A Generic Architecture for Agent Based E-Learning System

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Abstract—**E-learning refers to the way by which the learning content is provided by means of electronic technology. E-learning system is classified as either synchronous or asynchronous. It is the effective learning process so that the web-based learning system has become a promising paradigm in education. Agent based E-learning can manage the information overload, serve as academic experts, and create programming environments for the learners. There are several characteristics specific to E-learning system such as Interaction, Personalization, Adaptation, Intelligence, Interoperability, Accessibility and Security. Agent based architecture for E-learning system provides the above mentioned features to support instructional design, to retrieve relevant learning materials, to process and analyze data to enable meaningful E-learning recommendations to instructors and learners. But most of the existing E-learning architectures doesn't consider all the features in a single system. So there is a need for a generic architecture that should support all the features to make the E-learning system more efficient. In this paper, we provide a generic architecture for E-learning system. This architecture considers interactivity, personalization, adaptation, interoperability, collaboration, security to enhance the quality of learning process.**

Index Terms – E-learning, Agent based learning, Generic Architecture, Intelligent Tutoring System, Software Agents.

I. INTRODUCTION

E-learning refers to learning that is delivered or enabled via electronic technology. E-learning is defined as “the effective learning process created by combining digitally delivered content with support and services.” It is the instruction delivered electronically wholly by a web browser, through the Internet or an intranet, or through CD-ROM or DVD multimedia platforms. It is also defined as a technology that fully leverages the distributive power of the Internet and encourages investors to consider the ‘e’ in E-learning to represent ‘effective’ [12].

E-learning is classified as synchronous or asynchronous. Both terms refer to “the extent to which a course is bound by place and/or time,” Synchronous simply means that two or more events occur at the same time, while Asynchronous means that two or more events don't occur at the same time. An agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives. An intelligent agent is one that is capable of flexible autonomous action in order to meet its design objectives, where flexibility is achieved by reactivity, pro-activeness and social ability.

Agent based E-Learning provides tools and techniques to manage the information overload, serve as academic experts, and create programming environments for the learners E-learning intelligent agents are tools that can manage the information overload, serve as academic experts, and create programming environments for the learners [4]. In this way, the learning process is enhanced by having many agents collaborating and competing towards achieving the prescribed goals. Intelligent agents should be able to model the user in order to remember his/her knowledge, skills and learning style.

Available agent based architectures provide adaptable, interactive, distributed, collaborative, personalized, secured and intelligent E-Learning system to support instructional design, retrieve relevant learning materials, process and analyze data to enable meaningful E-learning recommendations to be made to instructors and learners. But most of the E-learning system considers only one feature into account. If the system considers all the features mentioned above into a single system then the system will be a efficient one.

This paper presents a Generic Agent-based Architecture for E-learning contains all the above mentioned characteristics so it will be an efficient architecture.

Section 2 presents the various architectures for Agent Based E-learning system and section 3 presents the Generic Agent-based Architecture for E-learning and then section 4 concludes the work and future enhancement.

II. EXISTING ARCHITECTURE FOR AGENT-BASED E-LEARNING SYTEM: A SURVEY

In this section we present different Agent-based E-learning architecture. The architectures given here are classified into (1) Intelligent Agent-based E-learning System; (2) Distributed E-learning System; (3) Adaptive E-learning System; (4) Interactive E-learning System; (5) Extensible E-learning System; (6) Double Agent Based E-learning System; (7) Multi-Agent based E-learning System; (8) Web Services E-learning System.

A. Intelligent Agent-based E-learning System

Konstantinos C. Giotopoulos et. al [12] developed a E-learning environment which incorporates Intelligent Agents

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and Computational Intelligence Techniques. This E-learning environment consists of E-learning platform Front-End, the Student Questioner Reasoning and the Student Model Agent. These parts were distributed geographically in dispersed computer servers, with main focus on the design and development of these subsystems through the use of new and emerging technologies. These parts were interconnected in an interoperable way, which used web services for the integration of the subsystems, to enhance the user modeling procedure and achieve the goals of the learning process.

