INFORMATION
TECHNOLOGY JOURNAL

Design of an Agent-based Academic Information System for Effective Education Management

S.C. Ng, C.K. Wong, T.S. Lee and F.Y. Lee
School of Information Technology, SEGi University College, No. 9, Jalan Teknologi,
Taman Sains Selangor Kota Damansara, PJU 5. 47810, Petaling Jaya, Selangor, Malaysia

Abstract: The aim of this study was to design and develop an agent-based distance learning management system, namely the Cybernetics 1 (C1) to support accurate decision making, resource allocation and operational control in an effective education management information system. C1 is a web-based open information system to manage the complete course of undergraduate students' study flow as well as enhancing the policy-making process of education institutions in line with the developing marketplace. This system is illustrated through a multi-stakeholders scenario that captures the operation of the undergraduate students' study flow problem. The approach of integrating agent technologies to web services enables C1 to become a more flexible, collaborative and efficient distance learning management system. The system is expected to reduce the work period with an average 75% based on the preliminary research study.

Key words: Information and communications technology (ICT), agent technology, management information system, decision support, distance learning management system, artificial intelligence

INTRODUCTION

These days, the Internet links thousands of organisations worldwide into a single network and creates a vast global electronic marketplace. Through computers and networks, human can accomplish transactions digitally regardless of locations. This process requires computer literacy and organisational or personal information processing, transmission and communication. Modern universities and colleges serve as platforms to create technology literacy and development of new technology skills not only by introducing ICT in the academic courses but also through getting students involved in the application of ICT. Web technologies become a part of the basic infrastructure for distance education (Marsap and Aytac, 2010; Hui, 2011). In view of the importance of this aspect, an agent-based distance learning management system, called Cybernetics 1 (C1) is proposed. C1 is a centralised web-based, open information system that incorporates the function of several departments to manage the undergraduate students' study flow. The system includes intake management, examination management, course management, financial management, etc. There are several pitfalls for the current human-based education management systems (Liang and Lan, 2010; Homeed and Mahmood, 2006). Every functional department in the system has special data requirements and the information connections among the departments are diverse. This phenomenon causes the poor data sharing and the problem of data inconsistency due to poor coordination of departments. Besides, the insufficient preparation of base data by the administrative staff results in the disassociation of data outside the system. Much time and effort is consumed to track the data for a minor data input mistake. Nevertheless, most current computer-based education management systems have the problem of superintended service objects (Duan and Zhang, 2007; Li and Liu, 2008). The system limits the service functions to in-school personnel. Some computer-based education management systems only encompass a few departments. The objective of the design of C1 is to overcome these limitations for the sake of improving the efficiency of the current undergraduate students' study flow management among the administrative staff, academicians and students. Besides playing the role of a management information system to cater for the smooth operation on information flow, C1 acts as decision support system to

---

Corresponding Author: S.C. Ng, School of Information Technology, SEGi University College, No. 9, Jalan Teknologi,
Taman Sains Selangor Kota Damansara, PJU 5. 47810, Petaling Jaya, Selangor, Malaysia
Tel: +60361451777

monitor students' academic performance. Another prominent feature of C1 is the application of software agent (Ng *et al.*, 2009a; Sun *et al.*, 2006) technology in the information system to ensure the effective resource allocation and reuse. It aids the education institutions in preparing courses that fit the current and future market needs. The aim of this study is to design and develop an agent-based distance learning management system, C1, to support accurate decision making, resource allocation and operational control in an effective education management information system.

OPERATION OF UNDERGRADUATE STUDENTS' STUDY FLOW

The proposed system design intends to model the current manual operation of undergraduate students' study flow (Fig. 1). Generally, the operation consists of 4 consecutive steps: (1) Register as a student, (2) Make payment to the Bursary, (3) Register for subjects at the Faculty and (4) Sitting for exams. The undergraduate students' study flow is illustrated by a scenario as follows:

- A student registers at Registry at the beginning of 1st semester. The registry department monitors the admission, graduation, termination and suspension of students
- The student settles fees and other payments at the Bursary. The Bursary collects payments from students
- The student registers for subjects at the Faculty
- The Examination Department verifies the student's payment status at the Bursary and the courses registered in the related Faculty to decide if the student is eligible to sit for final examination. The Examination Department is also responsible to print student results and transcripts at the end of a semester
- At the beginning of following semester, steps 2 to 4 are repeated until the end of the student's programme of study

