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Kansei Engineering based Evaluation for Distance Learning on Distributed Multiple Servers

Yoshio Moritoh[1], Yoshiro Imai[2], Tetsuo Hattori[2]

[1]Department of Management Information, Kagawa Junior College, 1-10 Utazu-cho, Ayautagun 769-0201 Japan
[2]Graduate School of Engineering, Kagawa University, 2217-20 Hayashi-cho, Takamatsu 761-0396 Japan
(Tel : +81-87-864-2244)
E-mail: [1]moritoh@kjc.ac.jp, [2]{imai, hattori}@eng.kagawa-u.ac.jp

Abstract: A distributed multiple server system is designed and implemented with Web-DB based services for Distance Learning as well as Emergency Communication. The system has employed multiple servers located in a distributed campus network environment. Each server of the system has multi-core processors. With virtualized CPUs by server virtualization, some programs are executed in parallel (on the virtual servers) so that our system can efficiently perform several functions. Based on our related works, two major applications are realized as a Cloud services on the system. It can provide Distance Learning environment for educational tool as well as Web-based surveillance functions with Emergency Contact. With Kansei Engineering approach, trial evaluation of system has been performed in some classrooms of distributed campus.

Keywords: Visual Computer Simulator, Distance Learning, Distributed Multiple Server System

1. INTRODUCTION

Computer Architecture education is very much useful in the domain of Information Science education because it provides total image computer structure and behaviour and then explains how a computer works correctly. Serval educational tools[1]have been developed and utilized in the practical education fields

Cloud approach is effective and efficient for realization of some e-Learning environment, especially, for development of Distance Learning and/or Collaborative Learning. Some powerful LSI technologies can provide multi-Core CPUs and virtualized servers with such CPUs. These are relatively useful to realize multiple server system for Cloud services.

This paper presents a visual computer simulation for Computer Architecture education and its conventional evaluation in the next (second) section, realization of cloud service with distributed multiple server system for Distance Learning environment and detail of cloud service with virtualized CPUs in the third section, approach of Kansei Engineering-based evaluation to relevant cloud service in the fourth section, and finally summarized conclusion in the last (fifth) section.

2. VISUAL COMPUTER SIMULATOR

2.1 Summaries of a visual computer simulator

First of all, a simulator called *VisuSim* has been implemented as pure Java program to provide two kinds of entries for both Java applet code and Java application one[2]. Each can be selected automatically to invoke the suitable mode of Java program. Namely, for example, *VisuSim* recognizes its invoking environment and decide to execute as a Java applet in the environment of browser or to work as a Java application in the environment where the Java VM executes in the DOS prompt of Windows or in the command interpreter of Linux.

A necessary condition is to equip the Java VM prepared to execute the simulator. So it is very useful because any executable environment will do, just like Windows, Linux and/or Macintosh. There are both sides of views for our visual simulator as are summarized below. The first one is a tool to visualize an internal structure and behavior of computer. It is useful for teacher to show students how a computer works graphically and to explain step-by-step actions of internal register and memory with *VisuSim* which is shown in Figure1. The second is an e-Learning tool to provide an Assembly Programming environment. Such a case is suitable enough to support Assembly Programming Exercise during lecture.

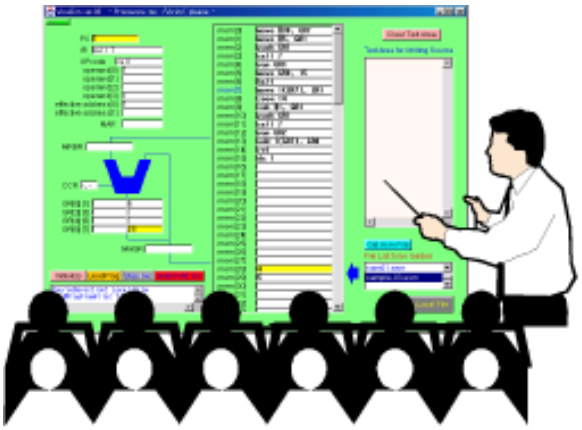

Fig. 1 Using *VisuSim* in Classroom Lecture of Computer Architecture.

- Visualization tool:

VisuSim has 8 sets of general-purpose registers, including Stack Pointer, and 256/512 words of main memory. It can

simulate computer internal behavior in a register-transfer level. For example, a teacher of Computer Architecture can utilize it to demonstrate graphical view about von Neumann computer architecture by means of wall-hanging screen and PC projector just like Figure1.

- e-Learning tool for Exercise environment:

VisuSim is utilized for writing essays and answering problems of Assembly Programming exercise. Users(Students) of *VisuSim* can understand computer behavior, program processing and well-defined algorithm through verification of assembly program execution. So it is very applicable for users to write correct programs and recognize how a computer processes their programs at the register-transfer level.

