An Xbox Kinect Approach: Transforming Traditional Projector Screens Into Interactive Smartboards

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Abstract

Smartboards add numerous benefits to the classroom experience; however, they are with many shortcomings. Some of these shortcomings include cost, requirement of extra equipment and limitation of instructor participation. The proposed project intends to transform a traditional projected screen (on a whiteboard) into a smartboard in order to facilitate teaching and learning in the classroom. It intends to do this by using an Xbox Kinect, which is a highly advanced camera that detects human body movements and gestures. The Xbox Kinect will detect the human body movements and gestures, which will be mapped to different actions in certain applications (e.g., writing, highlighting, clicking) on the projector screen. The Kinect based whiteboard will be more affordable than smartboards, improve instructor participation with audience, and be able to function with no extra equipment such as electronic pens. Furthermore, the only means required to interact with the Kinect based whiteboard is the instructor himself/herself. The long term goal of the proposed project is to move one step closer towards helping humans interact easily with computers.

Keywords: Xbox Kinect, smartboards, whiteboards, gestures, body detection

Introduction

Smartboards changed whiteboards forever by transforming them into an interactive system. The computer screen can be projected on the smartboard display, allowing the user to control all computer applications by interacting with the smartboard (Gérard & Widener, 1999). The user could write, draw, open desktop applications, operate software, and even surf the web using the smartboard. If used appropriately, this updated system helps students learn better (Swan, Kratcoski, Schenker, & van't Hooft, 2010), and teachers teach better (Muhanna & Nejem, 2013). The benefits to students are improved motivation and attention (Singh & Mohammed, 2012), enhanced oral interactions (e.g., by enabling students solve problems on the board while other students provide instructions) and increased cognitive processes (e.g., as highlighting, color coding and organizing content on the board makes it easier for students to group, process and understand information) (Gérard & Widener, 1999). The teaching benefits include easy writing and highlighting, saving or sending lessons electronically, and sharing class lessons among other faculty members with ease (Starkings & Krause, 2007).

Although the smartboard may bring many benefits into the classroom experience, it also comes with a number of shortcomings. First, it is expensive (average price being approximately $2500 compared to $100 for a whiteboard). Along with the cost of the board, additional costs are added as extra software must be purchased for all the capabilities to work (Ridenour, 2010). Second, the smartboard comes with an electronic pen that is used to write, draw and click on applications. This is a problem because only one person at a time can use the pen (Preston & Mowbray, 2008), and also because no one will be able to use the board if the pen were to get lost. Lastly, if something has to be typed, the user has to walk back and forth from the keyboard, which may be located far away from the smartboard; this limits instructor participation with the audience.

While these shortcomings are the main reasons educational institutions are not investing in smartboards, they could be countered by using other technology. One way to counter the smartboard problem is by using a device called the Xbox Kinect (Figure 1), which is a motion sensing video game console that allows players to play video games by moving their body parts.

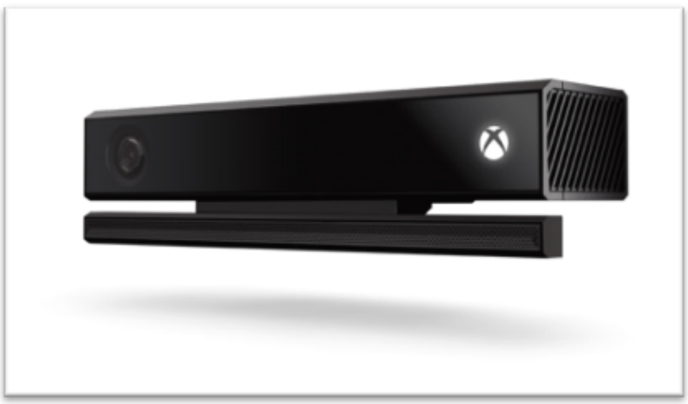

Figure 1. The Kinect 2.0 is a 9.8″ x 2.6″ x 2.63″ (length x width x height) electronic device that is a highly advanced camera that detects human body movements.

For example, the Kinect lets users play a tennis video game by swinging their hands like a tennis racquet. This is possible as the Xbox Kinect is a highly advanced camera with a depth sensor that perceives the user's body and the surrounding environment in three dimensions.

Research has shown that the Xbox Kinect can be used to control PowerPoint presentations (Osunkoya & Chern, 2013), make any projection on a hard surface touch-sensor enabled (Wilson, 2010), and help people with disabilities interact with computers (Hyuk & Hyun, 2013). This is accomplished by allowing users to utilize simple hand gestures to perform a variety of tasks once the device is connected to a computer via a USB interface. However, no one has yet created a whiteboard that is fully controlled by the human body; that is, without the use of electronic pens and the ability to control applications with human gestures. This provides us rationale to use the Xbox Kinect to transform the traditional classroom projector display into an interactive whiteboard, which will allow users to write with their fingers and control applications with their hands. If the proposed proposal is successful, the new system will help instructors connect and participate with audience members better and reap all the benefits of a smartboard without any electronic pens, and also by only using the human body and natural gestures. It will also be very affordable (approximately $99, which is the cost of a Kinect).