C1 DESIGN

Software agent is an encapsulated computer program that is situated in an environment and it exhibits the
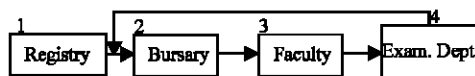

Fig. 1: Undergraduate students' study flow

nature of flexible, proactive and autonomous action in that environment in order to meet its design objectives (Ng *et al.*, 2009b; Chao *et al.*, 2001). Agent technology has the potential to simplify the complexity of a problem by means of providing a natural and elegant way to model the interaction of system components (Lim and Zhang, 2003). Comparing to ordinary web services that contain multiple modules, an agent system embodies a number of agents distributed in cross-area networks to accomplish a common goal. Owing to this, C1 extends the Web services paradigm in the way that agents are utilised on behalf of the service owner on autonomous resource retrieval and allocation. Figure 2 shows the scheme of how software agents acquire information from multiple network platforms. When a user sends a request to C1, the resource allocation agent acting on behalf of the server application first searches the requested information in local domain network. If the information is not available in local domain, the resource allocation agent then migrates to another platform to perform the information retrieval task. Meanwhile, C1 initiates multiple agents to carry out the same task at different network platforms. This topology shortens the resource allocation time and optimizes the reuse of resource over the network.

Functional description: In terms of the nature of participants involved, C1 carries out two major responsibilities-as a website providing information for public consumption and as an in-house distance learning management system for the administration, academicians and students. As an in-house distance learning management system, C1 is equipped with the following characteristics:

- **Interoperability:** The system maintains the consistency of input and storage data. Synchronization of data is carried out between subsystems of the departments involved
- **Robust:** The system is not susceptible to faults caused by improper user entry. Exception handling enables C1 to anticipate error conditions or unexpected events during the running period of the system. The system is capable of supporting batch data processing
- **Secured:** Data is the primary asset of a management information system. C1 must guarantee the security of data by protecting the data from virus attacks and illegal compilation of data. The system should routinely back up the data. Different access levels are assigned to the users with different data requirements
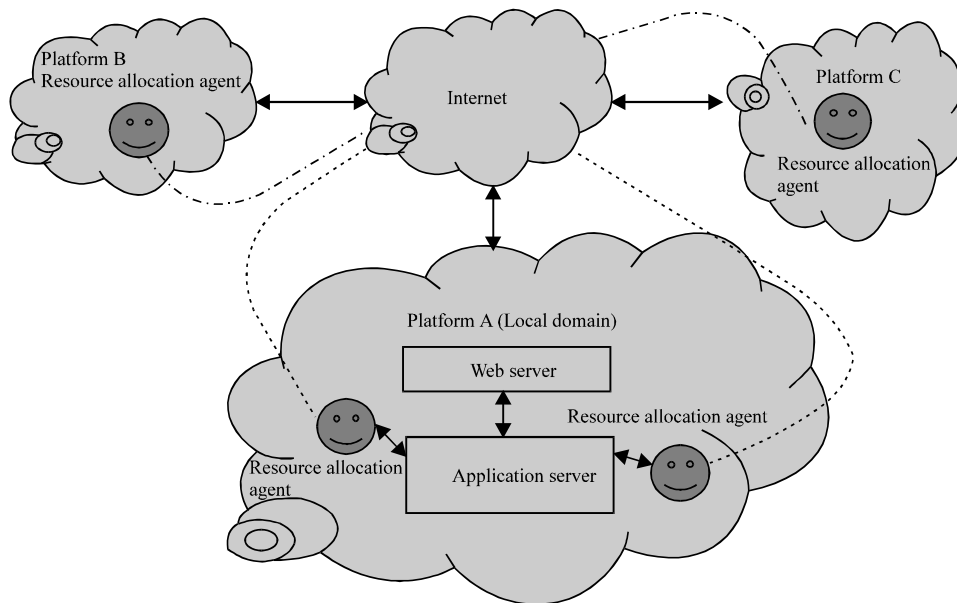
Fig. 2: C1 multi-agent system

