Interactive Lecturing Using Laser Pointers

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Extended Abstract

Introduction

One of the main criticisms of lecture-based learning is the lack of student engagement (Biggs, 1996; Butler, 1992). However, it is widely used because it can accommodate a large class size, has a high information delivery rate, and the lecturer has tighter control over the content and structure of lessons (Steinert & Snell, 1999).

Current strategies for encouraging active learning during lectures include questioning the students, having group discussions, and role playing (Steinert & Snell, 1999). Technology has also been employed in making lectures interactive. For example, interactive voting systems allow students to use clickers to respond to feedback polls or multiple-choice questions posed by instructors during the lecture (Van Dijk et al., 2001). It is now also possible for students to submit questions or feedback via SMS and Bluetooth which can be received immediately by the instructor (Doroja et al., 2011; Musthafa, 2013). One common and intended feature of these technologies is that students’ identities remain anonymous, which may encourage them to participate more actively (Roberts & Rajah-Kanagasabai, 2013).

The system proposed in this paper aims to facilitate interactive lectures by allowing students to make choices and answer questions using nothing more than a laser pointer that they can use to interact directly with the lecture slides. This reduces the need to distribute a clicker to every student before every lecture and also allows the student to stay focused on the lecture itself while interacting with the instructor anonymously.

Methodology

The system makes use of computer vision technology to detect the bright dots that the light from a laser pointer makes when it hits the projection screen on which the lecture slides are projected and displayed. The interactive regions on a slide are visually marked by square patterns known as fiducial markers. To allow the system to “see” the laser dots, a webcam is attached to the computer that is used to run the computer vision software in parallel with a slideshow presentation program, such as Microsoft PowerPoint or OpenOffice (Figure 1).
Interacting with a slide leads to four possible behaviours, namely (i) advancing a slide, (ii) going back a slide, (iii) going to a specific slide, or (iv) conducting a poll after which the presentation will go to a pre-defined slide depending on the polling result. An estimation of the relative popularity of the choices can be displayed on screen. Providing an exact count of the number of students who pick each choice, however, is not possible as the system uses the relative amount of laser pointer interactions with each choice to determine the relative popularity of choices.

A fiducial marker is a square pattern constituting a two-dimensional binary code which encodes a number. Unique fiducial markers are used to mark interactive regions on the slides for different purposes. For example, fiducial marker #1 can be used to go to a particular slide when the laser pointer interacts with it, while fiducial markers #2, #3, #4 and #5 can be used to poll the students on their answers to a particular question, with each marker representing a potential answer. It is possible to use square pictures as fiducial markers, but the reliability in their detection is much less predictable as it depends on the features of the picture as well as its similarity to other pictures that the system is trained to detect.

Prototype Implementation

A prototype of the proposed system has been implemented which includes a marker-generating tool to generate and define the purpose of the fiducial markers. Creating a presentation using the prototype system is fairly simple. First, the instructor authors the slides using any software, while using the marker-generating tool to generate and paste images of the fiducial markers onto the slides (Figure 2). Within the tool, the instructor also specifies the behavior triggered by each fiducial marker, e.g. whether to advance a slide or go to a particular slide number. The behaviours are then saved in a separate behaviours file.
Before starting a lecture, the instructor aligns the webcam to the projection screen, making sure its line of sight is roughly perpendicular to the screen to maximise the efficacy of the fiducial marker’s detection algorithm. The computer vision software is then activated and used to load the behaviours file, while the slideshow presentation program is also started up and used to load and display the slides. The computer vision software’s interface is minimised so that it runs in the background.

The system requires at least a two-megapixel webcam in order to resolve laser dots and the laser pointers need to be sufficiently intense for the dots to be detected. The lecture theatre must also have the right lighting conditions for the system to perform reliably. For instance, the lights in the lecture theatre have to be dimmed, especially near the projection screen, though the room itself cannot be too dark lest the webcam images get too “noisy” leading to the false detection of interactions. The limited range of lighting conditions in which the system performs reliably is one drawback of the system.

**Conclusion**

In this abstract, we describe a system which enables instructors to create interactive lecture slideshows using laser pointers. The system needs no added infrastructure other than a webcam, which are built into most laptops, and it is feasible for each student to have a laser pointer, which can be obtained cheaply. The pace and focus of the lecture can be maintained as normal because the laser medium provides instantaneous interaction without distracting students with additional devices. With creative slideshow design and the system’s user-friendly functions, the instructor can devise highly engaging presentations which go beyond multiple-choice questions and polls. For example, instructors can give students more freedom to choose their own direction in terms of how the presentation should proceed or they can even turn the lecture into a mass multiplayer gaming experience. As such, this system is a good way of incorporating active learning into lectures.
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References


