Gathering Requirements for Hospital Management System Using Intelligent Agents

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Abstract—A Hospital Management System (HMS) streamlines hospital operations, enhances administration and control, provides better patient care, strictly controls operational costs and helps in improving many other functionalities. Besides it a HMS should be able to respond to evolving requirements. Unfortunately, a HMS developed using conventional software development practices may not meet this requirement as it may need system reengineering. An intelligent agent based HMS can adapt to such situations without system reengineering. The biggest advantage of intelligent agent based system is that its constituent intelligent agents can sense, learn and dynamically modify their functionalities according to the evolving requirements. In turn, the evolving nature of agents helps agent based systems to enhance automatically their capabilities according to the user's changing working behavior. In this paper we describe a novel software intelligent agent model that automatically senses and gathers user's requirement and generates a report for HMS developer for improving the functionalities of the underlying HMS which is already deployed and operational at customer's site.

Index Terms— Intelligent agent, Hospital management system, Requirement engineering.

I. INTRODUCTION

The software requirement engineering determines the functional or non-functional requirements for engineering software. The requirements engineering is the first stage of any software project development. It is the process of determining functions of the software systems. The process encompasses all activities concerned with the requirements eliciting, analyzing, documenting, validating and managing software or systems. In requirement engineering [1] the real world goals are explored and established for the software system that is being developed. Before any project, the requirements of the user are collected to accomplish the user's task. The first stage of requirements engineering process is requirement gathering. Unfortunately, complete requirements cannot be perceived at a given point of time. The reason is that they evolve with time — mostly they are observed after the system deployment. This evolutionary nature of requirements poses difficulties in almost every phase of software development process. With every change in requirements, the system analyst is required to recollect the changed or new requirements, then analyze and document them. Consequently in all the steps of software development human intervention is required for the changed requirements. This paper proposes a model of software intelligent agent [2] that automatically senses and gathers user's new requirements and generates a report of it and finally sends it to the developer. This model of software intelligent agent gathers the requirement through various learning methods. The intelligent agents can either be embedded with HMS or installed at user's site. During the course of HMS operation, the intelligent agents sense new requirements from user's operations and use them to evolve HMS dynamically by adding functionalities that satisfies the newly captured requirements.

In what to follows we define software intelligent agent and its features. Afterwards, Section III describes the hospital management [3, 4] domain and use of intelligent agents in software systems development for this domain. In Section IV we present a review on related work. The proposed model is presented in Section V. Section VI concludes the paper along-with recommendations on future work.

II. SOFTWARE INTELLIGENT AGENTS

A software intelligent agent is defined as a computer program that works on behalf of a user to accomplish the user's task. It uses artificial intelligence (AI) techniques in pursuit of the goals of its clients. An intelligent agent can also be defined as a piece of software that acts for a user or other program, and decides appropriate actions. While in action an intelligent agent perceives its environment through sensors and acts on that environment through effectors. For a better understanding of intelligent agents we list some definitions from the agent related literature.

A. Definitions

- An agent is an identifiable computational entity that automates some aspect of task and performs decision making to benefit a human entity [5].

- Intelligent agents are goal-driven and autonomous, and can communicate and interact with each other. The goal of these agents is to perform the common task according to the user's need [6].

- Intelligent agents sense their environment and engage in decision making whereby they select actions, and execute their actions, which, in turn, impact their environment [8].