- **Intelligence:** The system is incorporated with a knowledgebase to monitor the students' academic performance. C1 generates statistical reports of academic performance. Rule-based reasoning (Abu-Naser *et al.*, 2010) is implemented as the knowledgebase to capture the possible causes of students' poor performance in their studies based on the statistical information. This information is acquired from students' attendance record, participation in lecture, coursework assessment and students' feedback on lecturers. Based on the ranking of the click-through rate on the course programs, the system can dynamically update the courseware to meet market demands. This information is connected directly to resource management subsystem. The agents residing in the web application act on behalf of the subsystem to execute cross-platform resource sharing and retrieval
- **Scalability:** To meet the ongoing and changing requirements of the business, the system is flexible in its ability to include new and more powerful features in the future

System architecture: C1 is implemented centrally in order to maintain the consistency of data with relations to the change in time, place, people and environment (Fig. 3). Browser-Server (B/S) paradigm (Li *et al.*, 2010; Yang *et al.*, 2009) is applied on this web-based distance learning management system. The user can access C1 in and out campus. There are six major components of C1, namely the database, knowledgebase, web server, database server, hub and client computers. The database performs the centralised storage of data. The in-campus and off-campus users access C1 through web browsers. HTTP requests are sent to the web server to call the function of data transmission, processing and analysis. The database server in return sends the query result back to the web server. The processed data is then displayed in the web browser in response to users' requests. Simultaneously, the web server interacts with the rule-based inference engine performing as knowledgebase to evaluate the students' academic performance. The inference engine analyses the possible factors that contribute to the students' academic performance. This information aids the institution in taking corrective actions to improve the quality of the overall academic performance. Agents encapsulated by web server applications carry out the task of cross-platform resource retrieval and allocation on the Internet to collect information on the development of new trends in marketplace. The institution is thus able to upgrade the academic programmes offered from time to time to keep pace with the ever-changing market demands. The system is programmed using the Hypertext Preprocessor (PHP) (Suzumura *et al.*, 2008) language for server-side applications. Apache (Suryanarayanan and Christensen, 2000) and MySQL (Di Giacomo, 2005) are selected as the web server and the database server respectively. It is noted that in the B/S model, the client access the web server via a browser and interacts with the database through a middle tier. Comparing to the
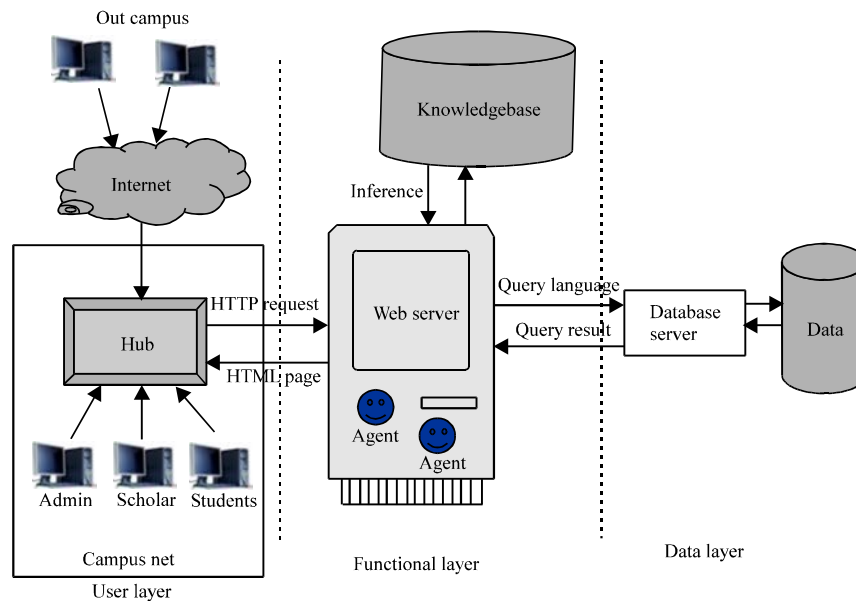
Fig. 3: C1 B/S based system architecture

client-server paradigm, B/S model eliminates the need for application version management and updates at the client side of the system. The user can access C1 with a browser without the location constraints.

