Imagine snapping hundreds of photos with an unmanned aerial vehicle (UAV) as you guide it around a construction site. Imagine, afterwards, taking these new photos of the site and quickly building them into a photorealistic 3D model. This 3D model of the site could help you visualize a new, finished structure in that same location. No more drafting or surveying would be needed, and you’d have quick access to the context surrounding a planned building. Designing new construction on such a site could be made more efficient and effective than ever before.

This process describes the magic of photogrammetry as performed with the help of a UAV and Autodesk® ReCap™ Photo. Photogrammetry is the practice of using photographs to measure and model physical objects and scenes. Autodesk ReCap Photo makes use of the power of high-core-count Intel® Xeon® processors and cloud computing to push photogrammetry to a new level of ease, speed, realism, and accessibility. Consisting of a desktop app and a photo-to-3D web service, Autodesk ReCap Photo quickly converts photographs shot around a scene—normally with UAVs—into high-resolution 3D models that can be used in architecture, engineering, and construction. The models can be imported for use in engineering and design applications (such as Autodesk® Revit®, Autodesk® AutoCAD® Civil 3D®, or Autodesk® InfraWorks®), or they can be used for visualizations based in on-screen animations or virtual reality (VR), where the power of Intel Xeon processors delivers a seamless, high-quality experience.

“Autodesk® ReCap™ Photo scales extremely well on high performance multi-core Intel® Xeon® processors to generate highly detailed and accurate 3D models. It provides smart features with smooth interaction in spite of the massive data generated by the reality capture sensors on the UAVs”

Murali Pappoppula
Senior Software Development Manager

Figure 1. A UAV performing reality capture by taking hundreds of photographs around a building
Challenges with Photogrammetry and 3D Rendering

The advantages of using digital 3D models for design and engineering have long been understood. Using photographs to accurately create 3D models, however, has traditionally presented certain practical challenges, especially for large-scale scenes. One common hurdle has been the difficulty of taking enough photographs, at the proper angles required for photogrammetry, while remaining within budget. The increasingly widespread availability of affordable UAVs, however, has made the cost of gathering photos suitable for 3D modeling more approachable for many companies.

Another significant challenge for architecture, engineering, and construction companies has been the length of time required to process photos into a usable 3D model. This problem arises because the next step of the 3D modeling workflow—the model-computing phase—is especially CPU-intensive. During this stage, many complex calculations are used to extract 3D information (based on camera location, orientation, focal length, and distortion) from the overlapping portions of hundreds of photos. Hundreds of thousands of additional calculations can then be performed to complete the triangulations and correlations required to generate an accurate 3D representation of a captured scene or object, including its surface, elevation, volume, and texture.

On the typical desktop computers used in small- or medium-sized architecture, engineering, and construction companies, this processing can take many hours or even days. Companies who attempt to use insufficiently powerful computers might even witness their systems hanging indefinitely while a series of photographs is processed.

Powerful Workstations and Scalability in the Cloud Bring Fast Processing to All

Using a workstation with a high number of CPU cores is not always sufficient to overcome the lack of speed involved in creating a 3D model from photographs. After all, application performance does not automatically improve on multicore systems. Applications need to be specifically designed to take advantage of multicore processing. Fortunately, Autodesk ReCap Photo is just such an application, having been painstakingly engineered to scale well on high-core-count Intel Xeon processors.

One further hurdle remains for some companies, however, before they can enjoy the benefits of a 3D model built through reality capture. Businesses typically need to invest in powerful workstations that include many CPU cores to dramatically reduce the amount of time required to perform operations that scale well on multicore CPUs, and not every firm is prepared to make that kind of an investment. To solve this problem and bring photo-to-3D modeling within the reach of all construction, design, engineering, and architectural companies, Autodesk has made the photogrammetry process of Autodesk ReCap Photo available as a cloud service backed by multicore Intel Xeon processors.

Once the 3D model is created through the cloud service, other functions, such as visualization, editing, and exporting, are performed locally on the workstation.