An evolving software intelligent agent has learning abilities. They can learn new concepts, acquire abilities to adapt the environmental changes, and evolve to perform better tasks in ever-changing situations. In software terms an evolving agent should sense and acquire changing/new requirements autonomously, co-operate to other agents and modify itself to fulfill those requirements. Specifically, they are expected to perform continuously three functions: perceive dynamic environmental changes; take action(s) to affect conditions in the environment; and use reasoning to interpret percepts, solve problems, draw inferences, and

determine actions. Agents bring information about their environment, called percepts, through sensors [1]. Agent-Environment interaction is depicted in Figure 1. The figure consists of environment, agent, sensor, effectors', percept and action components. Agents perceive knowledge through sensors from the environment and perform actions according to their perception.
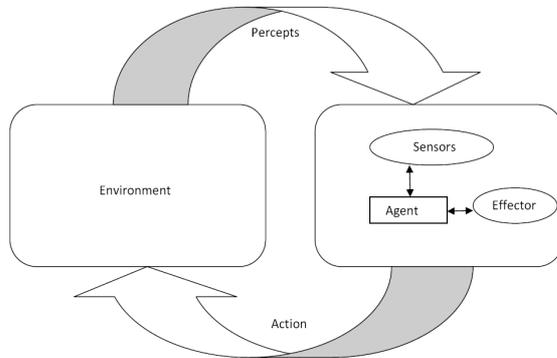

Fig 1: Agents interact with environments through sensors and effectors [1].

B. Benefits of Software Intelligent Agents

To realize the importance, some common attributes that give intelligent agents [7] abilities to play a focal role in evolving software development are discussed below:

- **Autonomy:** It makes an intelligent agent perform tasks automatically with control over their actions and internal states.
- **Self-learning:** It makes intelligent agents change their behavior and adapt to evolving requirements.
- **Proactive:** It makes intelligent agents take decisions based on their knowledge. .
- **Communication:** It makes intelligent agents communicate with other agents to learn new capabilities and evolve together.
- **Co-operation:** It induces co-operative learning through agent-to-agent interactions.
- **Mobility:** It makes intelligent agents mobile so that they can travel throughout computer systems in order to accumulate knowledge and carry out tasks.
- **Goal Driven:** It makes intelligent agents aware of their ability and performance.
- **Reactivity:** It makes intelligent agents responsive to all related events.

In practice, agents have each one of these attributes. Agents may have different combinations of attributes. The combinations depend on knowledge, capabilities, reliability, resources and responsibilities that may be required in agent design. So, agents may have attributes according to their nature which determines agent types.

C. Types of Software Intelligent Agents

Software intelligent agents can be categorized into various categories according to their way of working. Some of them are discussed below:

- **Cooperative agents:** These agents communicate with other agents and act according to the results of their communication.
- **Proactive agents:** These agents initiate actions on their own and use their intelligence to accomplish a task.
- **Adaptive agents:** These agents can learn from their experience and then change their nature automatically to adapt to the situation.
- **Personal agents:** These agents are proactive and they work in accordance with a particular user's need.
- **Collaborative agents:** These agents are proactive and cooperate with other agents.

III. THE HOSPITAL MANAGEMENT SYSTEM

The manual hospital system includes registration of patients, storing their details in a file as a record and also the patients' bills of the hospital. Manually it is very difficult to manage the entire hospital system. It takes too much time to find out particular record of the user and is very difficult to manage number of records sequentially. Many problems have been experienced in such systems. Some of the problems are described below.

- **Lack of immediate retrievals:** It is very difficult to retrieve particular information like to find about patient's information or history, the user has to go through various record books and this process requires time and efforts.
- **Lack of immediate information storage:** The information generated by various transactions takes time and efforts to be stored at right place.
- **Lack of prompt updating:** Changes are difficult to make as it involves heavy paper works that take too much time to update records.
- **Error prone manual calculation:** Manual calculations are error prone and take a lot of time and may result in incorrect information.
- **Preparation of accurate and prompt reports:** It is a difficult task to collect information from various record books.