SYSTEM APPLICATION

C1 intends to be implemented and tested in the management of distance learning students in the SEGi Education Group. Four primary departments, namely the Registry, the Bursary, the Examination Department and the respective Faculties, participate in the pilot implementation of C1. The functions of C1 include recruiting undergraduate students, financial management, registering courses online, academic record management and academic programmes management. The work period and user response will be used to justify the performance of the system. Integration testing will be carried out to ensure the feasibility of C1.

CONCLUSION

This study aims to design an agent-based distance learning management system to manage the complete course of undergraduate students' study flow. Unlike the conventional management information systems that handle only data processing and storage, the proposed distance learning management system, C1 is integrated with rule-based reasoning to aid in the decision-support task of monitoring the students' academic performance.

Moreover, agent based systems enable C1 to allocate resource effectively over cross-platform environments. This resource is useful for education institutions to prepare for the changing trends in the education industry.

REFERENCES

Abu-Naser, S.S., H. El-Hissi, M. Abu-Rass and N. El-Khozondar, 2010. An expert system for endocrine diagnosis and treatments using JESS. J. Artificial Intell., 3: 239-251.

Chao, K.M., A.E. James and P. Norman, 2001. A framework for intelligent agents within effective concurrent design. Proceedings of the 6th International Conference on Computer Supported Cooperative Work in Design, July 12-14, London, pp: 338-343.

Di Giacomo, M., 2005. MySQL: lessons learned on a digital library. Software, 22: 10-13.

Duan, R. and M. Zhang, 2007. Design of web-based management information system for academic degree and graduate education. Integration Innov. Orient E-Soc., 252: 218-226.

Homeed, T.S.K. and A. Mahmood, 2006. Systematic multimedia courseware development using a software engineering style process model. Inform. Technol. J., 5: 726-734.

Hui, Y., 2011. Ad hoc networks based on rough set distance learning method. Inform. Technol. J., 10: 1038-1043.

Li, H. and Q. Liu, 2008. Design and implementation of educational information resource management system based on SOA. Proceedings of the International Symposium on Knowledge Acquisition and Modeling, Dec. 21-22, Wuhan, pp: 424-428.

Li, W., J. He, H. Wang and H. Li, 2010. B/S model management-control integration system based on OPC technology. Proceedings of the 2010 International Conference on Computational Intelligence and Software Engineering, Dec. 10-12, Wuhan, China, pp: 1-4.

Liang, K.L. and Z. Lan, 2010. Local universities of china management information system integration model design. Proceedings of the International Symposium on Intelligence Information Processing and Trusted Computing, Oct. 28-29, Huanggang, pp: 18-20.

Lim, M.K. and Z. Zhang, 2003. A multi-agent based manufacturing control strategy for responsive manufacturing. J. Mater. Process. Technol., 139: 379-384.

Marsap, A. and S. Aytac, 2010. Integration o f virtual and academic counselling system in Distance Education for Health Management (DEHM). Procedia Soc. Behav. Sci., 2: 1955-1962.

Ng, S.C., M.N. Sulaiman and M.H. Selamat, 2009a. Intelligent negotiation agents in electronic commerce applications. J. Artificial Intel., 2: 29-39.

Ng, S.C., M.N. Sulaiman and M.H. Selamat, 2009b. Machine learning approach in optimizing negotiation agents for E-commerce. Inform. Technol. J., 8: 801-810.

Sun, J., X. Hui and M. Li, 2006. An internet-based multi-agent framework for build-to-order supply chain management. Proceedings of the 6th World Congress on Intelligent Control and Automation, June 21-23, Dalian, pp: 7029-7033.

Suryanarayanan, K. and K.J. Christensen, 2000. Performance evaluation of new methods of automatic redirection for load balancing of Apache servers distributed in the Internet. Proceedings of the 25th Annual IEEE Conference on Local Computer Networks, Nov. 8-10, Tampa, FL. USA., pp: 644-651.

Suzumura, T., S. Trent, M. Tatsubori, A. Tozawa and T. Onodera, 2008. Performance comparison of web service engines in PHP, Java and C. Proceedings of the IEEE International Conference on Web Services, Sept. 23-26, Beijing, pp: 385-392.

Yang, A., J. Wu and L. Wang, 2009. Based on B/S of the three-tier architecture of the questions the management system. Proceedings of the 3rd WSEAS International Conference on Computer engineering and Applications, (CEA'09), Wisconsin, USA., pp: 186-190.