2.2 Relation between Scores of Essay and Examination of Computer Architecture

Secondly, it is investigated whether there is any relation of Scores between "Essay using *VisuSim* " and semester-end Examination or not. It has been not yet a perfect investigation and confirmation to analyze any relation between Essay and Examination yet. We should not exactly mention about a kind of relation between Essay and Examination. So we would like to demonstrate some kind of good correlation of Scores between Essay and Examination in 2009. Such a relation is shown in Figure 2.

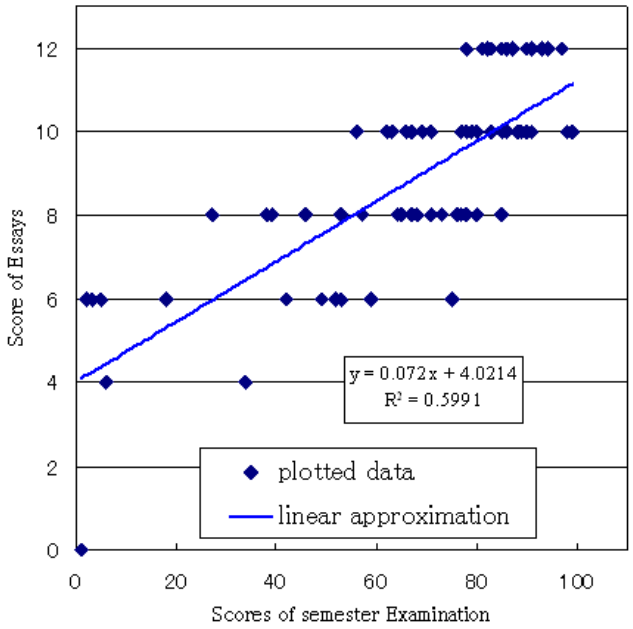

Fig. 2 Relation of Scores between Essay and semester Examination.

This result of comparison is the same aptitude of previous ones, for example, in 2007 and 2008. So it can be confirmed that the simulator *VisuSim* helps students learn "Computer Architecture" in some way according to the above comparison and/or correlation between Scores of Essay and semester-end Examination. Of course, it is necessary to explain that contents of semester-end Examination are not only about basic vonNeumann computer architecture but also include Logic Circuits, Microprogramming, Pipeline Processing and its expansive Architecture, memory architecture,and System Architecture.

Students who know only vonNeumann computer architecture cannot perfectly understand the above themes of "Computer Architecture" and cannot always make excellent scores of semester-end Examination. So we would like to confirm that understanding several themes of "Computer Architecture" is significantly affected by understanding vonNeumann computer and such a case is also significantly affected by using our simulator, *VisuSim* .

3. CLOUD SERVICES ON VIRTUALIZED CPUS OF MULTIPLE SERVER SYSTEM

3.1 Cloud Services on Virtualized CPUs

It is very efficient to realize parallel programs execution and smart management of concurrent services. If some applications need more powerful CPU services, with virtualized CPUs by server virtualization, some programs are executed in parallel (on the virtual servers) so that such a specific system can efficiently perform several functions. In the above case, each information server and its hypervisor (mentined below) can adjust its facilities to migrate (assign) virtualized server and related resources to relevant applications according to dynamic demand changing and/or modification.

One of multi-core CPUs is assigned to execute most useful Linux-based Web-DB software fundamentals. This is a basic layer (i.e. platform) for usual and classical applications. Another is sometimes assigned to multimedia information processing modules, such as image understanding, video transmission, voice generation and so on. Some of them are potentially adjusted to carry out asynchronous information sharing functions and support for emergency contact and/or urgent situation changing.

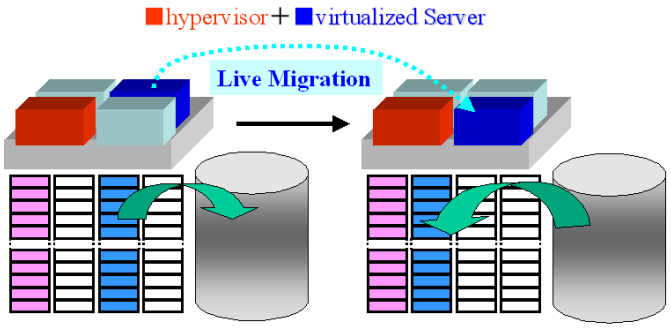

Fig. 3 Live Migration in multi-core CPU architecture.

In figure 3, special-purpose controlling monitor called "hypervisor" can switch one task on some virtualized server from one to another through "Live Migration" context-switching mechanism.