The above mentioned problems may be minimized by developing a computerize system but these problems also hamper the computerization of the hospital management process. As mentioned before, development of a HMS is subject of this research. We expect the computerized hospital management system should prove beneficial and it would streamline operations, enhance administration & control, provide a better patient care with strict cost control and improved facilities. In addition the system may be powerful, flexible, and easy to use. The proposed intelligent agent-based hospital management system [3, 4] is for super specialty and multi specialty hospitals, to cover a wide range of hospital administration and management processes. In this paper, intelligent agents are initially installed at user's computer at the development time of the HMS. These intelligent agents sense and gather user's new requirements automatically. In this paper patient agent, doctor agent, nurse agent and environment agent are designed to collect respective user requirements for HMS and send the collected

requirement report to developer for enhancement of HMS. These agents interact separately with the user and automatically understand and gather user's requirements. After gathering the requirements, agents generate a report for user requirements collaboration and send that to the developer for the HMS enhancement.

IV. RELATED WORK

Many researchers have used software intelligent agents in various applications that automatically perform the task on behalf of users. Yang Hongqia, et.al [3] describe the formation of agents of hospitals with intelligent and coordinative characteristics. They also discussed patient agent, doctor agent, nurse agent and environment agent working for their proposed hospital management system. These agents can perform hard coded task. This is a useful attempt at the innovation of hospital's modeling method. In other development, Henry Lieberman [4] demonstrated how software agents incorporate learning, personalization, pro-activity, context-sensitivity and collaboration will lead to a new generation of medical applications that will streamline user interfaces and enable more sophisticated communication and problem-solving.

Ilaria Baffo1, et al. [9] proposed a multi agent system (MAS) based approach to model the drugs management processes and solve the limited resources assignment problem through a combinatorial auction mechanism's Ali, et.al. [10] Presented an automated delivery system for clinical guidelines that assists clinicians in diagnosing and treating patients with chest pain in the emergency department. This system automatically delivers appropriate clinical guidelines given the relevant patient data.

The problem with all these proposed systems is that it only involves the cure of patients, reduces cost, effort and time of the user. But it does not collect the requirement of the particular user. User need to perform the same task again and again to find the same information. That's why this paper proposes a model of intelligent agents that automatically senses and gathers user's new/changed requirements.

V. INTELLIGENT AGENTS FOR AUTOMATED REQUIREMENTS GATHERING

We present intelligent agent models for automated requirements gathering for computerized Hospital Management System (HMS). While analyzing the hospital management process we discovered that there are several tasks that are being performed independently and for tasks multiple intelligent agents can be created. These agents can be made to gather or sense users' requirements automatically even after the deployment of the HMS if the requirements gathering and the sensing are done through sensing and learning. In this paper we present designs of four such agents. They are: Patient Agent, Doctor Agent, Nurse Agent and Environment Agent.

- **Patient Agent:** A patient agent simulates the role of patients. The agent helps patients in consultancy about doctor selection according to his need and symptoms. The agent

gathers patient's requirements and prepares a requirement report in the developers' comprehensible form and sends that to him.

- **Doctor Agent:** A doctor agent plays the role of a doctor. It's the main aim is to gather requirements of the doctor such as time saving approaches to deal with the patient and prepare report for developer. A doctor agent also collects the advisory requirements such as suitable treatment and medication for a particular patient.

- **Nurse Agent:** A nurse agent plays the role of a nurse. The design of nurse agent is similar to the doctor agent. A nurse agent helps a doctor agent and acts in coordination with doctor agents.

- **Environment Agent:** The environment agent is responsible for the hospitality of the hospital. It maintains the arrangement of various hospital units such as wardrooms, ICUs and operating rooms. It is the part of user interface of the computerized HMS. An environment agent senses requirements related to user interface of the HMS software and helps doctors and patients in the selection of various hospital resources such as ICUs, operating rooms, and wardrooms.

