Keepon Dancing

How a seemingly simple robot bounced and shook his way into the hearts of children

by Marek Michalowski

Photos courtesy of author

"Keepon wants to dance," I told Hideki Kozima, the designer of the squishy yellow robot. I had come to Kozima's lab in Kyoto as a research intern. He put one of his Keepon prototypes on my desk and left me to code. The unmoving robot stared at me blankly, but its rubber body seemed to quiver with the potential to bounce and shake. Keepon had never danced before, but if a robot could ever have a secret desire, I sensed this was it.

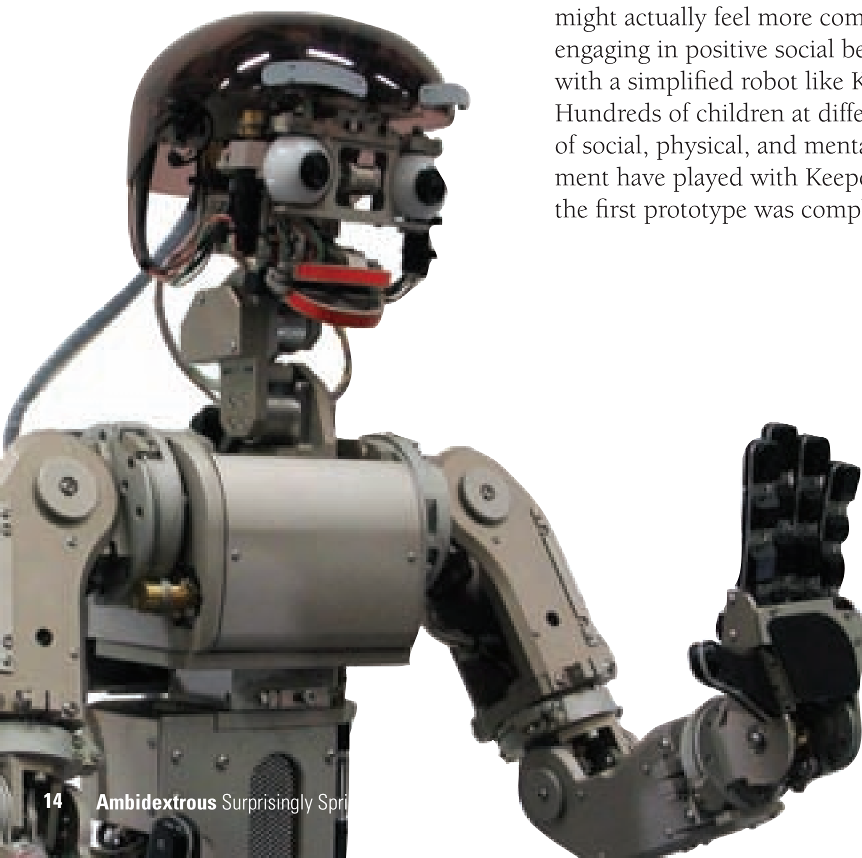
Keepon: His eyes are cameras and his nose is a microphone. Four motors in the base allow the robot to turn its body left and right, nod its head up and down, rock its body side to side, and compress vertically in a "bobbing" motion.

Kozima arrived at Keepon's simple foam appearance in a roundabout manner. Keepon's predecessor was a sophisticated humanoid robot named Infanoid. Kozima developed vocal imitation and shared visual attention for Infanoid in order to study human language acquisition. Meanwhile, he studied social development by observing interactions between Infanoid and young children, particularly those with developmental disorders such as autism. Children were fascinated by Infanoid but tended to fixate on its individual moving parts rather than treating the robot as a social partner. Kozima turned his philosophy around and designed Keepon as the simplest possible social creature—just a body, a head, two eyes, and a nose. With only four motors tugging on wires running up into the robot's body like an inverted marionette, Keepon is able to direct its attention around a room and express simple emotions through bodily movement—and it seems that the dramatically reduced complexity indeed makes for a more socially engaging robot.