Christos E. Alexakos et.al [3] presented an innovative platform that integrates intelligent agents in legacy E-learning environments. It introduced the design and development of a scalable and interoperable integration platform supporting various assessment agents for E-learning environments. They introduced a scalable implementation architecture that is based on an agent platform. This platform is used in order to manage the execution of the various intelligent agents for supporting legacy E-learning systems.

Nicola Capuano et. al [14] proposed an Agent Based Intelligent Tutoring System for Distance Learning (ABITS) that would be useful for several knowledge domains. The architecture of ABITS was composed of three different kinds of Agents. Evaluation Agents: are interested of evaluating and updating Cognitive States and whole Student Models (remember the “Update All” use case); to do this, they interact with the Metadata Base, the ABITS Database, the Affective Agent and the Pedagogical Agent. Affective agents are interested of evaluating and updating Learning Preferences; to do this, they interact with the Metadata Base and the ABITS Database and Pedagogical agents are interested of evaluating and updating Curriculums; to do this, they interact with the Metadata Base, the ABITS Database and the Courses Database.

Yi Shang, Hongchi Shi and Su-Shing Chen [21] presented an Intelligent Agent Distributed Environment for Active Learning (IDEAL). This system supports student-centered, self-paced, and highly interactive learning approach. Students' learning-related profiles, such as learning styles and background knowledge, were used in selecting, organizing, and presenting learning materials. IDEAL is a Web-based, distributed, multi-agent learning system with three tier architecture. This system ties the Web clients (for students) and the underlying information servers (for courseware and student profiles) together with the multi-agent resource management. The information and agents were supported by a distributed system consisting of workstations and storage devices connected via high-bandwidth networks. This system was implemented using the prevalent Internet, Web, digital library, and multi-agent technologies.

José M. Gascueña and Antonio Fernández-Caballero [8] introduced an application of agent-based Intelligent Tutoring System (ITS) for enhancing E-learning/E-teaching. The first goal of this ITS was that the alumni learn more and better, that is to say, to be able to structure learning matter in such a way to facilitate the learning facilities. One characteristic to take into account in learning is the rhythm the student is able to learn. Thus, the ITS has to adapt rhythm it introduces the concepts to the learning rhythm of each student. Another aspect widely considered in learning theory is reinforcement by rewarding a correct answer and penalizing the errors. Another goal in our environment is to enhance teaching as well as learning.

Sabin-Corneliu Buraga [18] proposed an agent-oriented extensible framework based on Extensible Markup Language (XML) family for building a hypermedia E-learning system available on the World-Wide Web. Here focus was given to the implementation solutions of an E-learning (tutoring) Web-based system by deploying mobile agents that can exchange information in a flexible way via XML-based documents (such as RDF assertions or/and SOAP messages).

B. Distributed E-learning System

Hasan Al-Sakran [7] proposed an Agent-based Architecture for developing E-learning system that supports the objectives of E-learning using mobile agent technology. This architecture provides users the ability to collect, analyze, distribute and use E-learning knowledge from multiple sources. The mobile agent technology is particularly suitable for developing distributed E-learning systems because it supports intelligent and distributed storage, allows an optimal personalized E-learning environment and enhances modularity, flexibility and reliability.

Dan Gâlea et.al [4] proposed a framework of intelligent agents with BDI architecture that can search server knowledge bases in order to investigate the knowledge sub-graph until all knowledge items are given perceptual explanations. This framework consists of a number of agent servers that have the capability to host and transport agents in the network. Also, servers have local knowledge bases, which the agents can consult. The agents have a BDI (belief-desires-intentions) architecture E-learning system. They presumed that every item of knowledge for such a purpose could have two types: (i) Perceptual: knowledge the learner can directly understand, without prior information (e.g.: the concept of natural number or color); (2) Extended: knowledge that requires prior understanding of other concepts (e.g. a programming language cannot be understood without knowing what a computer is). Here they discussed the main issues concerning E-learning and its advantages over traditional instruction. They also presented a few possible implementation approaches and insist on the use of intelligent agents for E-learning.

