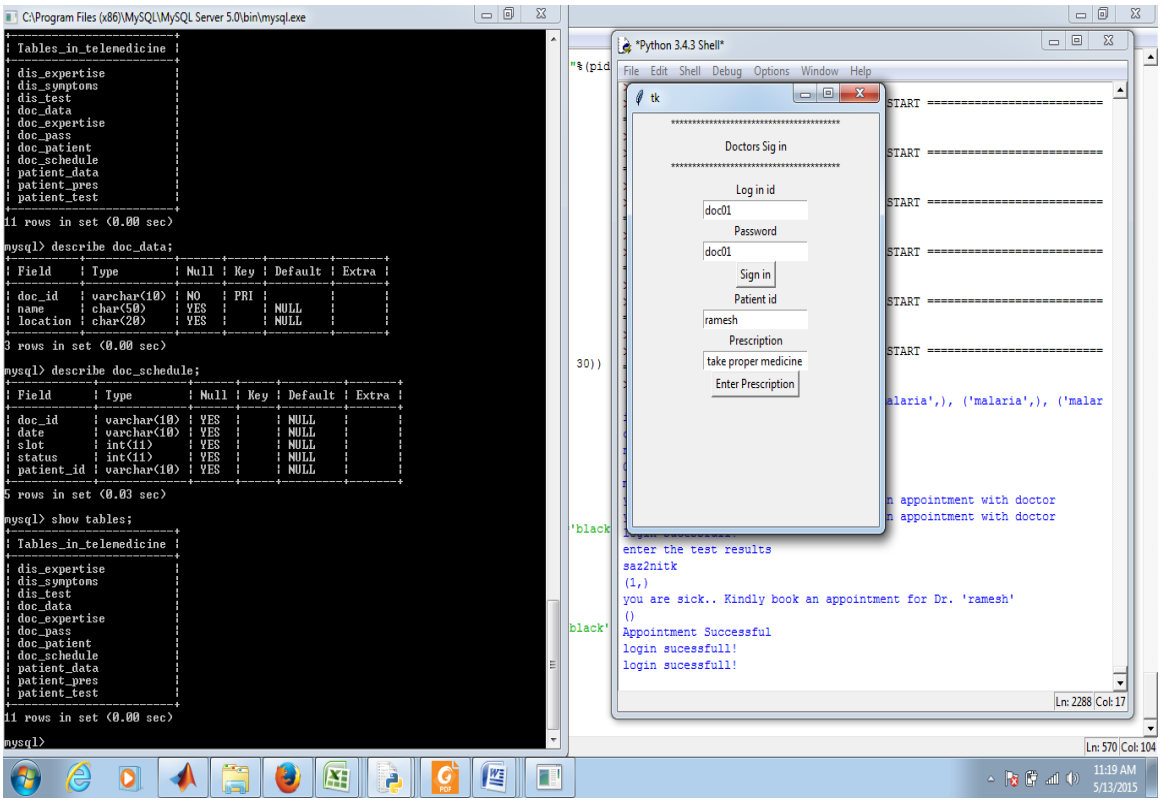

Figure 15: Database Representation

CHAPTER 6: CONTRIBUTION

This research work consists of a new approach where telemedicine system using multi-agent system is introduced. In today's era researchers' main focus is to make the universe autonomous. With the same aim, I've chosen the multi-agent environment in which agents can autonomously think without any user intervention. Thus in this research work, the task decision making is done autonomously. The task arrives at the agent and agent will try to accomplish it successfully by negotiating with other agents. Many researchers though gave various approaches of telemedicine in multi-agent environment. I have proposed a hybrid approach for the telemedicine in multi-agent system.

In my approach, I have modelled three modules, namely diagnosis, appointment and first-aid.

Diagnosis will help the patient in disease diagnosis; this will help to reduce the treatment time till the appointment with the specialist is fixed. This will assist to do all required formalities and test before hand which can reduce the wastage of time and money by reducing the consultation time and consultation fee at least for one appointment. Following will be the scenario multi-agent system for diagnosis.

First- aid module will assist in case of emergencies while at home or while reaching the hospital in ambulance.

Appointment module will help the patient to get the appointment from the doctor without wasting his time and money. Also the scheduler agent helps to optimize the appointment providing procedure by keeping in record the schedule of the doctor as well.

