

Software System for Automatic Creation of Operation Manuals for Real-Time Use by Students During Lectures

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Abstract – Recently, classes in which students use their own Personal Computers (PCs) to follow lecture instructions are becoming increasingly commonplace. However, in situations where students are unable to fully understand a portion of an ongoing lecture or have missed portions of the instructor's explanation due to late arrival, it is unlikely that they will be able to catch up with and track ongoing explanations and/or perform operations in tandem with the instructor. However, it is also burdensome for the instructors that have prepared such classroom materials to alter their lessons to accommodate students who are late or having difficulties. Accordingly, we developed a system that automatically creates operation manuals for real-time use by students during lectures and confirmed that students who were late for classes in which it was used could recover from such delays on their own.

Keywords - *Operation manual; Automatic creation; Computer-assisted instructions; Global hook*

I. MOTIVATION

Recently, classes in which students use their own Personal Computers (PCs) to learn how to use applications, such as Microsoft Word or Excel, or to practice programming techniques, have become increasingly commonplace. In such classes, the instructor projects their desktop display onto a screen that is used to demonstrate how the software is used and to show students how to perform operations.

Normally, the screen changes that result from the instructor's actions are explained just before a new window appears, and the instructor typically clarifies what s/he intends to do by highlighting the operation target with the mouse cursor. However, not all students are always able to hear and understand the instructor's explanations and students who lose track of an operation in progress will be unable to perform that operation independently.

In an earlier study, Bando et al. developed a system that uses two screens, one displaying the state before an operation and the other displaying the expected result [1]. This system allows students to recognize the before and after conditions for an operation at a glance. However, the problem with this system is that explanations regarding the corresponding

operation are limited, and the system only displays the most current operations. Hence, students whose understanding of the operations is incomplete will be unable to follow the entire demonstration. Additionally, students will be unable to review the operation after the lecture.

In another study, Itamiya et al. developed a lecture recording system that can superimpose blackboard-writing and images from the lecturer's PC screen on the student's device in real time using a video camera [2]. However, since the required operations are performed during the lesson while explanations are provided, long intervals tend to occur between operations and the efforts required to confirm student comprehension levels may be inappropriate during lectures.

Furthermore, students who are late to attending the instructor's demonstration need the ability to rapidly configure their devices to the same state as the lecturer's PC, which means that they have to compensate for the lack of instructions regarding the operations they missed. To address such issues, the creation of an instruction manual would be very desirable. The use of manual creation software [3][4], makes it possible for instructors to reduce the labor involved when creating lecture materials to a certain extent, but it remains very time consuming to create such detailed manuals.

In this paper, we discuss the process of creating lecture materials without requiring additional labor in Section II. Section III explains our newly developed system, and Section IV summarizes our work.

II. CONCEPT

The ultimate goal of our research is to enable all students to operate their PCs in tandem with their instructor's operations and provide a way for students who do not fully understand previous operations, or who have arrived at the lecture late, to compensate for their incomplete knowledge. However, as noted above, it is usually very time consuming for instructors to create such detailed manuals.

The purpose of this research is to provide a system that creates an operation manual of an ongoing lecture for student use without requiring any special work on the part of the lecturer. To accomplish this, it is necessary to provide a method by which they can quickly grasp the operation target and perform any required operations they have missed or do not understand. However, since this must be done while the

lecture is in progress, students must first complete those missed operations and advance their screens to match the instructor's PC in the shortest period of time possible.

Our newly developed system creates a screenshot of the instructor's PC at each operation change, that students can watch as a slideshow. More specifically, first the system creates a screenshot of the instructor's PC window just before an operation. Second, based on the operation of the active window, it extracts the operation target. Third, the system highlights the targeted operation on the captured image and inserts a text explanation of how the operation is performed (such as via a left mouse click). Finally, the edited image capture is sent to a Web server.

Since each of these tasks is performed in real-time every time the instructor performs an operation, students who are late or unable to attend the lecture, or who need help understanding the processes involved, can review the entire process on the Web server.

III. DEVELOPED SYSTEM

The system developed in this study consists of an operation log storage module on the instructor's PC and an operation log publish module on the Web server. In the subsections below, we will explain these modules, the results used in the class, and then discuss the system.

A. Storage Module

This module runs on the Windows 10 Operating System (OS). During operation, the instructor's application constantly exchanges messages with the OS regarding keyboard and mouse input operations. Our system monitors these messages using Global Hook technology and extracts all WM_LBUTTONDOWN messages (left mouse button clicks), WM_RBUTTONDOWN messages (right mouse button clicks), WM_KEYDOWN messages (press any key operations), and WM_MENUSELECT messages for the active window. As a result, all of the required information is extracted without the need for any special operations other than the instructor's demonstration.

Figures 1(a) to 1(f) show the captured screen images created by this module when using Windows Notepad while our system is active. Figures 1(a) and 1(f) were created by analyzing the form of the WM_LBUTTONDOWN message, Figures 1(b) and 1(e) were created by analyzing the form of the WM_KEYDOWN messages, and Figures 1(c) and 1(d) were created by analyzing the form of the WM_MENUSELECT messages.

