Computer model predicts how people perceive softness of 3-D printed objects

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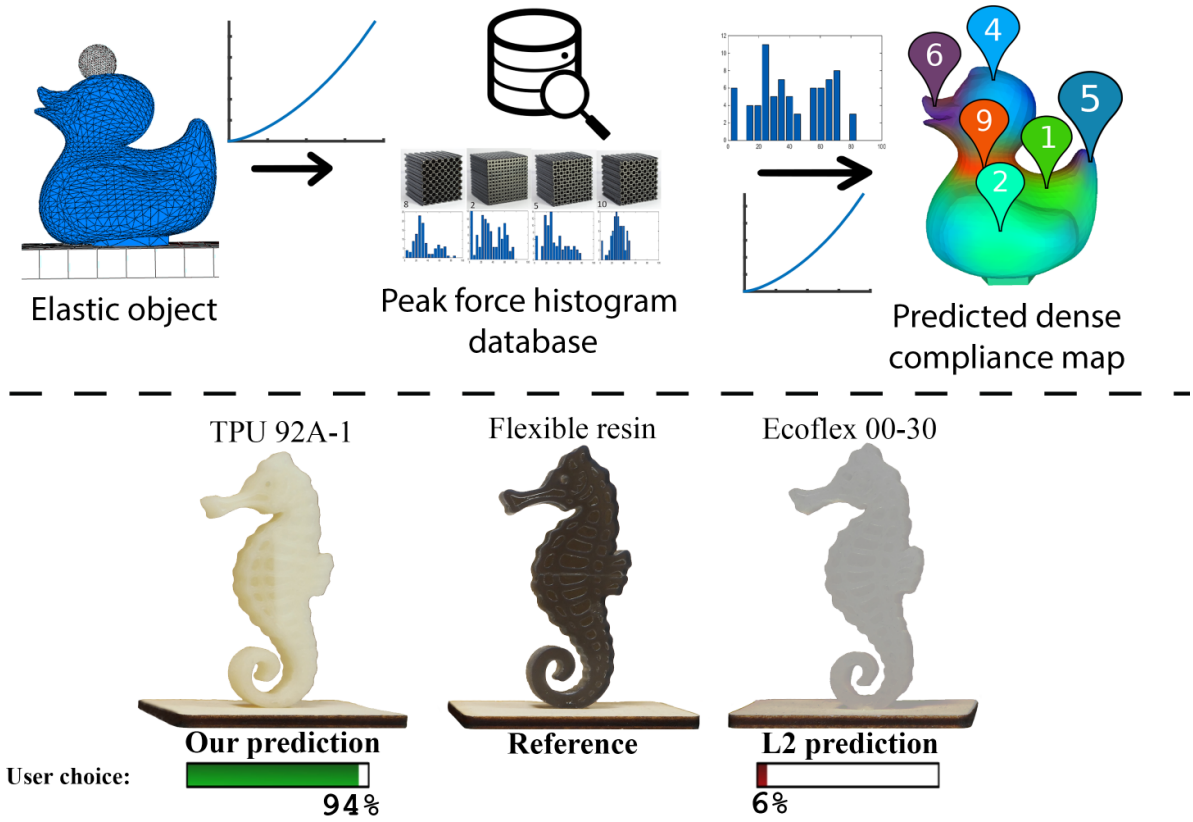

Credit: Disney Research

A plastic ducky produced by one 3-D printer may look the same as one produced by another printer, but it doesn't necessarily feel the same. To help designers produce copies with the same feel as well as looks of the

original, researchers have developed a way to predict perceived softness and stiffness of an object.

Such a capability would be important for producing pieces of apparel that are consistently comfortable, as well as toys and other objects that are expected to function in a predictable, interchangeable manner, said David Levin, an associate research scientist at Disney Research.

The researchers created a perceptual model for nonlinear elastic objects—objects that vary in stiffness depending on how much they are compressed. The model was based on the results of experiments in which people poked at 3-D-printed materials and compared their feel.

The researchers—including scientists from Disney Research, the Massachusetts Institute of Technology, the Max Planck Institute for Informatics, and Saarland, Comenius, and Harvard universities—will present their model July 24 at the ACM International Conference on Computer Graphics & Interactive Techniques (SIGGRAPH) in Anaheim, Calif.

"Perception of the softness of a material is a complex phenomenon and not one that can simply be determined by measuring how much the material deforms when a certain force is applied," said Jessica Hodgins, vice president at Disney Research. "People use many cues to judge softness, including texture, size and location, so it was critical to base the model on what humans perceive. This team was able to use that input to accurately predict how objects of various materials and geometries will feel."

Though 3-D printers can produce objects of the same shape, not all 3-D printers use the same raw materials or processes, which means they do not always produce objects with the same feel, said Wojciech Matusik, associate professor of electrical engineering and computer science at

MIT's Computer Science and Artificial Intelligence Laboratory. But by varying the internal structure of the object, it is possible to tailor how an object responds to squeezes and pokes.

The perceptual model can guide this process, so that objects produced by different printers using different materials ultimately feel the same, he added.

In developing their model, the researchers took their physical measurements of how force deformed 12 sample materials and related them to how 20 people perceived the feel of those materials. The people were asked to evaluate three blocks of material at a time; each was presented with 78 such trials, results in a total of 1,560 comparisons.

Because shape also affects the feel of an object, the model was extended beyond these simple shapes to include more complex geometries. To validate the extension, displacements were measured at various points on a plastic ducky and then testers were asked to palpate the same object and evaluate their feel based on different points - head, tip of the beak, body and tail.

The entire model was subsequently validated in tests in which it was able to accurately predict the objects chosen by participants based on their perceptions of which objects felt the most dissimilar.

More information: "An interaction-Aware, Perceptual Model for Non-Linear Elastic Objects-Paper" [PDF, 24.19 MB]

Provided by Disney Research

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