Tangible Tube

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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 among children, teenagers and even some of the adults. Consoles such as Nintendo and Sony PlayStation are considered as the pioneers that popularize video games in our society. However, most video games

only require the users to press the buttons on the controller in which the results will be displayed on the built-in screen or TV. There is no other interface between the users and the system besides pressing the button in the handheld controller. In 2006, Nintendo released Wii, a console that uses a remote controller which detects users movements in 3-D. This is the first commercial console that introduced a new and interactive way of playing video games since it requires the user to be physically moving the controller instead of only pressing the buttons. However, the part of our body that is involved is only our hand.

In this paper, we present Tangible Tube, an interactive and tangible user interface system that explores a unique form 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 be used on interactive applications and games. There has been a number of existing works which examine similar user interaction, but none has been aimed for a general entertainment system.

Tooka [1]: This is a tube which acts like a musical instrument. Two players can blow from the opposite ends of the tube and produce sound collaboratively by controlling their breathings 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 focuses more on producing sound like a musical instrument, our tube is simply a device used for interaction between the users and our software which focuses primarily on gaming. Our tube is also capable of offering more variety of user interactions as it detects rotation and translation of the tube while the Tooka seems to support only pressure modulation and button presses.

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 Tangible Tube and BLUI seem to be able to support similar applications; 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 an input device using breath pressure as control input. The Pipe uses similar sensors that are used in Tangible 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 applications.

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 an Inertial Measurement Unit (IMU). The IMU captures the three-dimensional motion of the tube and translates it into 2-dimensional position on the screen. 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, the magnitude of the users breathing into the tube is also captured.

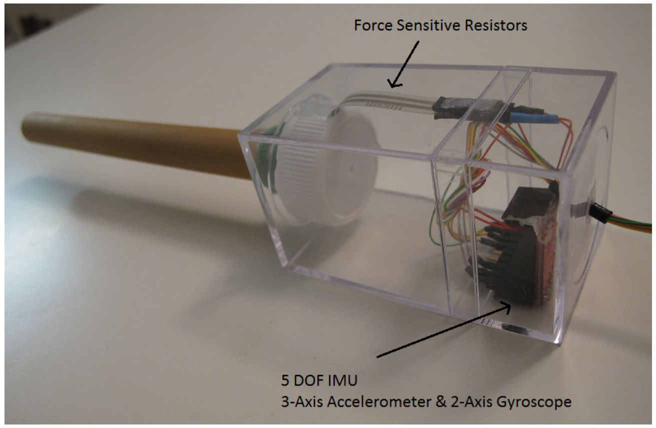


Figure 1: Our Tangible Tube with all the sensors.

Figure 2 shows an overview of how our Tangible Tube system works as 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 which is then displayed in an output system such as computer screen.

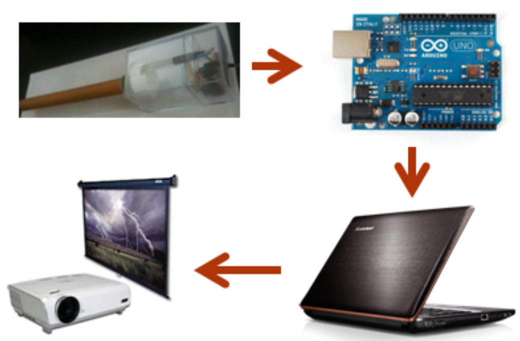


Figure 2: Overview of how our system works.

We have developed two applications that 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. Additionally, making existing processing applications to work with our Tangible Tube requires very minimal changes to their code base since we have made the interface to the hardware 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 paint will be. Changing the color of the paint is achieved by rotating the tube. We implemented the strokes to be brush-like, as if the user is painting with a real brush.

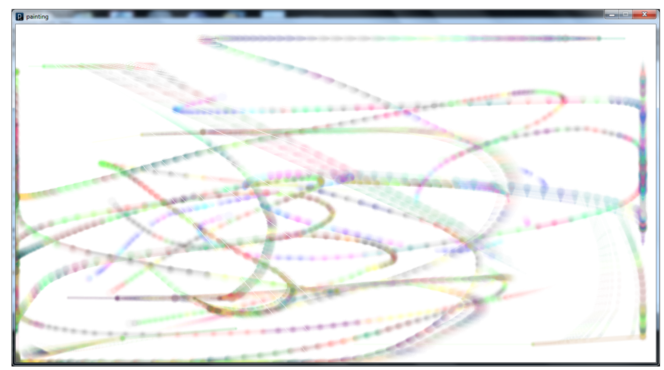


Figure 3: A screenshot of our painting application, drawn by our tester.

Balloon Popping Game

The next application is a game in which the user is required to pass through a set of levels by popping the balloons that randomly appear on the screen, as shown in Figure 4. This is done by moving the pointer to where the balloons are and blowing into the tube. The game consists of two levels: in the first level, the pointer and the balloons' color are all black so that user only needs to point and shoot. This level is intended to familiarize the user with the basic concept of controlling the movement of our Tangible Tube to achieve the desired objective. In the second level, the colors of the generated balloons are randomly chosen between red, blue and green. For the user to be able to pop the balloons, the user will have to match the color of the pointer and each balloon by rotating the tube before blowing into the tube.