**Figure 2.** With Autodesk® ReCap™ Photo, 3D models are built from photographs through cloud-based resources, but other functions rely on local resources.
Solution Brief | From UAV to VR in No Time: Autodesk® ReCap™ Photo Quickly Renders 3D Structures Thanks to Multicore Scalability

Different workstation configurations should be used to optimize performance for different design needs, as shown in Table 1.

Table 1. Suggested systems for various design needs

<table>
<thead>
<tr>
<th>Workflow</th>
<th>Autodesk® Applications</th>
<th>Suggested Intel® Workstations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry-level computer-aided design (CAD) modeling, design, and simple models</td>
<td>Autodesk® AutoCAD®, Autodesk® Revit®</td>
<td>• Intel® Xeon® processor E3 family–based system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CPU: 4 cores</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Entry-level graphics card</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 16–32 GB RAM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Serial ATA (SATA) solid-state drive (SSD)</td>
</tr>
<tr>
<td>Complex CAD models, and VR visualizations</td>
<td>Autodesk Revit, Autodesk® Inventor®, Autodesk® Stingray, Autodesk® AutoCAD® Civil 3D®</td>
<td>• One Intel Xeon W processor or Intel Xeon Gold processor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CPU: 8–10 cores</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Professional graphics card</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 32–64 GB memory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Intel® SSD 750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Series (with Peripheral Component Interconnect Express® [PCIe*])</td>
</tr>
<tr>
<td>Simulations, rendering, photogrammetry, and VR design</td>
<td>Autodesk® Maya®, Autodesk® 3ds Max®, Autodesk® Stingray, Autodesk® ReCap® Photo</td>
<td>• 2x Intel Xeon Gold processors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CPU: 14+ cores per processor (28 cores total)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High-end graphics card</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Memory: 64–128 GB DDR4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Intel SSD 750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Series with PCIe</td>
</tr>
</tbody>
</table>

Virtual Reality Visualizations on Intel Xeon Scalable Processors

Starting with photos taken by UAVs, Autodesk ReCap Photo can quickly create 3D models that can be exported into Autodesk® Stingray to create VR visualizations. Viewers can then use a head-mounted display (HMD) to step into the 3D model after the visualization is complete and experience the entire visual environment with six degrees of freedom (DOF), as if those viewers were at the original scene.

VR represents a compelling visualization method that is growing fast in popularity. A high-quality VR experience, however, requires heavy local processing power. 3D models created from UAV photos consist of high-density polygons, which are needed to preserve the models life-like appearance. The same is true for VR architectural visualizations created from Autodesk Revit and Autodesk® Revit LT™ models through the Autodesk Revit Live service. A powerful system is required to perform the fast calculations needed to simulate the lifelike 3D environment without latency as the viewer moves around in that environment.

Servers and workstations based on the latest Intel Xeon Scalable platform are excellent candidates for performing these high-quality VR visualizations through an HMD. Intel Xeon scalable processor–based servers and workstations can pack up to 28 cores and 56 threads in a single processor and support up to 1.5 TB of DDR4 memory. In addition, all systems based on Intel Xeon Scalable processors include 48 PCIe 3.0* lanes per CPU, allowing you to add many high-performance graphics cards to a single system.

Autodesk Photo ReCap on High Performance Workstations Results in Faster Performance

Benchmark testing performed by engineers at Intel and Autodesk demonstrates the scalability of Autodesk ReCap Photo on Intel Xeon processors on a local workstation. By upgrading to the latest workstation with SSD storage, users can experience both faster load and processing times. Creating a 3D model from 164 test photos was found to be about 44 percent faster when performed on the latest Intel Xeon Scalable processor–based workstation, compared to a 3-year-old platform.1

![Image](316x666 to 495x731)

The Power of Intel® Xeon® Processor–based High-Performance Computing in the Cloud

The Autodesk® ReCap™ Photo photogrammetry process runs on cloud-based virtual server instances powered by the Intel Xeon processor E5 v4 family. Small jobs run on eight virtual cores while large jobs run on 32 virtual cores. The high core counts of the Intel Xeon processors that power this process allow the service to build 3D models much faster than would be possible on a two- or four-core workstation, with all other factors being equal (such as memory and graphics processing unit [GPU]). The time savings made possible by the high-core-count Intel Xeon processors are then passed along to designers, architects, and engineers, making the employees and their firms more productive.