Chapter 7: Conclusions

A multi-agent approach has been utilized in this thesis and a robust database management system has been designed for application in telemedicine. The agent approach seems suitable for telemedicine because of its commitment to intercommunication, crucial topic in any collaborative activity as telemedicine. Furthermore, the variety of interconnected and distributed resources proper of medical data and tasks makes the agent paradigm a good choice for the analysis and implementation of medical systems, as already done in the field of patient management. In this thesis a new hybrid approach is given. Agents are provided with the decision making capabilities and a knowledge base to infer the results. In our approach, the attention is mainly focused on communication of multimedia patient data being based on the same resources and structures, although with different aims: expert consultation, diagnosis, and case archiving.

The system has been designed for application in telemedicine which can prove to be crucial in future applications for rural areas. The remote areas can easily be monitored using the technology without manual presence of the doctors.

This figure represents the first aid module which works on the expertise of doctors and their location

CHAPTER 8: FUTURE SCOPE

The system based on Multi agent technique appears to be more desirable and superior technology for telemedicine only because of its capability to work as an intercommunicate system which will automatically give prescriptions to patients in emergency when doctors are not available. Moreover, the diversity of distributed and interconnected resources necessary for medical data and tasks makes the agent prototype a good choice for the examination and execution of medical systems, as even now done in the field of patient management. In this thesis a new hybrid approach is given.

Agents are modelled with knowledge base and the decision making proficiencies and to conclude the results. In our methodology, the main consideration is focused on communication of audio-visual aid or multimedia patient data which is dependent on the same structures, resources and organizations, but with changed aims which are expert consultation, diagnosis, and case archiving.

In future we are going to stress on the safety and security measures and observing and monitoring of the patients by implanting sensor network into this methodology.

References

[1] Henkemans, Olivier A. Blanson, et al. "A hybrid Multi Agent System architecture for distributed supervision of chronic patients in the eHealth setting." Euromedia, 2007.

[2] Bellifemine, Fabio, Agostino Poggi, and Giovanni Rimassa. "Developing multi-agent systems with JADE." Intelligent Agents VII Agent Theories Architectures and Languages. Springer Berlin Heidelberg, 2001. 89-103.

[3] H.S. Nwana, D.T. Ndumu and L.C. Lee. ZEUS: An advanced Tool-Kit for Engineering Distributed Multi- Agent Systems. In: Proc of PAAM98, pp. 377-391, London, U.K., 1998.

[4] Sycara, Katia P. "Multiagent systems." AI magazine 19.2 (1998): 79.

[5] Cao, Fang, Norm Archer, and Skip Poehlman. "An Agent-based Knowledge Management Framework for Electronic Health Record Interoperability." Journal of Emerging Technologies in Web Intelligence 1.2 (2009): 119-128.

[6] Chakraborty, Sougata, and Shibakali Gupta. "Medical application using multi agent system-a literature survey." International Journal of Engineering Research and Applications 4.2 (2014): 528-546.

[7] Vicari, Rosa M., et al. "A multi-agent intelligent environment for medical knowledge." Artificial Intelligence in Medicine 27.3 (2003): 335-366.

[8] Yang, Qiao, and John S. Shieh. "A multi-agent prototype system for medical diagnosis." Intelligent System and Knowledge Engineering, 2008. ISKE 2008. 3rd International Conference on. Vol. 1. IEEE, 2008.

[9] Koutkias, Vassilios G., Ioanna Chouvarda, and Nicos Maglaveras. "Agent-based monitoring and alert generation for a home care telemedicine system." Proceedings of the AMIA Symposium. American Medical Informatics Association, 2002.

[10] Zambonelli, Franco, Nicholas R. Jennings, and Michael Wooldridge. "Developing multiagent systems: The Gaia methodology." ACM Transactions on Software Engineering and Methodology (TOSEM) 12.3 (2003): 317-370.

[11] Gill, Kaveri. "A primary evaluation of service delivery under the National Rural Health Mission (NRHM): findings from a study in Andhra Pradesh,

Uttar Pradesh, Bihar and Rajasthan." Planning Commission of India, Government of India (2009).

[12] Nabeth T. , Liana Razmerita2, Albert Angehrn1 and Claudia Roda "InCA: a Cognitive Multi-Agents Architecture for Designing Intelligent & Adaptive Learning Systems" Centre for Advanced Learning Technologies, INSEAD, Bvd de Constance, 77305 Fontainebleau Cedex 2004 route des lucioles, France

[13] Béhé, Florian, et al. "Semantic management of intelligent multi-agents systems in a 3d environment." Intelligent Distributed Computing V. Springer Berlin Heidelberg, 2012. 309-314.