Method

Apparatus

The primary apparatus used will be the second version of an Xbox Kinect called Kinect 2.0 (Figure 1). Kinect 2.0 is the most suitable for my research as its sensor could track as many as 6 complete skeletons and 25 bone joins per person (Kinect hardware, 2016). This means that more than 2 people can use the Kinect based whiteboard at a time. Kinect 2.0 is also more efficient at depth data sensing, such as visualizing small objects clearly (e.g., fingers/fingertips), recognizing subtle facial features and detecting body movements (Kinect hardware, 2016).

Procedure

In addition to majoring in Computer Science, I am majoring in Psychology too. I hope to apply my psychology knowledge and research skills to examine the most natural gestures to use with the Kinect-based interactive whiteboard.

There are many existing Kinect-based applications that use gestures (Boulos et al, 2011; Gameiro, Cardoso & Rybarczyk, 2013); however, the proposed project will focus on which gestures work best when working with an interactive whiteboard, in a teaching environment. For example, what gestures should the user use to write, draw or click? Should waving the users hand or finger work? What if the user does not intend to draw, but simply intends to emphasize content on the board using their hands? What about if the user wanted to save or zoom-into a document? Answering these questions requires thorough and in-depth research and the careful selection of a set of gestures to carry out the intended tasks.

After selecting a tentative set of gestures, majority of the proposed study will be spent programming the Kinect to (1) enable the device to detect the set of gestures and (2) run certain applications or programs if those gestures are performed by the user. For example, the Kinect would allow the user to draw (application) on the projector screen only if both of their palms are closed (gesture) with one finger pointing outwards (Figure 2).

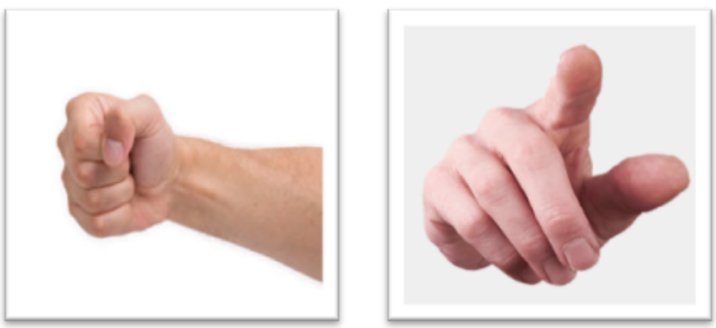

Figure 2. Assuming the user is right-handed: They would have to clinch their left fist and point towards the whiteboard, with their right hand, to draw.

The Kinect will detect the closed palms with the pointing figure and enable the user to draw accordingly; however, if both or one of the user's palms are opened, the Kinect will not allow drawing. This enables the user to explain or emphasize content on the screen without always drawing on it. This is just one example of how the interactive whiteboard will function. There will be other gestures (e.g., hand panning, waving) that execute certain tasks (e.g., saving, highlighting, changing color, selecting text) programmed into the device.

The official Kinect Software Development Kit (SDK) will be used to program the intended gesture detection and application execution. The SDK is a library of software development tools and is resealed by Microsoft (official manufacturer of Kinect) to help people build their own programs for the Kinect. According to Soltani, Eskandari, and Golestan (2012), the Microsoft SDK comes with in-built features such as skeletal tracking and depth data capturing to detect body movements. These features will be utilized in the proposed project. Applications for the Kinect SDK are programed using a programing language called C# (pronounced C-Sharp). Part of proposed project will be spent familiarizing myself with the Kinect SDK and C#. This includes learning to write code in C#, which, once executed, will recognize hand, finger, and body movements. C# will not be a novel programming language to me, as I will be working with it during the spring 2017 semester for my Psychology independent study with Dr. Elyssa Twedt, in which I will create simple games (using C#) to conduct psychological experiments in virtual reality.

As with any project, the proposed study is not without foreseeable limitations. The first barrier is that the chosen set of gestures are not optimum in executing the desired task. For example, although the gesture of holding up both arms with the user's thumbs touching each other (Figure 3) brings up the menu to change the current writing color, it may not be favored by many users.

Figure 3. The above hand gesture (left) could be used to bring up the menu (right) to select the current color of the pen. The needed color could be selected with a touch.