All these agents operate in coordination with each other. They are provided with learning abilities so, being a HMS constituent, they learn various requirements while the HMS is in operation. These agents work independently in gathering the requirements from HMS users as well from each other. Moreover, if required they co-operate among various agents and finalize tasks. Needless to say, each intelligent agent generates a report for developers of the HMS for the purpose of enhancing the HMS performance. The complete scenario of agent in action is depicted in Figure 2 below where agents interact with HMS users, among themselves and HMS developers.
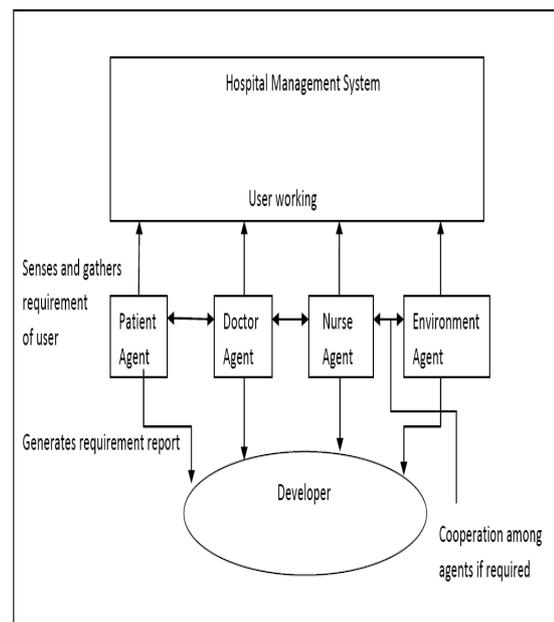

Fig. 2: Agents in hospital management system

VI. CONCLUSION AND FUTURE WORK

An intelligent agent based HMS is expected to provide feasible solutions to the problems that evolve after the deployment of HMS and during its operation. The reason is that such a system can evolve with emerging requirements captured by its intelligent agents. In addition to this, agents evolve themselves and gain expertise in better understanding of emergent requirements that bound to emerge during the system operation. Application of suitable learning and sensing technique for agents is topic of intensive research. Development of these agents opens new challenges in the software development process. Software intelligent agents reduce burden of developers and user in identifying requirements. Therefore, once the agents are developed, they reduce maintenance cost of the software that is the major issue in software production.

REFERENCES

[1] Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach. Prentice-Hall, Inc, pp. 31-51, 1995.

[2] Kavitha C.R & Sunitha Mary Thomas, "Requirement gathering for small Projects using Agile Methods", International Juornal of Computer Applications (IJCA) Special Issue on "Computational Science - New Dimensions & Perspectives (3) Published by Foundation of Computer Science", pp. 122-128, 2011.

[3] Yang Hongqiao, Liu Xihua, Wu Fei and Li Weizi, "Multi-agent based modeling and simulation of complex System in Hospital", in Proc. Sixteenth Int. Conference on Industrial Engineering and Engineering Management, pp. 1759-1763, 2009.

[4] Cynthia S. Hood and Chuanyi Ji, "Intelligent agents for proactive fault detection", in Proc. Conference on Internet Computing, pp. 65-72, vol.2, issue .2, 1998.

[5] Ebrahim (abe) Mamdani and Jeremy Pitt, "Responsible Agent Behavior -A Distributed Computing Perspective", IEEE Internet Computing, pp. 27-31, vol. 4, issue. 5, 2000.

[6] Noureddine Boudriga, and Mohammad S. obaidat, "Intelligent Agents on the Web-A Review", IEEE Computing in Science and Engineering, pp.35-42, vol. 6, issue.4, July 2004.

[7] Henry Lieberman, "Intelligent Agent Software for Medicine", and Cindy Mason, Studies in Health Techno Inform, vol. 80, pp. 99-109, 2002.

[8] Amy Greenwald, Nicholas R. Jennings, Peter Stone, "Agents and markets", IEEE Intelligent Systems, pp.12-14, vol. 18, issue: 6, 2003.

[9] Ilaria Baffo, Giuseppe Stecca, and Toshiya Kaihara, "A multi agent system approach for hospital's drugs management using combinatorial auctions", IEEE International Conference on Industrial Informatics - INDIN, pp. 945-949, 2010.

[10] S. Ali, P. Chia, K. Ong, "Graphical knowledge-based protocols for chest pain management", in proc. Conference on Computers in Cardiology, Hannover, Germany , pp. 309–312, 1999.

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