O. P. Rishi et.al [15] presented a methodology where using Case Based Reasoning (CBR), ITS provides student modeling for online learning in a distributed environment with the help of agents. They conceptualized Case Based Distributed Student Modeling ITS architecture to support student-centered, self-paced, and highly interactive learning. In this system the first step in building an effective learning environment is building a Case Base where the system maintains a rich set of cases (scenario) of student’s learning pattern, and employs an efficient and flexible case retrieval system. This maximizes the interactivity between the ITS and the students; and customizes the learning process to the needs of an individual student. The system must use the student’s learning profile such as learning style and background knowledge in selecting, organizing, and presenting the learning material to support case based learning. It also supports personalized and more intensive interaction

between the student and the ITS. Distributed CBR based student modeling enables adaptive delivery of educational contents and facilitates automatic evaluation of learning outcomes. This system also incorporates a new approach to course content organization and delivery, which can be developed, based on distributed and agent based instructional components. Instructional components represent the customized interactive presentation of any topic of a subject or different subjects.

Shinichi Motomura et. al [20] presented a novel framework for asynchronous Web-based training. This system had two distinguishing features. Firstly, it is based on P2P architecture for scalability and robustness. Secondly, all contents in the system are not only data but also agents so that they can mark user's answers, can tell the correct answers, and can show some extra information without human instruction.

C. Adaptive E-learning System

Peter Brusilovsky and Hemanta Nijhavan [16] presented the KnowledgeTree, a framework for adaptive E-learning based on distributed re-usable learning activities. This architecture anticipated the presence of at least three kinds of servers: activity servers, learning portals, and student model servers. The KnowledgeTree architecture was open and flexible. It allows the presence of multiple portals, activity servers, and user modeling servers. The open nature or it allows even small research groups or companies to be "players" in the new E-learning market.

Peter Brusilovsky [17] presented a KnowledgeTree, architecture for adaptive E-Learning based on distributed reusable intelligent learning activities. Capitalizing on the success of integrated Learning Management System (LMS), KnowledgeTree aims to provide one-stop comprehensive support for the needs of teachers and students who are using E-Learning. It doing so it attempts to replace the current monolithic LMS with a community of distributed communicating servers. This architecture presented four kinds of servers: activity servers, value-adding services, learning portals, and student model servers. These kinds of servers represent the interests of three main stakeholders in the modern E-learning process: content and service providers, course providers, and students.

D. Interactive E-learning System

Shaikh Mostafa Al Masum and Mitsuru Ishizuka [19] provided a visualization model named Web Online Force Directed Animated Visualization (WebOFDAV) This E-learning model consists of a number of model components. The users interact with the system through a character-agent enabled user interface (i.e., intelligent agent interface); at the core of the proposed E-learning model is the black box of major components of the proposed model. The other components of this models are User Knowledge Tester; Natural Language (NL) Parser; Virtual Assessor (VA); Data Mining & Knowledge Discovery; Knowledge Base (KB); Lesson Plan Generator (LPG); Virtual Teacher; User Performance Testing (UPT); Information Visualization.

E. Personalization in E-learning System

Chih-Ming Chen et. al [1] proposed a genetic-based personalized E-learning system that generated appropriate learning paths according to the incorrect testing responses of an individual learner in a pre-test. Judy C.R. Tseng [9] proposed an adaptive learning approach by basing upon two main sources of personalization information, namely learning behavior and personal learning style. In this approach questionnaire had been used to determine the initial learning styles of the students. The interactions and learning results of each student have been analyzed while adjusting the subject materials. But this approach was very difficult in developing six versions of subject materials to meet the personalization requirements.

C. J. Huang [2] incorporated the PBL (Problem-based learning) activity into an open software E-learning platform, Moodle, and a learning diagnosis tool was added in the platform to alleviate the loading of the instructors. The learners' transcripts posted on discussion board and chatting room were first preprocessed by the learning parameter extraction module to truly reflect the learners' planning on the solutions to the designated problem. The extracted parameters were further fed into a classification algorithm to examine the quality of the learners' suggestions and some appropriate feedback was issued to the learners/instructor if needed.

