A Tabletop Lecture Recording System based on Gesture Control

Yong-Quan CHEN, Chiung-Fang CHANG and Po-Chyi SU, *Member, IEEE*

***Abstract*—This research presents a lecture recording system that employs gestures and digital cameras to facilitate remote-distance teaching. The lecturer can teach in front of a desk or table, on which a Pan-Tilt-Zoom (PTZ) camera and a depth camera, i.e., Kinect, are installed. The lecturer can control the PTZ camera to record the teaching process by the gestures, which are designed as simple as possible so that the lecturer can focus more on explaining the course content, instead of the recording operations. The lecturer can write the notes easily on a paper or show the physical course material to enrich the lecture content. Digital slides can also be adopted when necessary to benefit the learning experience of students. Besides, the proposed system can help to reduce the effort/time for possible post video production.**

I. INTRODUCTION

The rapid progresses of digital technologies and networking facilities revolutionize our daily life, including education. Teachers and lecturers nowadays can make use of various advanced tools to help students understand the course material more efficiently. Some students may choose to take an off-site course or distance learning at their homes or local areas to overcome barriers of time or space. They may watch the video recorded in advance or via teleconferencing. With the course content being digitalized, many educational methodologies become possible and can benefit both lecturers and students.

Traditional ways of teaching require that students attend a classroom and lecturers present at the same time/location using the blackboard or digital slides. The major advantage is to link the lecturers and students in a closer manner, which may not be achieved by other teaching styles or advanced approaches. The lack of flexibility draws most of criticisms. Besides the time and space constraints, teaching by writing on the blackboard makes the course materials less reusable especially when these data are not digitalized. It is also questioned often that the lecturers may block the view of students when writing on the blackboard. Teaching with digital slides is one common approach. However, if there is less support from appropriate facilities, students usually complain the faster pace of teaching when only slides are shown. Using tablets certainly helps in a certain degree but may increase costs and be less convenient.

Many researchers seek to improve traditional education by video recording of lectures. If less expensive methods that do not require setting up an advanced recording environment or hiring professionals are preferred, automatic lecture recording is one research direction. One or multiple cameras, especially Pan-Tilt-Zoom (PTZ) cameras, are employed to track and record the lecturer in a classroom [1]-[4], along with the course material shown in the class. Including the scenes of lecturers in the course video is proven to be an effective way of increasing the learning interests from students at remote sites. Such devices as Kinect, which provides the depth information, may also be used to extract more reliable scenes of interest to improve the recording by PTZ cameras [5]-[8]. Although these schemes can be applied in classrooms and track the lecturers reasonably well, many existing issues in traditional teaching still have to be addressed. Besides, PTZ cameras may be easily affected by accidental events or persons so practical systems for automatic video recording usually require that the lecturers wear something for visual tracking or signal sensing, which limits the convenience of such methods.

This research presents a table-top lecture recording system, which allows the lecturer to sit in front of a desk or table to teach the students at remote sites or for the lecture recording. Fig. 1 shows the primitive setting with a PTZ camera (a red square), Kinect (a yellow square) installed above the table, and a monitor (a green square) for the lecturer to check the recorded scene. The bottom-right of Fig. 1 shows the view of the PTZ camera when it is operated toward the table. There are a few advantages of such a design. (1) Since the lecturer's writing plays an important role in teaching, writing on a table with a pen is certainly more convenient than on a blackboard with a chalk. (2) The scheme is not limited to the usage in a classroom. We can imagine that a tutor teaches the students via video conferencing. (3) Kinect helps to reliably detect some gestures for the lecturer to operate the video recording more easily. (4) The lecturer can teach by writing on papers or by digital slides, and even show physical course materials to the students. (5) The scheme is easy to set up and less expensive. Some design details are described as follows.