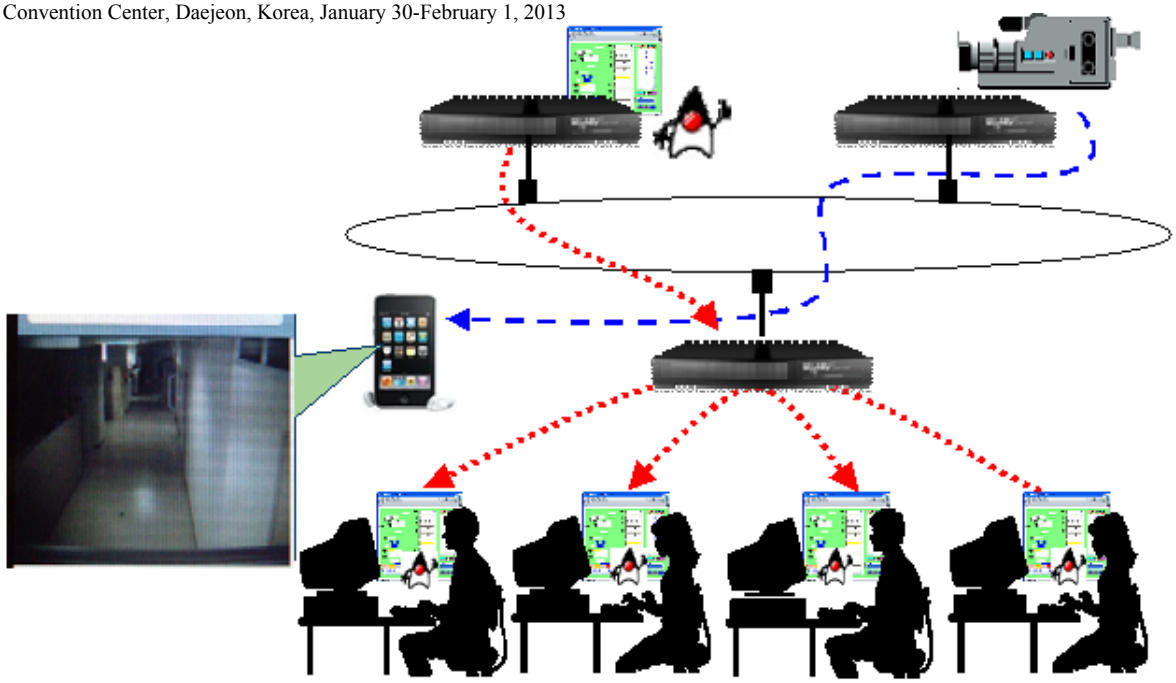

Fig. 4 Overview of Distributed Multiple Server System with *VisuSim* for Distance Learning Environment

3.2 Distributed Multiple Server System for Distance Learning Environment

Figure 4 shows an overview of system configuration for a distributed multiple server system. The system has been implemented in a distributed campus network environment. And each sub-system includes rack-mounted server, UPS and some kinds of clients, such as usual PC, PDA/mobile phone and multimedia input/output devices. Sub-systems are linked and interconnected with campus network by means of Giga high speed and/or Wi-Fi wireless LAN.

Each information server also employs multi-core CPU architecture and virtualized server technology, namely Virtual Machine Scheme, provided by Citrix Xen Server Virtualization[1]. With such a powerful technology, the same system configuration can support stationary normal routines as well as emergent special routines without extra scheme nor irreglar provision.

Key idea for distributed multiple sever system is to utilize the above "Virtual Machine Scheme" in order to construct not only Distance Learning environment with *VisuSim* as one of stationary routines but also Web-based surveillance functions with Emergency Contact as one of other routines. Merits of the system shown in Figure 4 are as follows;

- The system has been utilized for daily business routine of Distance Learning environment. With *VisuSim* , Assembly Programming exercises can be carried out through "Computer Architecture" education as one of Distance Learning practices.
- The system can provide Web-based surveillance service and could be useful with Emergency Contact in the case of extraordinary condition like fire, earthquake, and so on.

For the sake of suitable evaluation about our distributed multiple server system, we would like to take an opportunity to employ Kansei Engineering approach and perform trial evaluation in some classrooms of distributed campus. And the relevant results are demonstrated in the next section.

[1]http://www.xen.org/

4. EVALUATION WITH KAISEI ENGINEERING

4.1 Qualitative Evaluation of Simulator on Cloud

There are some comments and recommendation described in Essays from the students, who learned "Computer Architecture" education. They includes relatively subjective expressions, but, at the same time, they can be also qualitative evaluation about *VisuSim* and the relevant distributed multiple server system from the students who were real users of them. Some of positive comments are as follows:

- It is easy to verify and point out mistakes through step-by-step excution and display the result by *VisuSim* .
- I can check change for contents of registers and memory provided by *VisuSim* .
- As I use sample programs through *VisuSim* , it is good enough for me to write new similar ones.