E. Reategui et. al [5] presented an alternative approach to educational AHS (Adaptive Hypermedia Systems) in which a virtual character personalizes the interaction with the user through the use of a particular recommender system. The character has natural language communication abilities; it can learn students' profiles and use knowledge to recommend appropriate contents and activities. Through its interaction with the user, the character was able to collect and organize information about students in order to identify appropriate suggestions of contents. The recommender system employed a knowledge representation scheme that was easy to understand and modify, teachers/tutors to explore the types of recommendations been.

F. Interoperability in E-learning System

Kai Wang et.al [10] proposed a Web services-based framework for E-learning portal systems. This framework was designed with the objective of presenting a flexible integration model that will impart intelligence and adaptiveness to each individual learner in the E-learning environment. This framework includes two parts: portal framework and Web services framework. Portal framework is comprised of presentation component, portal engine component and portlet container. Web services framework usually includes a service provider, a service broker, and a service requester. A Service provider delivers any learning information, material, or process as a self-contained, self-describing modular service across different platforms.

The main advantage of this framework is that Instructor/Learner will use this framework to their learning objects or services based on portal universally anywhere, any time with any device through common communication protocols. This architecture key value of interoperability and

accessibility would enhance the future collaboration E-learning portal systems to communicate more efficiently and share data more easily.

G. *Security in E-learning*

Security is a crucial issue for E-learning. Frank Graf [6] provided two concrete solutions to improve the security. First, a framework for secure testing was provided and second, a solution was presented to deal with the problem of confidentiality and protection of copyright. Thus illegitimate access and Redistribution of the course material can be prevented.

Khalil El-Khatib et al. [11] examined privacy and security issues associated with E-learning. They presented the basic principles behind privacy practices and legislation and investigated the popular E-learning standards to determine their provisions and limitations for privacy and security. Privacy requirements for E-learning systems are explored with respect to the "Privacy Principles".

III. GENERIC ARCHITECTURE OF AGENT-BASED E-LEARNING SYTEM

The Generic Architecture of Agent-based E-learning system is shown in the figure 1 below.

Available agent based architectures provide adaptable, interactive, distributed, collaborative, personalized, secured and intelligent E-learning system to support instructional design, retrieve relevant learning materials, process and analyze data to enable meaningful E-learning recommendations to be made to instructors and learners. But most of the E-learning system considers only one feature into account. So there is a need of a Generic Architecture for Agent-based E-learning System that supports all the features into a single system and thus the system will be consider as an efficient one.

A. *Layered Architecture*

It is an three tier layered architecture for E-learning System. The upper layer is the User Interface layer, which provides adaptive interface for online learners. The middle layer contains a number of agents that support Intelligence, Accessibility, Interactivity, Interoperability, Adaptation, Personalization, and Security. The lower layer is the Repository layer that contains two components: Learner Profile and E-content repository.

