Team produces 3-D-printed objects with variable elasticity using single material

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A 3D-printed teddy bear can have a stiff head, a pliable tummy and bendable arms, even though all of it is made of the same relatively stiff material, using a new method developed by Disney Research.

By using the printer to alter the small-scale structure of the material, the Disney researchers showed they could vary its elasticity dramatically within the same object. They developed families of compatible microstructures with varying elastic properties, enabling designers to select the properties desired for each region of an object.

The team demonstrated their new method to produce several deformable toys, including a teddy bear and a rabbit, as well as a pair of deformable tubes that might be used as a manipulator for a soft robot.

"Many functional objects in our everyday life consist of elastic, deformable material, and the material properties are often inextricably linked to function," said Christian Schumacher, a Ph.D. computer graphics student at ETH Zurich and at Disney Research. "3D printing usually involves only a single material or a very small set of materials. However, 3D printing easily produces complex, 3D microstructures which we can use to create metamaterials with properties beyond those of standard printer materials."

Schumacher and his colleagues will present their method for controlling elasticity in 3D printed objects at ACM SIGGRAPH 2015, the International Conference on Computer Graphics and Interactive Techniques, in Los Angeles Aug. 9-13.

Metamaterials - materials that derive their bulk properties from the shape and arrangement of their microstructures, rather than the composition of the material itself - are not new. What the Disney Research team sought to do is use a variety of these metamaterials so that different regions within a single object could have different elastic properties.

They began by sampling a number of microstructures to determine their properties. These were then grouped into families of similar structures that represent a range of elastic behaviors and that can be interpolated to smoothly vary the material properties over a wide range.

To create an object, these microstructures - measuring 8 mm on a side - are tiled together in the object's interior. The researchers created an algorithm for optimizing the combination of these microstructures, making sure that microstructures of different shapes connect properly.

In the demonstration objects, the team showed that this method could be used to produce fully articulated figures, with joints that bend even through the remainder of each limb was stiff. A simple, two-fingered manipulator developed for a soft robot featured two tubes designed to bend only in one direction when a balloon inside was inflated or deflated.

More information: www.disneyresearch.com/publica … ion/microstructures/

Provided by Disney Research

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