[14] Cowling, Peter I., Djamila Ouelhadj, and Sanja Petrovic. "Dynamic scheduling of steel casting and milling using multi-agents." Production Planning & Control 15.2 (2004): 178-188.

[15] Huin, S. F. "Managing deployment of ERP systems in SMEs using multi-agents." International Journal of Project Management 22.6 (2004): 511-517.

[16] Pépin, Nicolas, Olivier Simonin, and François Charpillet. "Intelligent Tiles-Putting Situated Multi-Agents Models in Real World." ICAART. 2009.

[17] Yang, Christopher C. "Patient Centered Healthcare Informatics." IEEE Intelligent Informatics Bulletin December 2014

[18] Rozenblum, Ronen, et al. "The impact of medical informatics on patient satisfaction: A USA-based literature review." International journal of medical informatics 82.3 (2013): 141-158.

[19] Dogra, inderjeet singh. "Use of Multi-Agents in Computerizing Clinical Guidelines." ACM Journal Name, Vol. V, No. N, Month 2009.

[20] Xiangjun, Zeng, et al. "Multi-agents based protection for distributed generation systems." Electric Utility Deregulation, Restructuring and Power Technologies, 2004.(DRPT 2004). Proceedings of the 2004 IEEE International Conference on. Vol. 1. IEEE, 2004.

[21] Yu, Ren, Benoit Iung, and Hervé Panetto. "A multi-agents based E-maintenance system with case-based reasoning decision support." Engineering applications of artificial intelligence 16.4 (2003): 321-333.

[22] Acampora, Giovanni, et al. "A multi-agent memetic system for human-based knowledge selection." Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on 41.5 (2011): 946-960.

[23] Campbell, Adam, and Annie S. Wu. "Multi-agent role allocation: issues, approaches, and multiple perspectives." Autonomous agents and multi-agent systems 22.2 (2011): 317-355.

[24] Bhat, Srividya, et al. "Intelligent Scheduling in Health Care Domain." International Journal of Computer Science Issues (IJCSI) 8.5 (2011).

[25] Mistry, Mijal, et al. "Utilization of web services as multi agents in healthcare system." Intelligent Systems and Signal Processing (ISSP), 2013 International Conference on. IEEE, 2013.

[26] Rosaci, Domenico, Giuseppe ML Sarné, and Salvatore Garruzzo. "Integrating trust measures in multiagent systems." International Journal of Intelligent Systems 27.1 (2012): 1-15.

[27] Xie, Dongmei, and Shaokun Wang. "Consensus of second-order discrete-time multi-agent systems with fixed topology." Journal of Mathematical Analysis and Applications 387.1 (2012): 8-16.

[28] Chen, Yao, et al. "Consensus of discrete-time second-order multiagent systems based on infinite products of general stochastic matrices." SIAM Journal on Control and Optimization 51.4 (2013): 3274-3301.

[29] HUANG, Qin-Zhen. "Consensus analysis of multi-agent discrete-time systems." Acta Automatica Sinica 38.7 (2012): 1127-1133.

[30] Devlin, Sam, and Daniel Kudenko. "Theoretical considerations of potential-based reward shaping for multi-agent systems." The 10th International Conference on Autonomous Agents and Multiagent Systems-Volume 1. International Foundation for Autonomous Agents and Multiagent Systems, 2011.

[31] Bogdanovych, Anton, et al. "Developing virtual heritage applications as normative multiagent systems." Agent-Oriented Software Engineering X. Springer Berlin Heidelberg, 2011. 140-154.

[32] Bellifemine, F., Caire, G., & Greenwood, D. *Developing Multi Agent System With Jade.* John Wiley & Sons,Ltd, 2007.

[33] Blanson Henkemans OA, Bonacina S, Cappiello N, van der Mast CAPG, Neerincx MA, Pinciroli "A hybrid multi-agent system architecture for distributed supervision of chronic patients in the e-health setting". *Euromedia 2007*,Ghent.

[34] Weiss, G. *Multiagent Systems*,Cambridge, Massachusetts: The MIT Press.1999

[35] M. Wooldridge, "*An Introduction to Multi Agent Systems".* John Wiley & Sons Ltd, 2002.

[36] Hsu, Wen-Shin, and Jiann-I. Pan. "Secure Mobile Agent for Telemedicine Based on P2P Networks." *Journal of medical systems* 37.3, volume-3, pp-1-6 2013.

[37] Vietnamese Association for Computing, Engineering Technology, and Science, "software agent for telemedicine" http://www.vacets.org/vtic97/txbui2.html [Accessed: August 1st 2014].