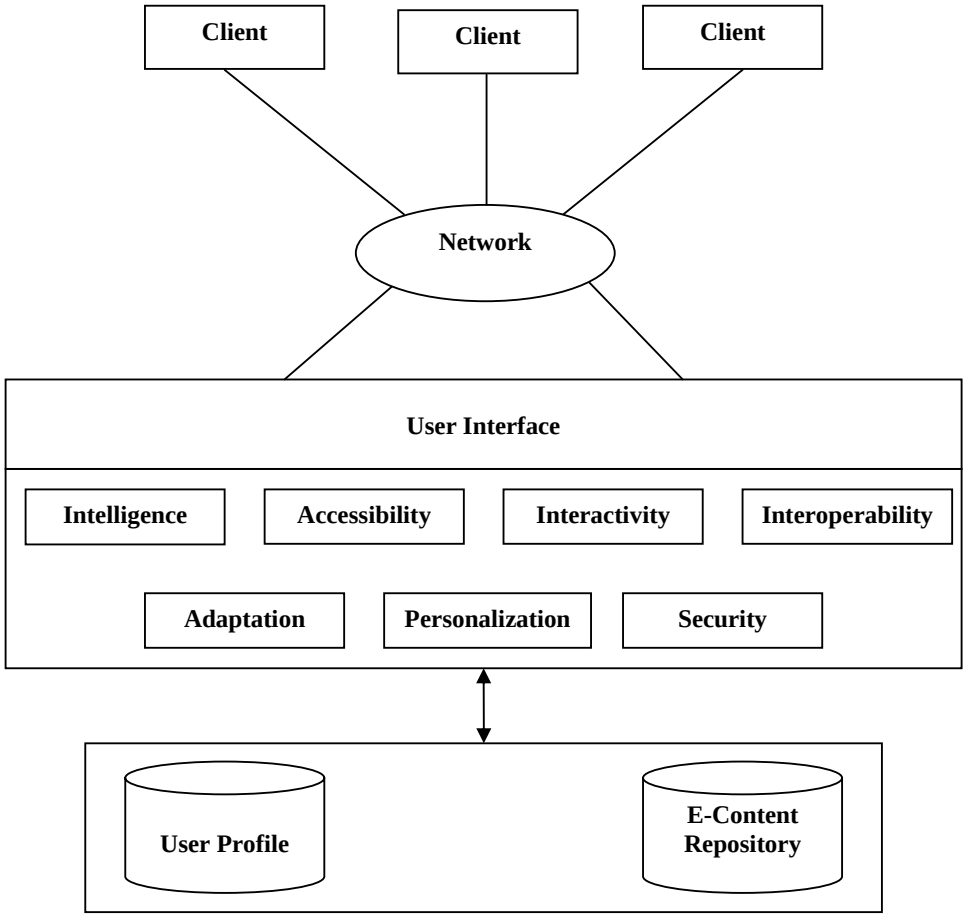

Figure 1. Generic Architecture of Proposed E-Learning System

The functionalities of each agent are given below:

Intelligent Agent – This agent provides dynamism in E-Learning and it perform specific tasks on the behalf of students, instructors, and other members of the educational community including parents and alumni.

Accessibility Agent – This agent provides easy accessible to geographically dispersed content of the E-learning system.

Interactive Agent – This agent provides interactive environment to the users where objects in the learning environment can be readily adjusted, modified or manipulated to accord with the user's preference. This enhances the learning process.

Interoperability Agent – This agent gives assurance of the E-learning systems inter-communication as well as with other human resources management systems. The focus on interoperability is motivated by the increased importance in reusing and combining various learning elements in different ways to meet diverse learning needs and to create more adaptable learning systems. This was seen as the key to realising economic benefits from better and more widely available education in developed and developing nations.

Adaptation Agent – This agent provides adaptability functionalities in the E-learning system. A learning environment is considered adaptive if it is capable of monitoring the activities of its users; interpreting these on the basis of domain-specific models; inferring user requirements and preferences out of the interpreted activities, appropriately representing these in associated models; and, finally, acting upon the available knowledge on its users and the subject matter at hand, to dynamically facilitate the learning process.

Personalization Agent – This agent provides a set of personalization functionalities such as personalizing learning plans, learning materials, tests and are capable of initializing the interaction with learners by providing advice, necessary instant messages, to online learners. It also provides personalized content management, learner model, learner plan and adaptive instant interaction.

Security Agent – Security considerations play an increasingly important role for distributed computing and it becomes an important challenge in order to insure that interested actors only have access to the right information at the appropriate time. This agent takes care of the security features / security challenges in E-learning systems.

IV. Conclusion

E-learning has become a part of education in recent times. The advancement in technology and communication has made teaching and training possible anywhere and anytime. This paper provided a Generic Agent-based Architecture for E-learning that provides features like intelligence, distributed, adaptive, interactive, extensible and collaborative in a single architecture and it is considered to be an efficient one. In future, much concentration will give to Agent Based E-learning for Distributed/Heterogeneous environment.

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