At the same time, some of negative comments are as follows:

- It is difficult for me to operate *VisuSim* , so I must help my friends teach me to operate it. Finally I do write my essay only just until deadline.
- When I modify my program, I have found mistake at the point where program jump from another routine. So I must adjust and shift the according routine.

These are not convenient so that it will be necessary to be improved. These comments must be considered to be precious recommendations for improvement of *VisuSim* and teaching methods. We should have a plan to modify our visual simulator from these feedbacks.

4.2 Using Condition under Distance Learning

It has been introduced in the previous papers that *VisuSim* is applied to Distance Learning. And it is also reported that using effect of *VisuSim* has been evaluated quantitatively through statistics analysis. In our case, it is confirmed that effectiveness of *VisuSim* is well evaluated in a domain for small users' space only.

Our assertion can be expansible to the following assumption; If some e-Learning tools have original communication facilities and/or information sharing ones, they can provide some kind of effect for Distance Learning under using condition of small member's space.

Based on our experience, we will introduce and discuss a category of member's size for Distance Learning. The category seems to be three scale of member's size, namely, a small scale for no more than 10 members, a medium one for no more than 30 members, and finally a large one for more than 30 members.

Table1 gives a category for Distance Learning environment. Methods for achievement are e-mail as uni-cast communication and bulletin board as broadcast one in Table1. These services are easily available in our distributed multiple server system for Distance Learning environment.

Table 1 Effect of Usage for Distance Learning Environment by means of Communication Facilities

	Unicast	Broadcast
small scale	Confirmation of Effect	Not Confirmed (But expectable)
medium scale	It is necessary to be confirmed	Same as in the left
large scale	Only unicast method would be difficult from our experience	It is considered to be useful

4.3 Evaluation based on Comments with Kansei Engineering approach

In the above case, multi-cast communication includes broadcasting one so that we will denote explicitly "multi-(broad)cast" in the later explanation. In uni-cast communication, e-mail needs knowledge about the participants in a small scale of cooperative education environment. There is a trend that a user who want to ask his/her question do communicate to others who seems to reply such a question. Probability and expectation are very important in order to achieve communication for information sharing in Distance Learning environment. Some comments in student's essay may include useful information and knowledge[3].

These comments has been analyzed and categorized in the six criteria, namely, "operate easily", "communicate efficiently", "response quickly", "virtualize smoothly", "reproduct(= repeat) flexibly" and "understand effectively". Evaluation has been performed in some classrooms of distributed campus through their students' essay. And analyzed results are averaged and expressed in Radar Chart shown in Figure5. Especially, it is confirmed that Communicabiliy, Virtuality, Reproductability and Understanding are good for students through real experience.

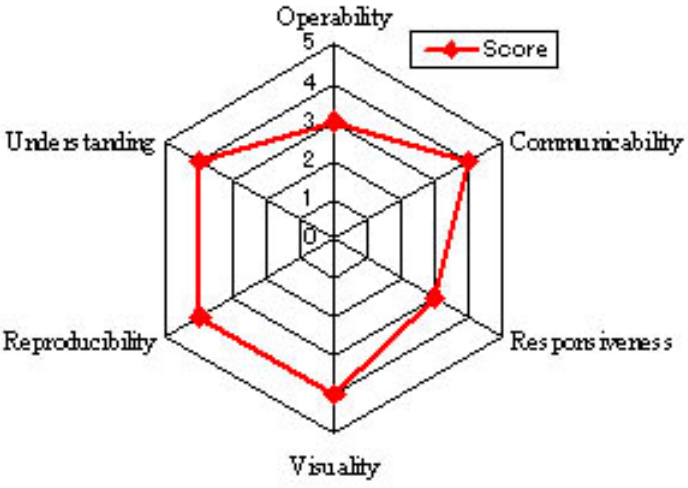

Fig. 5 Radar Chart of Evaluation for System by Kansei Engineering Approach.

5. CONCLUSION

This paper reports summaries of Distance Learning tool for Computer Architecture (visual computer simulator *VisuSim*), construction of distributed multiple server system with virtualized CPUs by server virtualization, and some evaluation for such server system from the aspect of users by means of Kansei Engineering approach.

It is concluded as follows;

- *VisuSim* is effective for students to learn "Computer Architecture" through a practical education.
- Distributed multiple sever system with "Virtual Machine Scheme" can construct Distance Learning environment with *VisuSim* as one of stationary routines as well as Web-based surveillance functions with Emergency Contact as one of other routines.
- Some kinds of evaluations have been performed through qualitative analysis and Kansei Engineering approach.

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