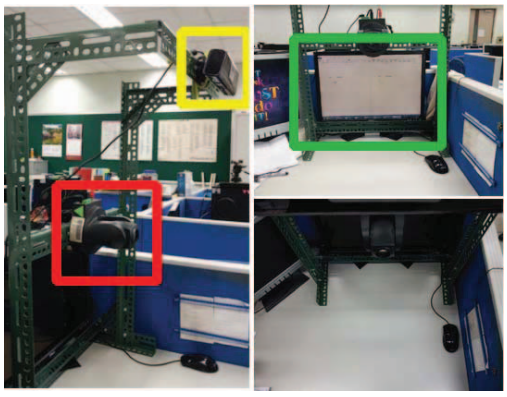

Fig. 1. The setting of the proposed table-top lecture recording system.

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II. IMPLEMENTATION

A. Gestures

The lecturer can operate the PTZ camera using gestures, which are detected via Kinect. Table I shows the list of gestures and the corresponding operations. The lecturer can use single/both hands, with spread, point and L shape to control the PTZ camera for capturing the lecturer's face, zooming-in a portion of papers on the table or returning to its original setting (zoom-out). We employ the 3Gear System API for Kinect [9] to determine the gestures more reliably. Tilting-up the camera to capture the lecturer's face is mainly adopted when the lecturer does not write the note or when the digital slides are used. The gestures are intuitive so that the lecturer can focus more on teaching. The initial setting is required to make the PTZ camera capture the scene of interest accurately.

TABLE I
GESTURES FOR OPERATING THE PTZ CAMERA

PTZ operation	Tilt-Up	Tilt-Down	Zoom-In	Zoom-Out	Camera movement
Hand(s)	Single	Single	Both	Both	Both
Hand Style	Spread	Spread	Point	Spread	L
Direction	Up	Down	Still	Out	Still
Touch	No	No	Yes	No	Yes
Target	Face	Table	Close-up	Return	Position

B. Modes of Teaching

The proposed scheme has two teaching modes. The first mode is to use the desk or table to simulate the blackboard, which is beneficial in teaching the lectures related to mathematics or theoretical derivations. The slide can also be used if the lecturer can print the hardcopy beforehand. The second mode is to use digital slides, e.g., a Microsoft Power-point file. The proposed system enables the lecturer to write on a paper, from which the handwritten scripts are extracted and super-imposed on the video frame showing the slide. The pen-point is detected by Kinect and an assisting red point will be shown on the monitor in front of the lecturer to ensure that the writing can be placed at the correct position. The basic idea is similar to transforming the table-top into a tablet to avoid including various digital devices when teaching a lecture.

III. DEMONSTRATION

Two examples are shown to demonstrate the proposed scheme. Fig. 2 shows that the lecturer is explaining a mathematical problem by writing the derivation and then applying the gesture to send the zoom-in command controlling the PTZ camera for displaying a figure in the textbook. Fig. 3 illustrates the combination of teaching by handwriting and digital slides. When the lecturer stops writing and wants to show his/her face on the screen viewed by the students, the camera can be operated to capture the face by the gesture and demonstrate it at the bottom right corner of the slide.

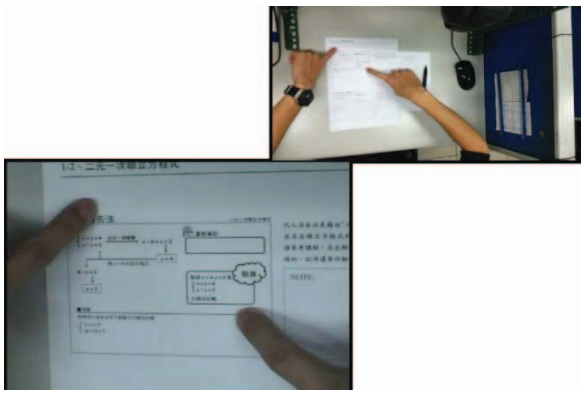

Fig. 2. The lecturer writes on a paper for explaining a math problem and then applies zoom-in to show a figure in details.

Fig. 3. The lecturer writes on a paper for explaining the binary tree and the handwriting is extracted and shown on the slide.

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