Tangible Tube

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CHI 2012, May 5–10, 2012, Austin, TX, USA.
ACM xxx-x-xxxx-xxxx-x/xx/xx.

Abstract
Tangible Tube is a device that invites users to play in a completely unprecedented form of interactions. Instead of utilizing traditional devices such as keyboards, mouse, joysticks and wii remote controls that challenges users on how swift and composed their fingers' movements are, Tangible Tube challenges users to play games using a tube that they will control through breathing.

Keywords
Tangible User Interfaces, Interaction Design, Children, Entertainment, User Experience, User Interface Design, Usability Research

ACM Classification Keywords
H.5.m [**Information interfaces and presentation (e.g., HCI)**]: User Interfaces, user centered design.

General Terms
Design, Experimentation

Introduction
Video games have become one of the most popular entertainments for most children and teenager, even young adults. Consoles such as Nintendo and Sony PlayStation were considered as the pioneers that popularize video games in our society. However, most video games only

require the users to press the buttons in which the results will be displayed on the screen, built-in screen or TV. There is no other interface between the users and the system besides pressing the button in the handheld. On 2006, Nintendo released Wii, a console that uses a remote controller to detect users movement in 3-D. This console introduced a new and interactive way of playing video games because it involves user to be physically moving the remote instead of only pressing the buttons.

In this paper, we present Tangible Tube, an interactive and tangible user interface system that explores a unique kind of interaction with the user, *i.e.,*through breathing control. We will discuss the features and possibilities of Tangible Tube becoming a new system to use an interactive applications and games. There has been a number of existing work that examines the same interaction, but none has been aiming for a general entertainment system.

Tooka [1]: This is a tube which acts like a musical instrument. Each player can blow from the opposite end of the tube and produce the sound collaboratively using their tongues and lungs, and by pressing the buttons. The main difference of this tube and our Tangible Tube is in the output produced. While the Tooka focused more on producing sound as a musical instrument, our tube is simply a device used for interaction between users and our software which focus primarily on gaming. Our tube is also capable for more different user interaction as it detects rotation and 2-D movement while the Tooka seems to support only pressure modulation and button inputs.

BLUI [2]: BLUI (Low-cost Localized Blowable User Interface) is a hands-free interaction between user and computer by blowing the computer screen to control the interactive application. Both our systems seem to be able to support similar application; however BLUI supports blowing directly to the computer screen while Tangible Tube uses a tube as a device for interaction.

The Pipe [3]: This is a music input device using breath pressure as control input. Pipe that is used in this projects uses similar sensors that are used in our tube such as accelerometer and force sensing sensor. The main difference is the output; The Pipe focuses on building a musical instrument while Tangible Tube acts as a device for users to control out application.

Implementation

Our Tangible Tube system has two components; the tube itself and the screen. As shown in Figure 1, the tube is attached to an acrylic enclosure that houses a small Force-Sensing Resistor (FSR) and Inertial Measurement Units (IMU) that possesses 5 degree of freedom from 3-axis accelerometer and 2-axis gyroscope. The IMU captures the 3-dimensional motions of the tube and translate it into 2-dimensional position on the screen using basic kinematics manipulation and euler's discretization method. Additionally, it also records the angle in which the tube is rotated and how fast it is rotating. With the FSR integrated in the tube, how hard the user breathe into the tube is also captured. All of these informations will then be passed into arduino which will be read by a processing module.

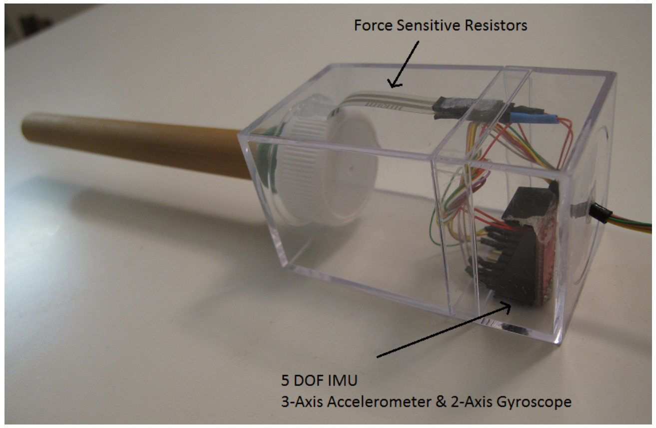

Figure 1: Our Tangible Tube with all the sensors.

