Proposal for a Lesson Support System using Computer Virtualization Technology

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***Abstract*—To understand how software operates, it is necessary to repeat an operation many times with the software. However, carrying out a repeat operation that involves settings is not easy. In this study, we use a snapshot of VirtualBox to restore a personal computers (PC) to any previous settings state. As a result, we developed a system that allows students to continue exercises by restoring their PC to an earlier state or by copying the state of an instructor PC.**

Keywords-computer virtualization technology; compute-assisted instruction.

I. INTRODUCTION

Recently, classes in which students use PC or tablet devices have become more commonplace [1]. Students are more accustomed to typing rather than performing operations using software [2]. It is important that students be able to repeat an operation several times in order to master the use of the software. However, students are often only required to imitate an instructor's operation in actual classes. In this study, we propose a system whereby students can repeat operations during a lecture.

In this paper, Section II introduces the problems students face when acquiring a new skill, Section III describes our proposal, Section Ⅳ explains the developed system, Section V evaluates of our system and presents a review by instructors and Section VI summarizes our work.

II. PROBLEMS

Instructors project their desktop display onto a screen which is used to demonstrate how to use the software, and show students how to perform the operations. Students need to perform an operation repeatedly in order to master the use of the software. However, students must restore settings by themselves when performing a specific operation.

For example, we use “Data Analysis Tools” when performing statistical processing with Excel [3]. When we want to add “Data Analysis Tools” to the ribbon, we need to check “File”> “Options”> “Add-ins”, “Manage:”, “Excel Add-ins”, “Go…”, “Analysis ToolPak”. If the instructor makes the students repeat the operation, the students must restore the ribbon to its original state when “Data Analysis Tools” was not added. Otherwise, any changes in add-ons

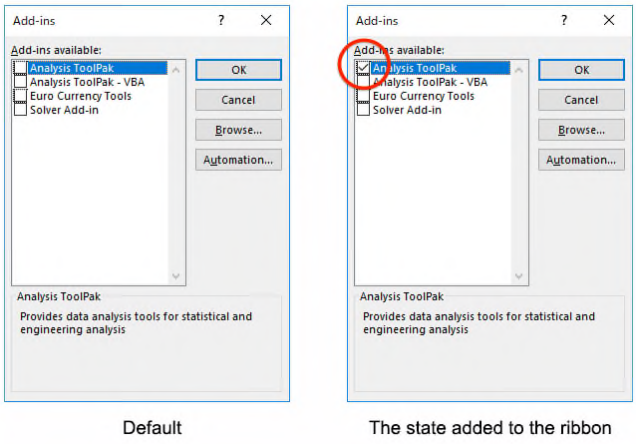

Figure 1. Dialog windows for add-ins settings.

are kept when repeating exercises (Figure 1). Some actions, such as the "Empty Recycle Bin" operation cannot be undone, and if the registry is rewritten by installing an application, it cannot be restored.

Students who are not skilled at performing operations with software need to practice the same operation many times. Therefore, even after some students have finished practicing an operation, others may take more time. Even in cases where all students have not finished practicing, the instructor may have to move on to the next exercise and end the practice session. As a result, the next explanation about how to use the software may not be understood by all students, forcing the instructor to delay future sessions until all students have finished their work in the previous session.

III. PURPOSE

The purpose of this research is to setup each student's PC to easily perform repeat operations. Specifically, when the students are instructed to repeat an operation, the new system would restore the student's PC to its original state. Or, when the instructor explains the contents of the next lecture to the students, the system prepares the student's PC by loading a state where it can perform the next operation. We propose the introduction of virtualization technology to realize this system. The snapshot function of virtualization technology can preserve the state of a PC. Students can perform

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operations from a preserved state by restoration, even after performing different operations.

For example, snapshots S1, S2 are taken before and after performing an operation in Excel (Figure 2). When snapshot S1 is restored, the PC can return to a state prior to activation of Excel, thereby allowing the student to repeat the same operation. Even if the desired operation has not been completed on Excel, the PC can revert to the state after the Excel operation was performed by restoring snapshot S2.

Students can use snapshots on Guest PC. Guest PC is a software function that emulates the working environment of one PC on a Host PC (Figure 3). Students can use the Guest PC without having to actively think about the Host PC when using the Guest PC with full screen. However, restoration of a state in the Guest PC can only be controlled by the Host PC. Therefore, the student not only operates the Guest PC, but also operates the Host PC to perform further operations during lessons and exercises (Figure 4). Additionally, if the snapshot was not properly taken, the state of the Guest PC cannot be restored.

The purpose of this study is to facilitate the restoration of a snapshot with 1 click on the Guest PC without the Host PC control of the Host PC. Furthermore, restoration of a state on a student's Guest PC based on a snapshot operation demonstrated by the instructor will be examined.

IV. DEVELOPED SYSTEM

The system developed in the study is shown in Figure 5. This system is constructed from five modules. We used VirtualBox [4] provided by Oracle as virtualization technology software. Modules were designed for this study using Java. A snapshot for the model operation to be performed by students during lectures was prepared by the instructor before the lecture.

