

InteractiveTop: An Entertainment System that Enhances the Experience of Playing with Tops

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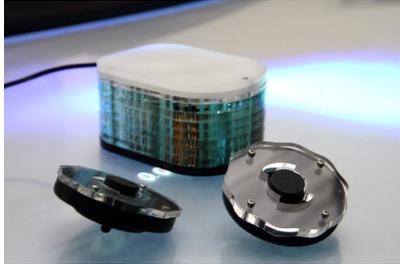


Figure 1: The Tops and the Accelerator

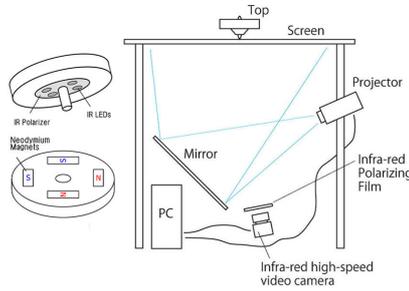


Figure 2: Table Hardware



Figure 3: Top Battle Game

1 INTRODUCTION

A top is a simple toy, yet its behavior is unique when compared with the behaviors of other physical toys. Its attractive behavior is based on the gyroscopic effect acting within the top. We sense the force of the gyroscopic effect when touching or handling them. We consider that this experience helps children become aware of a basic phenomenon of physics. In traditional research [Ishii et al. 1999], a visual and audio effect are often used to augment playing experience of sports or physical toys. In this project, we especially focused on augmentation of physical contact between the tops and the players by using force feedback.

In this project, first we attempted to create feedback from the top to the user. We focus on three top behaviors: (1) on-axis rotation, (2) horizontal translation and (3) collisions between tops. We developed a system to augment these top behaviors and provide feedback to the user with visual and audio effects and force feedback. Second, as the action from the user to the top, we allowed the user to control the top. In the case of traditional tops, there are ways to control the top such as direct touching with the hand or using a special item such as a whip. These methods require special techniques and are a significant element of the fun of playing with tops, however, it is difficult for a beginner to control a top. We increased the controllability of the top to open up new possibilities of playing with tops.

2 TECHNOLOGY

On the basis of these concepts, we developed a prototype system that extends the possibilities of playing with tops. Our system comprises three components: (1) a top accelerator, (2) top stage and (3) top device.

IR LEDs and a small battery are embedded within the top. The IR light is tracked by a high-speed camera under the stage (Figure 2). In addition, if the top rotates on the stage, the IR LEDs appear to blink on and off because of the action of a linear polarizer on the camera and another on the top. Our system calculates the positions and rotation speeds of multiple tops on the stage simultaneously

by detecting and counting the high-frequency IR blinking using the high-speed camera and real-time image processing exceeding 750 fps. The positions and rotation speeds of the tops are converted to the parameters of a physics simulator running on a computer. This simulation result is used to overlay visual and audio effects and detect collisions between tops or between tops and virtual objects.

We also developed an accelerator to increase the rotation speed of the top (Figure 1). This accelerator is compact and easy to use (Figure 3). The user increases the rotation speed of a top by positioning the accelerator 3 cm above the top without any physical contact. Furthermore, by moving the accelerator slowly toward the top, the user can position the top through a magnetic attraction between the accelerator and top. The accelerator also provides force feedback to the user. The user receives vibration feedback based on the rotation speed of the top because of magnetic attraction and repulsion between the top and accelerator. This vibration provides the user with a feel for the acceleration of the top. In addition, a motor and small disk are embedded within the accelerator to create a gyroscopic force. Furthermore, an electromagnetic solenoid generates a virtual impact force at the user's hand when the top collides with other tops. These devices are controlled by a microcontroller within the accelerator in synchronization with the top.

3 APPLICATION

We developed a novel game application called the Battle of Tops, which is based on the traditional top battle game (Figure 3). In this game, tops can be moved and accelerated freely with the player's accelerator.

References

- ISHII, H., WISNESKI, C., ORBANES, J., CHUN, B., AND PARADISO, J. 1999. Pingpongplus: design of an athletic-tangible interface for computer-supported cooperative play. In *Proceedings of the SIGCHI conference on Human factors in computing systems: the CHI is the limit*, ACM, New York, NY, USA, CHI '99, 394–401.

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