Robo Topobo: Improvisational Performance with Robotic Toys

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1 Introduction

Over the past twenty years, the types of toys that young children play with have undergone fundamental changes. While construction sets like blocks and LEGOs were once popular, now video games are the norm. Video games introduce elements of interactive, competitive, and dynamic play. These games often provide the player with a character on screen, allowing children a chance at performance, competition and expression not possible with constructive assembly toys. However, children can be more inventive with constructive assembly kits, creating their own physical objects that evoke a sense of ownership and pride.

Work in digital manipulatives [Resnick et al. 1998] and tangible interfaces [Ishii and Ullmer, 1997] has sought to turn children into designers of both physical form and digital behavior, leveraging the immediacy of physical modeling and the dynamics of embedded computer systems. While such systems can make complex ideas salient for children, most of them focus on engineering and design processes. Robo Topobo (Figure 1) introduces improvisational performance, typical of interactive systems like video games, as an approach to motivate children to engage in hands-on learning.

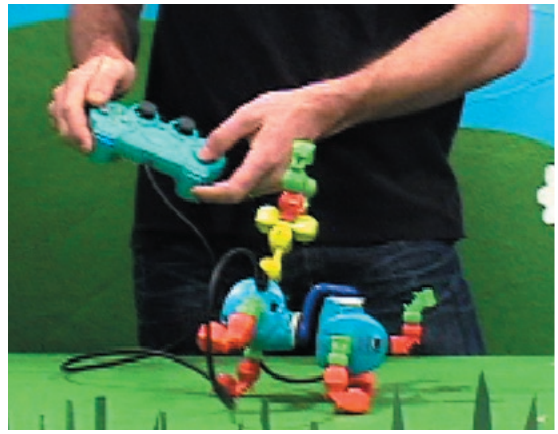

Figure 1: Robo, a modified video game controller, is used to perform a sequence of kinetic recordings with a robotic moose. The moose was designed, built and physically animated using the Topobo system.

2 Approach

“Robo” is a controller that allows users to save, replay, and modulate playback of up to four kinetic recordings created with Topobo, a modular robotic constructive assembly system. Topobo is composed of Passive components and Active (robotic) components with *kinetic memory* – the ability to record and playback physical motion. A child can construct a Topobo creation and physically program it to perform a motion repeatedly. Just as children learn about static structures by playing with blocks, they can learn about dynamic systems playing with Topobo [Raffle et al. 2004].

With Robo, children can save up to four kinetic Topobo recordings and spontaneously playback one of them with the touch of a button. Children can play recordings backwards, and can alter the speed and size of the Actives’ motions using two joysticks on the controller.

While Topobo alone offers an interactive way for children to construct and animate their own dynamic creations, Robo adds an aspect of performance and improvisation. Having the ability to alter the motion of the creation remotely is very similar to controlling a character in a video game. This control lends itself to interaction between multiple children in story-telling and competitive endeavors.

3 Use and Implementation

A child first builds a creation with Topobo. To record a motion, she presses a button and moves Topobo in her hands as desired. She presses the button again to stop recording and start a looping playback mode. She can save the recording with Robo by pressing Robo’s “record” button and then pressing one of its four “playback” buttons to assign the motion to that button. The records are not stored on Robo: Topobo Actives locally copy their recordings to one of four nonvolatile memory banks for later playback.

Topobo is a distributed system comprised of individual elements each with their own internal parameters (e.g. speed) that define their behavior. Topobo Actives have embedded motors and electronics to manage power distribution, motor control, and a custom distributed peer-to-peer network. Robo is a video game controller with customized firmware and electronics to communicate with Topobo. Robo allows for centralized global control of Topobo so that all Topobo Actives share a common set of parameters. All computation is embedded in the toys, and external power is supplied to a single Active for distribution to all other Actives in a creation.

4 Implications

In our experiments with story telling and robot design competitions, people found Robo to be intuitive, exciting and emotionally engaging, and seemed to focus more deeply on developing successful creations than users who played only with Topobo. Robo’s kinesthetic design freed users to focus their visual attention on the movement of their creations, and the interface appeared to support the kind of rapid design iteration children used to successfully develop walking robots with the original Topobo system.

We are using tangible interfaces to remove many of the restrictions of computers for children. With Robo Topobo, we hope to emphasize the organic and emotionally engaging aspects of robotic design, making engineering lessons implicit in a child’s creative process rather than the focus of it. While digital manipulatives have traditionally leveraged computer science and engineering models to engage children in hands-on learning, we believe a tangible approach that supports children’s performance and improvisation can enhance children’s motivation to learn complex ideas through hands-on play.

References

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