Software systems add motion to physical characters

August 8 2014

New 3D printing techniques have made it possible for just about anybody to fabricate fanciful plastic characters and sculptures, two new computational design methods developed by Disney Research Zurich are making it possible for even casual users to bring these creations to life by adding mechanical motion.

The methods apply to two specific types of characters – planar mechanical characters that are similar to shadow puppets, and linkage-based characters formed by networks of rigid links and hinged joints. In either case, the researchers have developed tools that lead the user in designing mechanisms that will achieve a desired cyclical motion, whether it be a dragon flapping its wings or a ballerina executing a pas de chat.

The same team of researchers, including scientists from Disney Research Zurich, ETH Zurich and Columbia University, developed both methods and will present them at ACM SIGGRAPH 2014, the International Conference on Computer Graphics and Interactive Techniques, Aug. 10-14, in Vancouver, Canada. The work was also presented at SCA 2014, the Symposium on Computer Animation, July 21-23 in Copenhagen, Denmark.

"The machinery for fabricating personalized mechanical toys, artifacts and even robots is becoming widely available, thanks to 3D printing," said Bernhard Thomaszewski, a Disney Research Zurich associate research scientist. "But without the assistance of specialized software,

designing such animated characters is a virtually impossible task for casual users."

At SCA 2014, the team presented ChaCra, their interactive system for designing planar mechanical characters. These are inspired by classic shadow puppets—rigidly articulated characters whose motion is controlled through a number of rods. In these characters, however, the rods aren't controlled by a puppeteer behind a screen, but are animated by a single actuator.

Users can sketch the body parts and pose them as desired; ChaCra then automatically computes the mechanical structure required to move the character to achieve those poses. The process is quick; the researchers found it took only a few minutes to design several sample characters.

Stelian Coros, a Disney Research Zurich research scientist, said the team was able to make the design process manageable by building each structure from three simple mechanisms – connectors that define relative motion between two components, trimmers that limit motion to a desired range, and propagators that transmit actuation from it source to the extremities. Each of these building blocks consists of two interconnected bars for which it is easy to set parameters.

At ACM SIGGRAPH 2014, the team will present a design system for linkage-based characters and kinetic sculptures, in which networks of rigid members and simple joints not only animate the structure, but become part of the work of art. The kinetic sculptures of such artists as Werner Gergaut and Andrew Chase inspired this approach.

"Despite the fact that the linkages are made from very basic components, they can create complex and often surprising motions," Coros said.

The team's process begins with a design for a mechanical structure in which the motion of every joint is controlled by a motor – a design that is impractically complex and expensive, but which enables the designer to freely configure the desired motion. The design tool enables the user to then successively replace the joint motors with new rigid links that mechanically couple the motions of different parts of the assembly.

Such an approach would be tedious and frustrating if done manually, but proved to be enjoyable with the design tool, Thomaszewski said. The tool not only makes this easier, but also enables the user to explore a number of possible configurations of linkages that can better approximate the desired motion while avoiding pitfalls that could cause the mechanism to grind to a halt.

More information: In addition to Thomaszewski and Coros, the team included Disney Research Zurich director Markus Gross, Damien Gauge and Vittorio Megaro of ETH Zurich and Eitan Grinspun of Columbia. For more information and for videos, visit the project web sites at www.disneyresearch.com/project … ge-based-characters/.

Provided by Disney Research