In these images, the target window or object is highlighted, and the click position is displayed by the cursor image if the operation is a mouse action.

B. Publish Module

This module runs on a Web server. On the top page, all the images sent from the storage module are displayed as thumbnails. To switch to the slideshow mode, the user simply clicks on one of the thumbnails. In the slideshow mode, there are backward and forward link buttons that permit users to navigate between images. In the highlighted part of the operation target, users can immediately identify

the changed parts. The cursor image and the operation annotations allow the user to identify the targeted operations.

C. Result

We conducted an experiment at a lecture to develop an Android application using the Eclipse development environment. In this lesson, the operations performed by a student to create a project (primarily mouse clicks), the operations used to create an Android Window (primarily click and drag) and the programming instructions (primarily keyboard input) were extracted for use.

Using our system, six students who were late for the lecture reviewed the missed portions of the lesson and attempted to catch up with the instructor's ongoing explanation. All of these students completed these missed operations, and were able to operate their PCs in tandem with their instructor's operations.

D. Discussion

When the pace of the instructor's explanation increases, the number of students who will be unable to follow the operations also increases. In this class, the instructor paced the lecture while periodically checking to ensure that all the students completed the operations in tandem with the presentation. To confirm the operations of students, we recorded the operation process. Checking the operations performed by students after the lecture, we found that a few students could not smoothly perform the drag operations. More specifically, even though the students observed the screen captures and identified the target object, they could not identify the drag destination from the screen capture, and had to click the forward link displayed by the Web browser to obtain that information.

However, once they became familiar with the system, the students realized they could quickly click forward to the next image to determine the drag destination, and then click back to the image displaying the mouse drag operation itself.

Next, we will discuss the times taken for the operation. In the lecture, since explanations are given as the operations are performed, the process takes longer than simply performing the actual operations. However, since there is no waiting time for students who perform operations while observing the operation manual created by the system, there were situations where some students finished the required operations more quickly than the students that simply listened to the lecture.

IV. CONCLUSION

In this paper, we report on a newly developed system that automatically creates an operation manual based on instructor PC operations that students can watch in real time during lectures, and which can be quickly reviewed by late arriving students. Using our system, the students who were late for the lecture reviewed the missed portions of the lesson and attempted to catch up with the instructor's ongoing explanation. All students successfully completed these missed operations, and were able to operate their PCs in tandem with their instructor's operations.

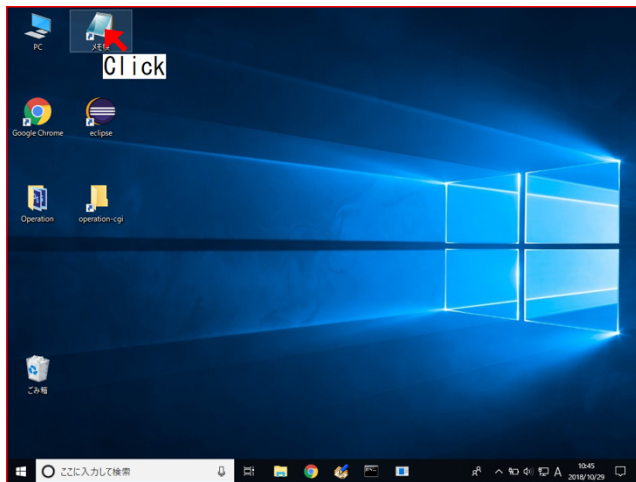
However, since the experiment described in this paper involved only a limited number of subjects and student participants, it will be necessary to apply the system to additional classes with larger numbers of participating students in future studies in order to more fully confirm its effectiveness.

ACKNOWLEDGMENT

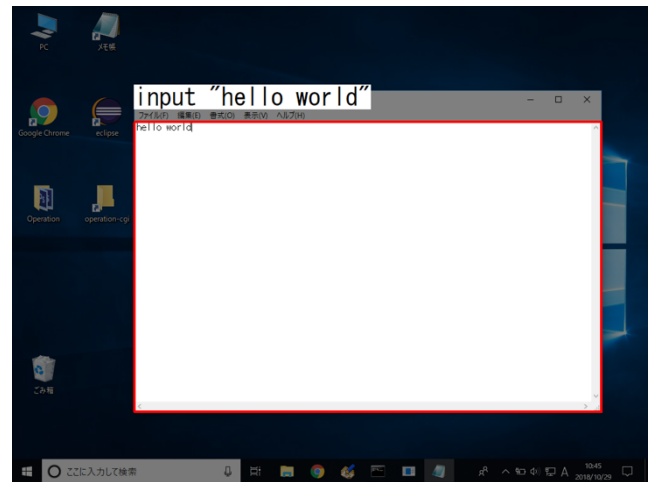
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REFERENCES