Although this is a hypothetical example, the underlying idea could be a concern in the proposed study. To overcome this limitation, I will ask my project mentor to engage in test runs and suggest different set of gestures, that he thinks would be suitable, for the Kinect based whiteboard. This may open the possibility of using many gestures to execute one task, where the user can choose which gestures to perform for a given task. A limitation that tags along with this is the fact that there could be too many desired gestures that seem suitable for one task. Therefore, do I program all of these desired gestures? If so, will the user have to learn and remember all the gestures? One solution to this is creating a standardized gesture sheet, and hanging a printed, laminated version in every classroom. This will help users easily refer and carry out the gestures as desired.

Another limitation is that the Kinect device will not be able to detect the gestures we wish to use. To counter this, I will have to select a set of gestures that are not very complicated. This will require an in-depth research of selecting easy to use, natural human gestures that will also have to satisfy the previous limitation, which is being user friendly. In addition to this, I will have to find gestures that previous research has found easy to detect using the Kinect.

The final limitation is time. The proposed project depends on gradual improvement and growth in certain skills and knowledge (e.g., learning C#, researching a set of preliminary gestures etc). If more time is spent acquiring these skills than predicted, the length of the project may expand; although, it is not expected to prolong, if from unseen circumstances it does, I plan to work on and expand the functionality of the proposed project as a Computer Science SYE in the Fall of 2017.

Conclusion

The end product of the proposed project will be an Xbox Kinect-based interactive whiteboard that has many functions of a traditional smartboard. It is intended to ease human-computer interaction and improve teaching and learning standards in the classroom. This is because the Kinect based whiteboard includes all the benefits of a regular smartboard. Furthermore, it is an environmentally-friendly approach to classroom instruction because no whiteboard markers with accompanying erasers, and electronic pens are required.

In terms of personal benefits, the proposed project will help me become a better researcher, programmer, and computer scientist; it will also widen my knowledge base of human-computer interaction and strengthen my fluency in the programming language C#. Because I hope to attend graduate school for Human Computer Interaction or Artificial Intelligence, the proposed project will significantly help me improve my chances of being admitted and perform better in my graduate studies.

I took a gap year to travel my home country, Sri Lanka, which exposed me to so much poverty and suffering that I had little knowledge about. Since then, it has been my long term goal to combine advance technology and education to provide an easy to use, accessible education system to poverty stricken children. Children who are unfortunate to have been born in poverty are extremely intelligent and eager to learn; however, they have no means of achieving this, as extremely rural areas, where they live, lack resources such as schools, water, health care and accommodation. This discourages teachers to live with and help these children. I am interested in creating a nexus between computer technology and people, and as a result improve the quality of life of underprivileged children and their education. The proposed project will be a minor step in helping me be an integral part in addressing worldwide issues, and following my passion to help, impact and empower people.

Appendix A: References and Figures

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Appendix B: Timeline

Week	Activity	# of Hours	Expected Outcome
1	• Research on what natural gestures humans prefer when instructing a classroom.	40/week	• Create a set of gestures in which each of them map to an application to run on the interactive whiteboard.
2	• Familiarization with the Kinect SDK. • Improve proficiency in C# by solving a series of practice problems and programming assignments.	40/week	• Ability to write code to run rudimentary applications for the Kinect. • High proficiency and knowledge about C#.
3	• Further study about Kinect SDK. • Writing code to make the Kinect detect subtle body movements; run small applications, if detection is successful.	40/week	• Ability to make the Kinect device detect body movements. • Complete understanding of the Kinect SDK compatibilities.
4, 5, 6	• Intensive coding week: Coding the Kinect device to detect the selected set of gestures in week 1, and run the applications mapped to those gestures.	40/week	• The Kinect device detects and runs applications when the gestures are performed.
7, 8	• Debugging week: Fixing flaws and incorporating ideas from my instructor from test runs.	40/week	• An interactive-whiteboard that is user-friendly (all gestures are efficient and easy to use).
9	• Fixing final flaws • Preparation of presentation	40/week	• Completed Kinect-Based Interactive Whiteboard

Appendix C: Level of Participation/Experience

Skills	Relevant Courses	Grades Received	Other Experience
Research Skills	(1) FYS (FRPG 2003) (2) Research Methods in Psychology (PSYC-205) (3) SYE (PSYC-498)	(1) 3.5 (2) 3.75 (3) Currently enrolled	Owen D. Young Library Student Worker
Programming Skills	(1) Intro to Computer Programming (CS-140) (2) Techniques of Computer Science (CS-219) (3) Computer Organization and Design (CS-220) (4) Data Structures (CS-256) (5) Programming Languages (CS-364) (6) Artificial Intelligence (CS-374) (7) SYE (PSYC-498)	(1) 4.0 (2) 3.75 (3) 3.5 (4) 4.0 (5) Currently enrolled (6) Currently enrolled (7) Currently enrolled	Computer Science Teaching Assistant Achieved 6th Place at the 2016 ACM Programming Contest at Clarkson University.
Familiarity with Computer Systems and Hardware	(1) Computer Organization and Design (CS-220)	(1) 3.5	Information Technology Technician at St. Lawrence University