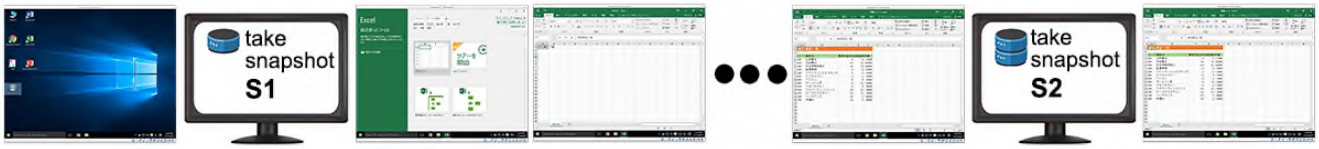

Figure 2. Example of taking a snapshot at different times.

Figure 3. Virtualization PC on Real PC.

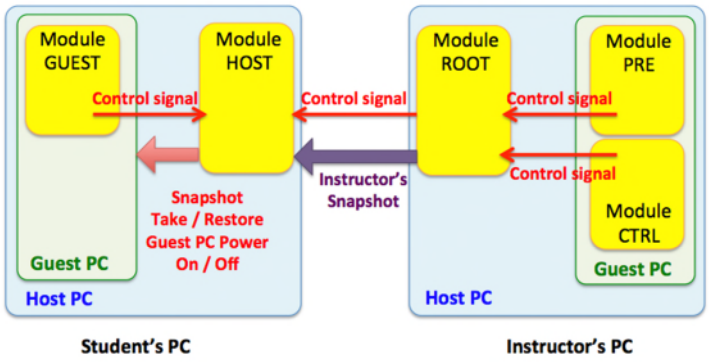

Figure 5. System structure.

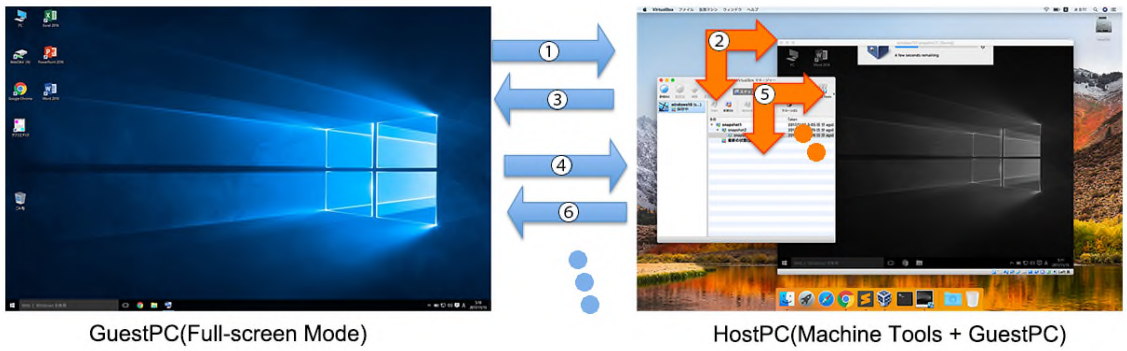

Figure 4. Traditional practice.

A. Student PC

Module HOST performs an operation on the student PC's Host PC, and Module GUEST performs an operation on the student PC's Guest PC.

Module HOST imports snapshots by lecturers onto student PCs. Then, Module HOST displays the Guest PC screen in full screen mode. Depending on the control signal of Module GUEST, a snapshot is either saved / restored for the student or the instructor's snapshot is restored on the Guest PC. These processes correspond to Table I when they are performed by existing functions of VirtualBox.

Figure 6 (A) shows the operation screen of Module GUEST, and the sending of a control signal from Module GUEST to Module HOST. The 'Import' button sends a signal to restore the Guest PC based on a snapshot from the instructor and the load button sends a signal to restore the Guest PC based on the snapshot of the student. The 'Save as' button sends a signal to take a snapshot of the state of the PC at that time. After progressing to the next session, the saved snapshot becomes restoration point information available by the 'Load' button.

Thus, students can use the Guest PC without having to actively think about the Host PC. They can perform the repeat operation or synchronize to the lesson with only one click of Module GUEST.

B. Instructor PC

Module ROOT operates on the Host PC for the instructor PC; Module PRE and Module CTRL operate on the Guest PC for the instructor PC.

Module ROOT has three functions. First, it performs the function of preserving snapshots of the instructor based on the control signal from Module PRE. Second, the function of transmitting the control signal that determines which snapshot is to be restored by Module HOST on the student PC is performed by Module CTRL Third, the transfer of the snapshot from the instructor PC to the Host PC of the student PC is performed with cooperation from Module HOST.

Figure 6 (B) shows the operation screen of Module CTRL, and the restore points from all snapshots are displayed as a list. The snapshot of the selected thumbnail image becomes the restoration information of the 'Import' button of Module HOST.