Figure 2 shows an overview of how our Tangible Tube system works in a whole. As we move or rotate Tangible Tube, our movements are recorded by an Arduino microcontroller. Arduino will then send all of the data it received to be used by the applications in the computer.

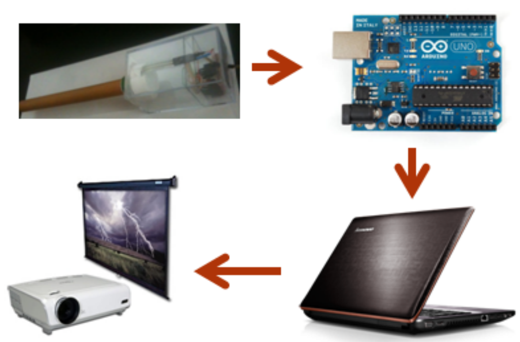

Figure 2: Overview of how our system works.

We have developed two applications to demonstrate the uniqueness and interactiveness of our Tangible Tube. The applications that we developed are written in processing since it provides a smooth interface with Arduino while boasting numerous easy-to-use graphical functions. Making existing processing applications to work with our Tangible Tube require very minimal changes to the existing code base since we have made the interface to the hardware to be very simple and generic.

Painting Application

Our first application is a painting application program. In this application, the user will be able to paint by blowing into the tube and the harder the user blows, the thicker the color is. Changing the color of the paint is achieved by rotating the tube. We implement the paint to be brush-like and the color will disappear after a while to make it more like painting with a real brush.

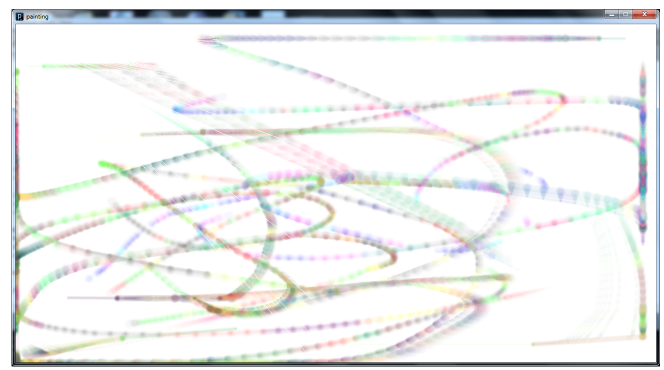

Figure 3: A screenshot of our painting application that one of our testers draws.

Balloon Popping Game

The next application that we developed is a game in which the user is required to pass through a set of levels by shooting down balloons that randomly appear in the screen, as shown Figure 4. This is done by moving the pointer to where the balloons are and blow into the tube. The game consists of two levels: stage 1 and stage 2. In the first stage, the pointer and the balloons' color are always black so that users dont have to rotate the tube to match the color. This stage is intended to familiarize the users with the basic concept on controlling the movement of our Tangible Tube to pop a balloon. In the second stage, the balloons are randomly generated with red, green, or blue color and the users will have to rotate the tube to match the color of the pointer with the color of the balloon before being able to pop the balloon.

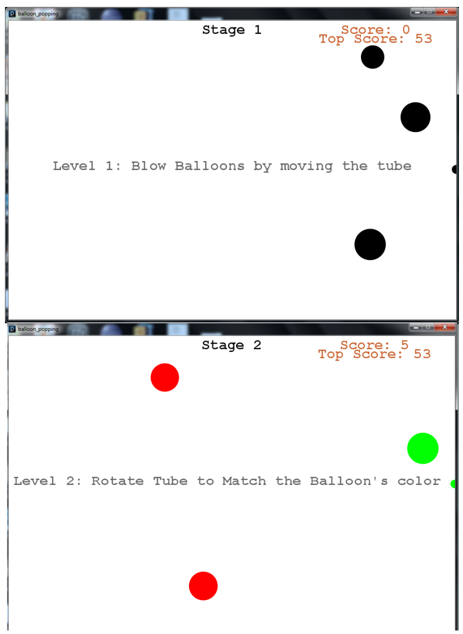

Figure 4: A screenshot of the beginning of each level of our balloon popping game.

