Remix and Robo: sampling, sequencing and real-time control of a tangible robotic construction system

Hayes Raffle*
Tangible Media Group,
MIT Media Lab

Laura Yip‡
Massachusetts Institute of Technology

Hiroshi Ishii†
Tangible Media Group
MIT Media Lab

1 Introduction

A major problem in introducing computing (and embedded computing in particular) to kids stems from the disconnect between the physical and computational realms, or the "layers of abstraction" that separate them [O'Malley and Fraser 2005]. We present a system that has eliminated the distance between computation and the "real world" while providing possibilities for sophisticated activities – intellectual, playful and physical.

2 Approach

Remix and *Robo* are controllers children use to sample and sequence the movements of a *Topobo* creation. They are designed to support children's narratives and improvisational performances with Topobo.

Topobo is a 3d constructive assembly system with *kinetic memory*, the ability to record and playback physical motion. Children use Topobo to design and animate playful robotic creations. A child may build a moose with Topobo, twist the moose in her hands to animate the creature, and then watch the moose replay these motions by itself. The same way stacking blocks helps children learn how stone buildings stand up, animating Topobo helps children learn how animals walk [Raffle et al. 2004].

Remix is a tangible sampler/sequencer to capture, adjust and recompose Topobo motions.

Robo is a modified video game controller that a child will use for real-time performance of his Topobo creation.

Topobo, Remix to Robo can be compared to video performance tools: in video performance, a camera will be used for pure data capture (Topobo), an editing suite will be used to sample, sequence and organize a library of video clips (Remix), and video-jockey tools will be used to perform video mixing spontaneously (Robo). Such tools are designed to be used interchangeably, have some functional overlap (e.g. one could conceivably video-jockey with raw unedited video data), and are tailored to support different usage patterns.

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 recording can be replayed and its speed, scale and direction controlled with Robo.

With Remix a user can place a wooden token in a recording slot to sample (record) arbitrary amounts of continuous motion. She can sequence up to four tokens (representing different motion records) for looping playback, while controlling the speed and direction of playback. Because Remix can sample a new record while it is playing a sequence, records can easily be looped, concatenated and nested.

* email: hayes@media.mit.edu
‡ email: yipla@mit.edu
† email: ishii@media.mit.edu

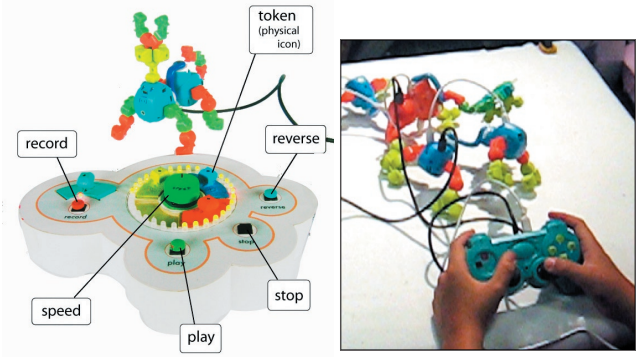

Figure 1: Remix, left, is a tangible sampler/sequencer for Topobo robotic construction toys, back. A child uses the Robo controller, right, to outperform his friend's creation in a "battle-bot" competition.

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. Remix is a tangible interface [Ishii and Ullmer, 1997] built of wood, paper and embedded electronics. Remix and Robo allow 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 Results

In our experiments with story telling and robot design competitions, people ages 7–adult find Remix and Robo to be an important part of their mastery of new ideas. The controllers motivate and support users to learn about dynamic physics concepts like center of mass and dynamic balance through focused play with Topobo. Some users employ the controllers as part of an iterative design process, where global control of variables allows users to better understand why their creations behave as they do. Other users focus on learning how to make Topobo perform predictable and controllable behaviors specifically to participate in new applications like competition or storytelling.

In hands-on learning, a child may build something that enters the child's social context. He may wish to *design* or *control* his creation's behavior in that context. With specialized controllers, children can design behavior with the spontaneity and improvisational spirit that radiates from experimentation and play.

References

1. Ishii, H. and Ullmer, B. 1997. Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms. *Proceedings of CHI 1997*. ACM Press, 234-241.
2. Raffle, H., Parkes, A. and Ishii, H. 2004. Topobo: A Constructive Assembly System with Kinetic Memory. *Proceedings of CHI 2004*. ACM Press, 869-877.
3. O'Malley, C. Fraser, D. "Literature Review in Learning with Tangible Technologies." NESTA Futurelab series. Report 12, 2005.