TABLE I. TRADISIONAL SNAPSHOT OPERATION

Take snapshot process
(1) Click "Machine" (2) Click "Take Snapshot…" (3) Insert Snapshot name (4) Click "OK"
Snapshot restore process
<< Guest OS Power off >> (1) Click "File" (2) Click "Close" (3) Click "Power off the machine" (4) Click "OK" << Snapshot restore >> (5) Select target snapshot (6) Click "Restore" (7) Click off "Create a snapshot of the current machine state" (8) Click "Restore" << Guest OS restart >> (9) Click "Start"

V. EVALUATION

We verified the effectiveness of the developed system. For the purposes of verification, we researched possible factors that could affect the actual operation, such as disk capacity and transfer time, and asked several instructors to review our research.

A. Performance

The snapshot stores all the information needed to restore the state of the computer. The information includes not only operations by the user, but also background operations run by the operating system. The larger the size of the snapshot, the more time it takes to save and restore a state. Tables II and III show the size, the saving time, and the restoring time of a snapshot.

Figure 7 and Figure 8 show the contents of Word [5] and Excel exercises, and the operations described are included in the Microsoft Office Specialist Study Guide [6][7]. From these results, we confirmed that snapshots can be saved and restored in as long as 10 seconds.

Although it depends on the work content, when performing the exercise during basic experimental class without using our system, it was necessary for the instructor to wait about 15 minutes for the students to re-do an exercise. The instructor was able to restore the previous state even in one minute by using our system.

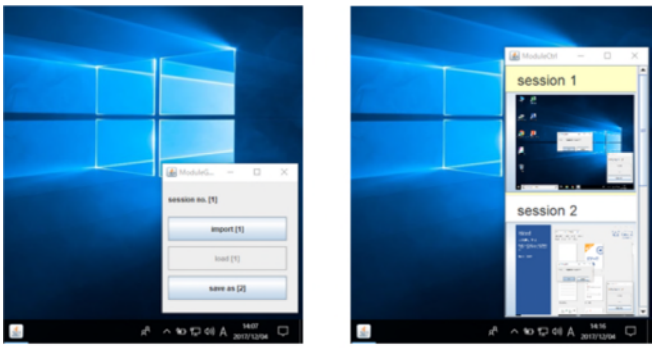

Figure 6. Module window figure caption: (A) Module GUEST (B) Module CTRL

TABLE II. SPEC OF PC THAT WAS USED

	Windows10 Pro (Lenovo Yoga2 Pro)		Mac OS Sierra (MacBook Pro 2012)	
	Real	Virtual	Real	Virtual
CPU	i7 (1.8GHz)	2CPU	i7 (2.3GHz)	2CPU
Memory	8GB	3GB	8GB	4GB
Storage	256GB	80GB	251GB	120GB
Used Space	–	24.8GB	–	29.8GB

TABLE III. SNAPSHOT SIZE AND RESTORE TIME

	Windows		Mac	
	Restore time	Snapshot size	Restore time	Snapshot size
Word	20sec	168MB	18sec	140MB
Excel	20sec	204MB	18sec	180MB
Idle	–	45MB	–	71MB

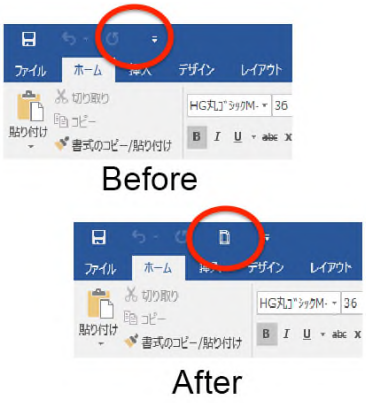

Figure 7. Before and after exercise of Word

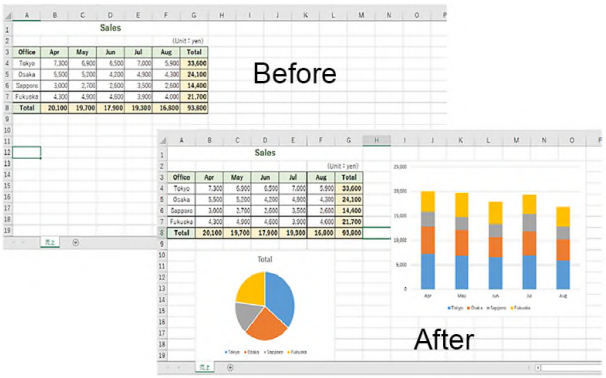

Figure 8. Before and after exercize of Excel

B. Review

Here are some of the comments from instructors:

1) Mr. Murayama (Information Technology):

- I think that it can be used at the time of class that students need to accumulate basic knowledge to advance to the next session.
- I would like to use it for debugging and verification of the system.

2) Mr. Fujino (Computer science):

- This tool will bring a lot of benefit to my computer science courses, such as operating systems and databases.
- Considering the situation of exercise, it will very convenient for students when they make mistakes in exercises if they can reset the states of the computer.

We got a favorable impression from instructors.

VI. CONCLUSION

In a conventional computer class environment, it is difficult for students to learn how to repeat an operation demonstrated by an instructor as the instructor has time constraints and must wait for each student to complete the operation.

In this paper, we introduce the possibility of a new classroom approach by using computer virtualization technology, and thereby demonstrated the performance of this system.

In the future, we are planning to confirm the system's effectiveness by using it in other instructional classes.

ACKNOWLEDGMENT

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