New techniques for an old challenge!!!

July 25, 2017

New AI technique creates 3-D shapes from 2-D images

WEST LAFAYETTE, Ind. — A new technique that uses the artificial intelligence methods of machine learning and deep learning is able to create 3-D shapes from 2-D images, such as photographs, and is even able to create new, never-before-seen shapes.

AI computers may soon be able to create new 3-D shapes just by looking at two 2-D images, such as photos, says Purdue University professor Karthik Ramani, and also come up with shapes for new images such as by "hallucination." (Purdue University image)

Karthik Ramani (https://engineering.purdue.edu/ME/People/ptProfile?id=12331), Purdue's Donald W. Feddersen Professor of Mechanical Engineering, says that the "magical" capability of AI deep learning is that it is able to learn abstractly.

"If you show it hundreds of thousands of shapes of something such as a car, if you then show it a 2-D image of a car, it can reconstruct that model in 3-D," he says. "It

Research News

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- **Surgical assessment tool could rapidly analyze cancerous tissue samples, improve patient outcomes**

can even take two 2-D images and create a 3-D shape between the two, which we call 'hallucination.'"

When fully developed, this method, called SurfNet, could have significant applications in the fields of 3-D searches on the Internet, as well as helping robotics and autonomous vehicles better understand their surroundings.

Perhaps most exciting, however, is that the technique could be used to create 3-D content for virtual reality and augmented reality by simply using standard 2-D photos.

"You can imagine a movie camera that is taking pictures in 2-D, but in the virtual reality world everything is appearing magically in 3-D," Ramani says. "Inch-by-inch we are going there, and in the next five years something like this is going to happen.

"Pretty soon we will be at a stage where humans will not be able to differentiate between reality and virtual reality."

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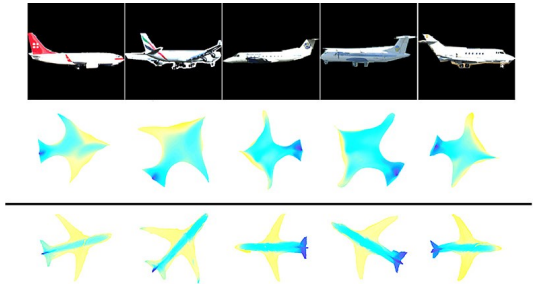

Computers using a new artificial intelligence technique developed at Purdue University can create 3-D shapes from 2-D images, such as these photographs of airplanes. The technique could help technologies such

(http://www.purdue.edu/newsroom/releases/2017/Q3/surgical-assessment-tool-could-rapidly-analyze-cancerous-tissue-samples,-improve-patient-outcomes.html)

- **New AI technique creates 3-D shapes from 2-D images (http://www.purdue.edu/newsroom/releases/2017/Q3/new-ai-technique-creates-3-d-shapes-from-2-d-images.html)**
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More Research News

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as virtual reality, augmented reality, and robotics. (Purdue University image.)
Download image (https://news.uns.purdue.edu/images/2017/ramani-airplanes.jpg)

(https://www.purdue.edu/newsroom/research/)

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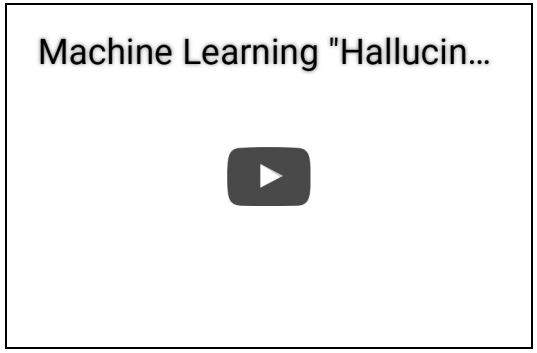
The computer system then learns both the 3-D image and the 2-D image in pairs, and then is able to predict other, similar 3-D shapes from just a 2-D image.

"This is very similar to how a camera or scanner uses just three colors, red, green and blue—known as RGB—to create a color image, except we use the XYZ coordinates," he says.

Ramani says this technique also allows for greater accuracy and precision than current 3-D deep learning methods that operate more using volumetric pixels (or voxels).

"We use the surfaces instead since it fully defines the shape. It's kind of an interesting offshoot of this method. Because we are working in the 2-D domain to reconstruct the 3-D structure, instead of doing 1,000 data points like you would otherwise with other emerging methods, we can do 10,000 points. We are more efficient and compact."



One significant outcome of the research would be for robotics, object recognition and even self-driving cars in the future; they would only need to be fitted with standard 2-D cameras, yet still have the ability to understand the 3-D environment around them.

Ramani says that for this research to be developed, more basic research in AI will be needed.

"There's not a box of machine learning algorithms where we can take those and apply them and things work magically," he says. "To move from the flatland to the 3-D world we will need much more basic research. We are pushing, but the mathematics and computational techniques of deep learning are still being invented and largely an unknown area in 3-D."

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Note to Journalists: An animated gif and a photo are available. A YouTube video is available at **https://www.youtube.com/watch?v=117YLkMcgqQ (https://www.youtube.com/watch?v=117YLkMcgqQ)** The video and a shorter, social-media friendly video are available on GoogleDrive here: **https://drive.google.com/drive/folders/0ByJTOBDgv4T-YjFvZFNQRWF4Wjg (https://drive.google.com/drive/folders/0ByJTOBDgv4T-YjFvZFNQRWF4Wjg)**

ABSTRACT

SurfNet: Generating 3D shape surfaces using deep residual networks

Ayan Sinha, MIT; Asim Unmesh, IIT Kanpur; Qixin Huang, University of Texas, Austin; and Karthik Ramani, Purdue University

3D shape models are naturally parameterized using vertices and faces, i.e., composed of polygons forming a surface. However, current 3D learning paradigms for predictive and generative tasks using convolutional neural networks focus on a voxelized representation of the object. Lifting convolution operators from the traditional 2D to 3D results in high computational overhead with little additional benefit as most of the geometry information is contained on the surface boundary. Here we study the problem of directly generating the 3D shape surface of rigid and non-rigid shapes using deep convolutional neural networks. We develop a procedure to create consistent 'geometry images' representing the shape surface of a category of 3D objects. We then use this consistent representation for category-specific shape surface generation from a parametric representation or an image by developing novel extensions of deep residual networks for the task of geometry image generation. Our experiments indicate that our network learns a meaningful representation of shape surfaces allowing it to interpolate between shape orientations and poses, invent new shape surfaces and reconstruct 3D shape surfaces from previously unseen images.

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