# Researchers develop software tools to create physical versions of virtual characters

July 19 2013

Achieving a desired motion in an animated physical character, whether it be a small toy or a full-sized figure, demands highly specialized engineering skills. But research teams at Disney Research have created a pair of software packages that can open the design process to people with a broader spectrum of skills and provide more creative choices.

One set of software tools can take a drawing of an articulated character and produce a type of animation that pre-dates video and film – gear-driven mechanical characters, such as a dancing clock, a galloping horse or a Sisyphean character pushing a heavy load. The other set takes digital characters that are deformable rather than articulated, such as jelly monsters, plants and jiggling buildings, and helps transform them into elastic figures that can simulate the movements of their virtual forebears. In both instances, the design pipelines take advantage of rapid manufacturing methods, such as 3D printing, to fabricate the physical characters.

"Translating animated characters to the real world is an extremely difficult task, whether you are building a mechanical character such as a wind-up duck or something that has only existed in the virtual world, such as a dancing Eiffel Tower," said Bernd Bickel, research scientist at Disney Research, Zürich. "It's a process that has always required expert designers and engineers, but our new software tools could open the process to non-experts while expanding the creative choices available to all designers."

The two research projects involved investigators from Disney Research, Zürich, Disney Research, Boston, ETH Zürich and MIT's Computer Science and Artificial Intelligence Laboratory. Both teams will present their results at ACM SIGGRAPH 2013, the International Conference on Computer Graphics and Interactive Techniques, July 21-25 in Anaheim, California.

"Although mechanical characters have been part of the toy industry since the 19th century, the design process is largely trial and error, even for the experts," said Bernhard Thomaszewski, a Disney Research, Zürich associate research scientist. "Most mechanical characters are therefore limited in scope and complexity, inhibiting the creative freedom of designers."

He was part of a team that developed a computational design framework for mechanical characters. To make the process as easy and flexible as possible, the framework can work with arbitrary types of mechanical assemblies, including both external drives and internal gearing. To handle the complex and non-linear motions of such assemblies, they selected some representative mechanisms and then pre-computed a sampling of possible motions.

A designer can then input an articulated character into the software system, select a set of actuation points on the character and sketch a set of curves to indicate the motion desired at each point. The system then draws upon the motion library to identify the mechanical assembly and its related set-up that best matches the desired motions. Simulation software then optimizes the assembly to achieve the animation envisioned by the designer.

In further steps, the gears driving the mechanisms are connected to each other through a gear train designed in a semi-automatic fashion. The system then checks to see that mechanical components won't collide when in operation; if problems are found, they are reported to the designer, who can edit the assembly to fix them. Finally, support structures to hold the components in place are designed, making the mechanical character ready for fabrication.

The researchers demonstrated the versatility of their software pipeline by designing ten animated characters and manufacturing seven of them. Design took less than a half hour in each case.

"Our characters are currently restricted to cyclic motions," said Stelian Coros, an associate research scientist at Disney Research, Zürich. "However, our research brings us one step closer to the rapid design and manufacture of customized robots that can sense and interact with their environments to carry out complex tasks."

The creation of deformable characters presents a different set of problems since by their very nature these characters lack articulation. As input, the design system begins with a 3D representation of the figure in its neutral state as well as a set of target shapes representing the desired deformations. The user can then select actuation points in the figure or, particularly when the character lacks any apparent articulation structure, the system can suggest a number of actuators and their locations.

Once the number and approximate locations of the actuators have been decided, the system optimizes the design, taking into account whether actuation will be applied using strings, pins or clamps.

In the third design stage, the system computes the distribution of stiff and soft materials within the character that will enable the desired deformations, while maintaining the overall shape of the character. Soft materials, for instance, might be placed near joints, with stiffer materials used in the limbs. This step took the most computation time of the three, but proved powerful; the researchers demonstrated, for instance, that material optimization enabled a straight bar to be deformed into four shapes very close to the target shapes using just two clamp-type actuators.

The researchers designed and fabricated both two-dimensional and three-dimensional characters – six in all – with the prototypes showing good agreement with their simulations.

"We believe our method is an important step toward physics-based design of real-world characters," Bickel said. "Now, we'd like to explore using a larger number or range of materials to build these characters and to design more elaborate actuation systems so that the animation of complex structures could be automated."

Provided by Disney Research

Citation: Researchers develop software tools to create physical versions of virtual characters (2013, July 19) retrieved 24 April 2024 from https://phys.org/news/2013-07-software-tools-physical-versions-virtual.html