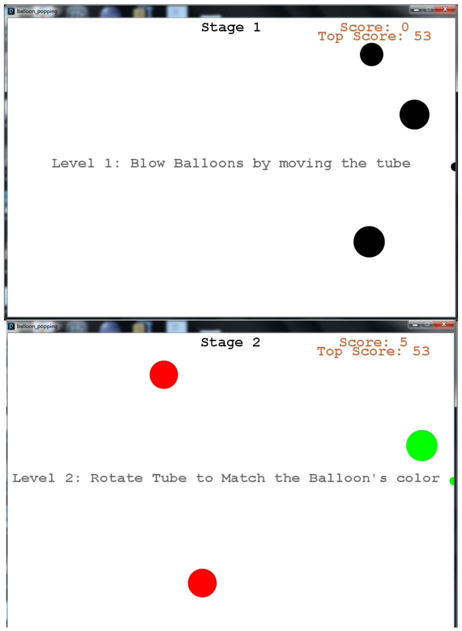


Figure 4: A screenshot of the beginning of each level of our balloon popping game.

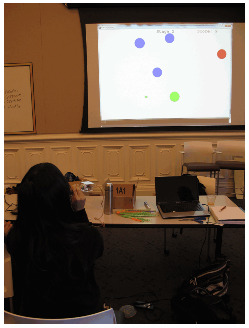
Design

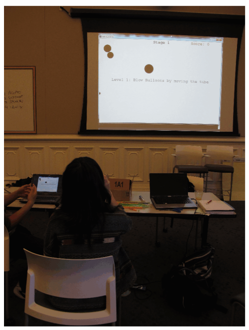
In this section, we describe the points that we took into account when designing our tube. Firstly, we would like to make sure that the users will immediately understand how to use Tangible Tube at the first sight of it without any instruction given to them. In order to accomplish this, we designed the mouth piece of the device similar to a blowgun so that the users will understand immediately that the tube is meant for blowing. We have also attached a colored circle in front of the mouth piece to inform the users that rotating the device will change the output color accordingly.

Evaluation

In order to measure how interesting and interactive our Tangible Tube is, we developed our applications to be able to accept inputs from both traditional input devices (*i.e.,*mouse and keyboard) and our Tangible Tube. For instance, in the balloon popping game, the user will be able pop the balloons by clicking them with the mouse. To match the balloons colors, the users will have to press the appropriate keys on the keyboard. After describing to our participants how our Tangible Tube works, the participants tried out the applications that we have developed with mouse and keyboard first, and later with the Tangible Tube as the input device.

The first thing that our testers did when trying out the Tangible Tube was figuring out how to control the small pointer on the screen. Since pointer in the screen is moving correspondingly as our testers played around with Tangible Tube, our testers adapted to the system naturally and in no time successfully played with our Tangible Tube. Additionally, we have also observed the bursting animation and sound that is generated whenever a balloon is popped gave the users a sense of accomplishment.





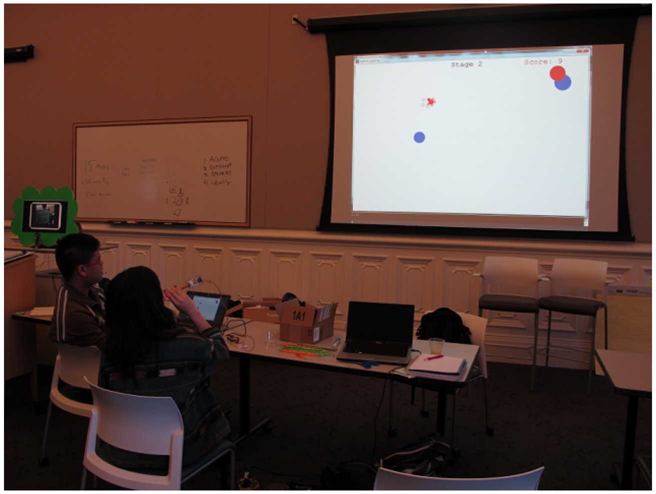


Figure 5: Our testers trying out Tangible Tube during a project showcase at UC Berkeley campus.

The challenging part is when the users have to match the color of the pointer with the color of the balloon by rotating the tube. It is not that obvious for our testers that they needed to rotate Tangible Tube in order to change the color of the pointer for this type of interaction is one of a kind. In the second level of our balloon popping game, after observing that they could not pop the balloon through blowing into the tube only, they started experimenting with orienting Tangible Tube in different positions and noticed that the color of the pointer changes. However, after some time, our testers eventually grasped this distinct feature of our Tangible Tube and continue to enjoy the rest of the game.

Discussions and Future Work

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

Following up to our previous point, a wireless Tangible Tube is also essential to maximize the user experience. Our current Tangible Tube prototype is still wired to the laptop. During the tryout, we distinctly observe how our testers were still constrained the length of the wire extending from the tube to the computer and therefore, could not move freely when using the applications. In a collaborative setting, this problem will be exacerbated since each of the users might impede the others' progress in the game due to space constraints which will detriment the user experience.

Finally, instead of merely utilizing computer screen as the output device of Tangible Tube, we believe that Tangible Tube output is best displayed on an unconventional 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 merely "another computer application".

Conclusion

In this paper, we have reported the design and the first prototype of a tangible user interface that revolves around breathing actions of the users instead of having the users press buttons. We believe that Tangible Tube invites the users into a realm of interactions that they have not explored before. The amusement experienced by our testers, even just by playing simple games we developed, has confirmed our success and encouraged us to explore Tangible Tube possibilities 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 few more important features as mentioned in the future work section.

Acknowledgment

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