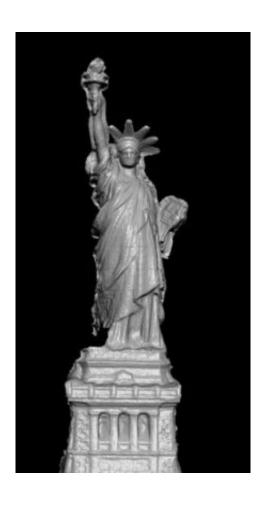# Vacation photos create 3-D models of world landmarks

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A virtual reconstruction of the Statue of Liberty, created from tourists' photos. Michael Goesele, TU Darmstadt

More than 10 million members of the photo-sharing Web site Flickr snap pictures of their surroundings and then post those photos on the

Internet. One group at the University of Washington is doing the reverse – downloading thousands of photos from Flickr and using them to recreate the original scenes.

A presentation in October at the International Conference on Computer Vision showed how photos from online sites such as Flickr can be used to create a virtual 3D model of landmarks, including Notre Dame Cathedral in Paris and the Statue of Liberty in New York City.

"The big breakthrough here is being able to compute very accurate 3D models from people's vacation photos," said co-author Steve Seitz, a UW associate professor of computer science and engineering. "The long-term vision is to be able to reconstruct the detailed geometry of all the structures on the surface of the Earth. Many people are working toward that goal, but by using online collections this work brings in a whole new source of imagery and level of detail."

Online photo-sharing Web sites such as Flickr and Google are popular because they offer a free, easy way to share photos. Flickr now holds more than 1 billion photos; a search for "Notre Dame Paris" finds more than 80,000 files. The study authors, experts in computer vision, believe this is the world's most diverse, and largely untapped, source of digital imagery.

But the freely available photos do present a challenge: these are holiday snapshots and personal photos, not laboratory-quality research images. While some may be postcard-perfect representations of a setting, others may be dark, blurry or have people covering up most of the scene.

To make the 3D digital model, the researchers first download photos of a landmark. For instance, they might download the roughly 60,000 pictures on Flickr that are tagged with the words "Statue of Liberty." The computer finds photos that it will be able to use in the

reconstruction and discards pictures that are of low quality or have obstructions. Photo Tourism, a tool developed at the UW, then calculates where each person was standing when he or she took the photo. By comparing two photos of the same object that were taken from slightly different perspectives, the software applies principles of computer vision to figure out the distance to each point.

"The general principle is very similar to how our eyes work," said lead author Michael Goesele, a former postdoctoral researcher at the UW who is now a professor at Technische Universität Darmstadt in Germany. "You get multiple views from different points of a scene, and then you find the same point in different views and infer from that the depth of the object."

In tests, a computer took less than two hours to make a 3D reconstruction of St. Peter's Basilica in Rome, using 151 photos taken by 50 different photographers. A reconstruction of Notre Dame Cathedral used 206 images taken by 92 people. All the calculations and image sorting were performed automatically.

"We don't quite get the accuracy of a laser scanner, but we're in the ballpark," Seitz said. The recreations of Notre Dame show individual figures carved into the stone facade. A model of The Duomo in Pisa, Italy, a building about 160 feet tall, is accurate to within a few inches. The resolution of the 3D model mostly depends on the resolution of the original photos.

Creating 3D reconstructions of individual buildings is a first step in a long-term effort to recreate an entire city using online photographs.

"We've downloaded about 1 million photographs of Rome from Flickr," Seitz said. "We want to see how much of the city we can reconstruct – including exteriors, interiors and artifacts." The group hopes to make

significant progress on the Rome project over the next couple of years, he said.

More details are at grail.cs.washington.edu/projects/mvscpc/. More about research incorporating online photo collections is at grail.cs.washington.edu/projects/cpc/.

Source: University of Washington