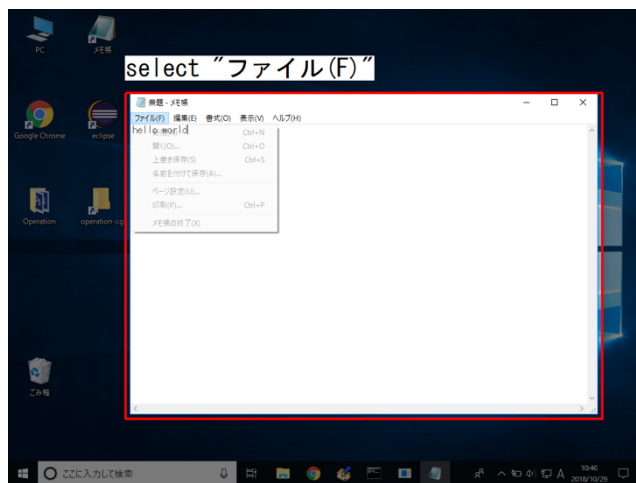
- [1] H. Bando, Y. Otsuki, and S. Sawada, "Prototyping of an educational supporting tool to ease instruction of software operation; automatic display of operation process and result," IPSJ SIG Technical Report, pp.1-8, 2003.
- [2] T. Itamiya, K. Tagawa, and H. Chiyokura, "Development of the Lecture recording system for Superimposing a Blackboard Writing and Lecturer's image on the Lecturer's PC Screen," Japan Society for Educational Technology, pp.119-128, 2011.
- [3] "Click! Recorder," 2014, [Online] Available from: <http://www.gluesoft.co.jp/en/ClickRec2> [accessed December 2018]
- [4] "iTutor," 2018, [Online] Available from: <https://itutor.jp/> [accessed December 2018]



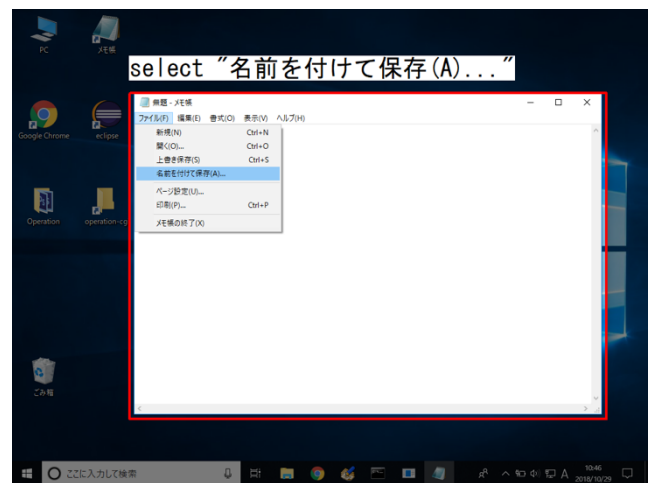
(a)



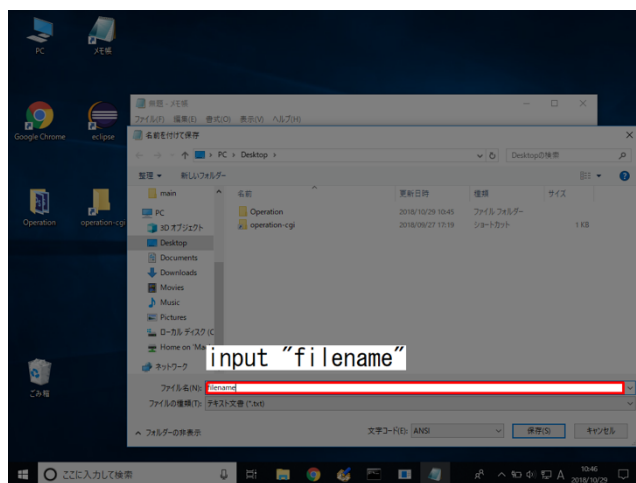
(b)



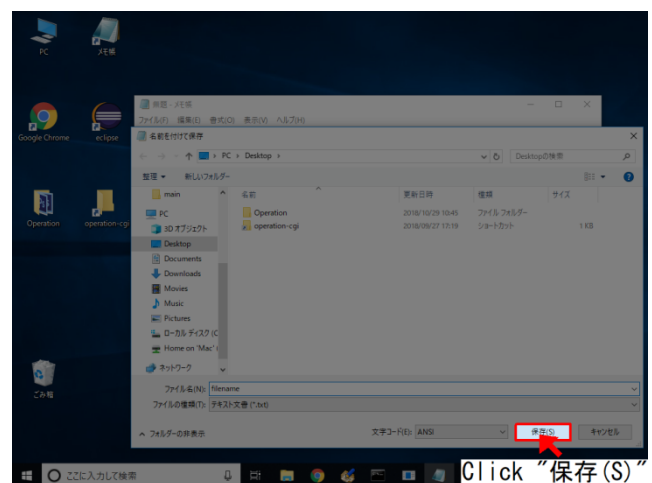
(c)



(d)



(e)



(f)

Figure 1. Sample images created by our system based on instructor operation.