We believe that Keepon—a combination of the Japanese word *kee*, meaning yellow, and an onomatopoeic *pon* for the "bobbing" movement—is effective at eliciting social interaction because of its minimal design, rather than in spite of it. Children with autism seem to be overwhelmed by the flood of sensory stimuli (visual, auditory, and tactile) from other people. Keepon's limited axes of movement and extremely simple appearance make it easy to understand. And our research suggests that children with social difficulties might actually feel more comfortable engaging in positive social behavior with a simplified robot like Keepon. Hundreds of children at different levels of social, physical, and mental development have played with Keepon since the first prototype was completed in 2003. Many of these interactions, unfolding over periods as long as a year, developed into significant relationships that have surprised therapists and parents alike. With Keepon under the control of a human operator in natural playroom environments, we have observed important social behaviors, such as eye contact, joint attention, and social referencing, from children who rarely exhibit such behaviors with other people. We believe that a robot like Keepon can serve as a useful tool for therapists in facilitating and studying social interactions.

Children with autism might engage more comfortably in positive social behavior with a robot like Keepon, designed as the simplest possible social creature.

This minimal design stance applies not just to therapeutic applications but to socially-interactive robots in general. A robot that successfully elicits social behavior even in children with autism might represent the "essence" of an interactive creature, which would make it even more effective with a typical population. Moreover, complexity may actually be a handicap—despite much research devoted to creating robots



Infanoid: A humanoid robot, he's built like a baby in a high chair. Twenty-nine motors give Infanoid a movable torso, arms with hands and fingers for pointing, grasping, and making hand gestures, and a head with emotionally expressive eyes, eyebrows, and mouth. Cameras and microphones allow Infanoid to attend to colorful objects and human faces and voices.

Keepon (opposite): His full range of motion allows him to dance and interact with children and adults alike.

with realistic, humanoid appearance and facial expressions, these robots are frequently perceived as “uncanny.” It is too hard to control a large number of degrees of freedom convincingly.

Just as a traditional animator can better convey the range of human emotions through the exaggerated movement of simple forms than extreme photorealism, we aim to make Keepon socially compelling through expressive movement rather than articulated features. For example, we believe that robots can communicate happiness more effectively by bouncing than by smiling. Keepon’s movement is convincingly lifelike because it is smooth and dynamic and because the primary actions of four motors are integrated, or filtered, into the secondary movement of a fleshy rubber skin.

Our work in making Keepon dance is similarly motivated by this goal of not just imitating lifelike movement but exaggerating it. Many of our bodies’ activities, from heartbeats to walking, are rhythmic. Beginning in the 1960s, social scientists like William S. Condon have studied the rhythmicity of social behaviors such as nodding and gesturing. It turns out that the rhythms of our gestures are synchronized with the tempo of our speech. Furthermore, the rhythms of speech and movement tend to be synchronized between interacting partners. The communication and negotiation of these rhythms, which help to regulate our interactions with each other, is often compared to a dance. Just like dances throughout our own human culture, our robots’ interactive “dances” have a beginning and an end. They can be characterized by tension, agreement, turn-taking, and the assumption of different roles. And they are most effective and satisfying when they are coordinated.

Our goal with Keepon is to design a robotic system capable of rhythmic synchrony with people. We are starting by having the robot dance with children in playroom settings. Keepon is an ideal platform for socially interactive applications: attractive, simple, robust, and capable of dynamic, expressive movement. Our system can currently detect rhythms in a variety of sensory modalities, including audio, video, accelerometers, and pressure sensors. Our software, built in the Max/MSP multimedia programming environment, uses these rhythms to drive Keepon’s motors with synchronized oscillatory commands. By randomizing a number of control parameters for each of the degrees of freedom, Keepon is able to change the way it dances in a nearly unlimited variety of “styles.” We are working to endow Keepon with an understanding of the relationship between its own rhythms and those of people and the environment, so that it can understand—and even shape—the various phases and roles in its interactions.

While Keepon was designed for children, and our current research on rhythmicity involves dancing in playrooms, the robot has demonstrated its more universal appeal in a secondary life as an entertainer. After a demo video of Keepon dancing to Spoon’s “I Turn My Camera On” went viral, we were invited to produce a professional music video with Spoon and *WIRED* for the song “Don’t You Evah.”

As we build social robots for entertainment, service, and research, it will be important for them to perceive the subtle rhythms in the behavior of their human partners. Otherwise, we will never move beyond the stilted, rigid, robotic interaction that people have come to expect from machines.

For more information on Keepon, go to: http://www.beatbots.org.