Design

In this section, we describe the points that we take into account when designing our tube. Firstly, we would like to make sure that users will immediately understand how does the tube function at the first sight of it without any instruction manual given to them. To accomplish this, we design the mouth piece of the device to appear similar to a blowgun so that users will know immediately that they need to blow. We also add a spectrum circle in front of the mouth piece to let the user know that rotating the device will change the color.

Additionally, we also designed our system to be more persistent so that users will not be quickly bored with our Tangible Tube when they are playing with it. Last but not least, we also plan to create multiple applications and games that can be control with the tube so that users will not be bored easily and will keep on testing the unlimited possibilities on what they can do with the tube.

Evaluation

In order to measure how interesting and interactive our Tangible Tube is, we developed our application to be able to take inputs from traditional input devices (*i.e.,*mouse and keyboard) and our Tangible Tube. For instance, in the balloon popping game the users will be able shoot down the balloons by clicking on the mouse and matching the color of the balloons and the mouse pointer that the user is controlling, the user will need to press some keys in the keyboard.

After describing to our participants how our Tangible Tube works, the participants tried out the applications that we have developed both with and mouse and keyboard and with Tangible Tube as the input device.

The first thing that our testers do when trying out the

Tangible Tube was figuring how to control the small pointer on the screen. Since there is a feedback from the screen to show where the pointer is, our testers adapt to the system naturally and in no time successfully playing with Tangible Tube. Additionally, the exploding animation and the sound impact that is generated whenever the balloon is popped have really given the users a sense of satisfaction.

Figure 5: The participants trying out The Tangible Tube during a project showcase on December 7th 2011 at UC Berkeley campus.

The challenging part is when you have to match the color with the color of the balloon by rotating the tube. This is when the unique interaction with the system starts. It is not that obvious for our testers that they need to rotate the Tangible Tube in order to match its color. However, after observing that they are not able to pop the balloon without matching the colors, they start experimenting with moving the Tangible Tube in a different way and start rotating while blowing the tube. However, we may need to improve on our hardware design since some users lamented on the sensitivity of our Tangible Tube.

Discussions and Future Work

In the future, we would like to explore how well Tangible Tube works in a collaborative setting. For instance, in the balloon popping game that we have developed, we could extend the game so that two people will compete to get a higher score or collaborate to shoot down a number of balloons under limited time. This will definitely ameliorate the interactivity and persistence of our tube.

Following up our previous point, making Tangible Tube wireless is essential to maximize the user experience. In our current prototype, our Tangible Tube is still wired to the laptop. In this case, the users will be constrained by how long the wire extending from the tube to the computer is and therefore, could not move as freely when using the applications. In a collaborative setting, this problem is exacerbated since multiple users could now impede each other's progress in the game due to space constraints which will definitely detriment the user experience.

Finally, instead of utilizing computer screen as the output device of our Tangible Tube, we believe that it will be best if it is displayed on an interactive output system such as a tabletop since that will enhance the interactiveness of our Tangible Tube. This way our Tangible Tube system will not be regarded by the users as just "another computer application".

Conclusion

In this paper, we have reported on the design and the first prototype of a tangible user interface that revolves around breathing actions of the users instead of one that utilize pressing keyboard or joysticks. We believe that this invites our users into a realm of interactions that they have not experienced before. The amusement of people who tested our Tangible Tube, even in simple games that we developed, have confirmed our success and encouraged us to explore this further.

This project is still ongoing and will continue to develop. From the feedbacks given by the testers, we believe that we can improve the systems greatly by adding a few more important features that we mention in the future work section.

Acknowledgment

We would like to thank Han-Shue Tan Ph.D., Jihua Huang Ph.D., and George Anwar Ph.D. for their numerous suggestions that improved this project a lot.

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