[38] Vincent Rialle, Jean-Baptiste Lamy, Norbert Noury and Lionel Bajolle "Telemonitoring of patients at home: a software agent approach" 2003 Elsevier CMPB journal, Volume172, Issue-3, pp-257-268, November 2003.

[39] Byung-Mo Han, Seung-Jae Song, Kyu Min Lee, Kyung-Soo Jang*, Dong-Ryeol Shin, "Multi Agent System based Efficient Healthcare Service",. In the proceeding of 8th International Conference on Advanced Communication Technology, ICACT 2006, Pheonix Park, vol. 1, Feb. 20-22, 2006,pp. 51-55.

[40] Golam Sorwar and Ameer Ali "Advanced Telemedicine System Using 3G Cellular Networks and Agent Technology" E-Health, vol. 335, Springer, 2010, pp 187-197.

[41] Olivier A. Blanson Henkermans, StefanoBonacina, Nicola Cappiello, Charles A.P.G. Van der Mast, Mark. A. Neerincx, Francesco Pinciroli, "A Hybrid Multi Agent System Architecture for Distributed Supervision of Chronic Patients in the eHealth Setting", http://www.researchgate.net/publication/228886058_A_Hybrid_Multi_Agent_System_Architecture_for_Distributed_Supervision_of_Chronic_Patients_in_the_eHealth_Setting/file/79e4150a38b6c1ad43.pdf

[42] Qiao Yang and John S. Shieh "A Multi-Agent Prototype System for Medical Diagnosis" 2008 3rd International Conference on Intelligent System and Knowledge Engineering

[43] Rosa M. Vicaria,, Cecilia D. Floresa, Andre´ M. Silvestrea, Louise J. Seixasb, Marcelo Ladeirac, Helder Coelho "A multi-agent intelligent environment for medical knowledge" 2003 Elsevier Artificial Intelligence in Medicine 27 (2003) 335–366

[44] Vassilios G. Koutkias, Ioanna Chouvarda and Nicos Maglaveras "Agent-based Monitoring and Alert Generation for a Home Care Telemedicine System" Proc AMIA Symp. 2002 : 395–399

[45] Sougata Chakraborty, Shibakali Gupta, "Medical Application Using Multi Agent System- A Literature Survey" Int. Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue 2(Version 1), Feb 2014, pp. 528-54

[46] Okba Kazar, Zaidi Sahnoun,LouisFrecon "Multi-agents system for medical diagnosis",www.pu.edu.jo/download/research/members/CSIT2006/vol4%20pdf/pg118.pdf .

[47] Douglas A. Perednia, MD, Ace Allen, MD, "Telemedicine Technology and Clinical Applications", vol-273, JAMA Feb 8, No-6

[48] PricewaterhouseCoopers, "Emerging Market Report: Health in India 2007",2007

[49] Kaveri Gill, "A Primary Evaluation of Service Delivery under the National Rural Health Mission (NRHM):Findings from a Study in Andhra Pradesh, Uttar Pradesh, Bihar and Rajasthan Planning Commission Of India", May 2009

[50] N.R.Jennings, M.J.Wooldridge, "Agent Technology Foundations, Applications, and Markets", Berlin, Germany: Springer-Verlag, 1998.

[51] R.S.Patil, R.E.Fikes, P.F.Patel-Schneider, D.McKay, T.Finin, T.Gruber, R.Neches, "The DARPA Knowledge Sharing Effort: Progress Report, Proc. of Knowledge Representation and Reasoning", 777-788, 1992.

[52] FIPA - Foundation for Intelligent Physical Agents, URL:http://www.fipa.org/,

[53] D.Milojicic, M.Breugst, I.Busse, J.Campbell, S.Covaci, B.Friedman, K.Kosaka, D.Lange, K.Ono, M.Oshima, C.Tham, S.Virdhagriswaran, J.White, MASIF: The OMG Mobile Agent System Interoperability Facility, Proc. 2nd Int. Workshop on Mobile Agents, Lecture Notes in Computer Science, 1477, 50-67, 1998.

APPENDIX- A PUBLICATIONS

[1] Neha Tyagi, Vaishnavi Singhal and Deepak Dahiya, "Role of software agents in telemedicine-A Review", accepted In the Proceedings of "Futuristic Trends in Computational analysis and Knowledge management", INBUSH ERA – 2015, Feb 25-27, 2015, Amity University Knowledge Park III, Greater Noida Uttar Pradesh, India.