Autodesk® Stingray to create VR visualizations. Viewers can then use a head-mounted display (HMD) to step into the 3D model after the visualization is complete and experience the entire visual environment with six degrees of freedom (DOF), as if those viewers were at the original scene.
Figure 4. Testing on a large dataset revealed a 45 percent speed improvement in rendering 3D photos when upgrading from a 3-year-old system (at top) to a workstation based on the latest server platform (at bottom, shorter bar is better)\(^1\)

Other testing showed the power of additional cores to boost performance. On a larger dataset, the most processor-intensive phase of the photogrammetry process—the texture phase—was completed 16.5 percent faster on a 28-core Intel Xeon processor–based system (two processors x 14 cores) than on a 20-core Intel Xeon processor–based system (two processors x 10 cores).\(^2\)

Figure 5. Completion times for the most processor-intensive phase of rendering (the texturing phase) showed a 16.5-percent improvement on the higher-core-count Intel® Xeon® processors (a lower bar is better)\(^2\)

**UAVs and Autodesk ReCap Photo Lead to Better Design**

Creating 3D models with a UAV and Autodesk ReCap Photo provides key advantages in engineering, construction, and design, advantages that are accessible to all businesses. First, the procedure saves time and money. It provides a fast and easy way to create an accurate 3D digital representation of a scene, sparing the expense of the many hours of engineering time that would otherwise be needed to build such a model from survey information. Perhaps more importantly, using a UAV with Autodesk ReCap Photo to quickly create a 3D model can lead to better designs and construction. With access to 3D models of sites now readily available, companies can design new buildings with an accurate representation of the surrounding context throughout the entire process.

**Assisting Construction**

Autodesk ReCap Photo is most often used to capture an outdoor scene before or after a change. For use cases such as conditions and contexts around buildings, ships, construction sites, quarries, mines, and infrastructure projects, companies can create multiple 3D models to compare construction progress as-built with the plans as originally designed. Backed by high-core-count Intel Xeon processors in the cloud, these useful 3D models can be created in an efficient way without interrupting workflow.

**Better Visualizations**

Designers can export 3D models created in Autodesk ReCap Photo to other Autodesk applications. For example, as already described, they could help provide VR visualizations through Autodesk Stingray. But a 3D model can also be used to create an animation in the Autodesk® 3ds Max® application. In both cases, architects, designers, and construction firms can make use of the power of the Autodesk ecosystem to better test their own design visions and better communicate those visions to their customers.

Storage is another important factor for performance on local workstations. Users can see significant load and save time improvements for 3D models by upgrading from spinning hard drives to SATA SSDs and PCIe* SSDs with NVMe Express* (NVMe*).
Conclusion: Multicore Intel Xeon Processors Accelerate Photogrammetry in Autodesk ReCap Photo

As proven by the test results, Autodesk ReCap Photo delivers quickly processed 3D models from multiple photos taken by UAVs around a scene or structure. The speed with which this operation is performed is a result of the application's scaling efficiency on Intel Xeon processors, a feature for which the application code was specifically designed. And because Autodesk delivers the photogrammetry process of Autodesk ReCap Photo through a cloud-based service running on high-core-count Intel Xeon processor-based servers, this processing speed and efficiency is now available to businesses of all sizes. To provide high-quality visualizations of these models in VR, businesses will profit from the most powerful Intel Xeon processor-based workstations and servers, such as those based on Intel Xeon W processors and the latest Intel Xeon Scalable processors.

Creating 3D models of an outdoor scene for use in architecture, engineering, and construction is now easier and faster than ever with the help of UAVs, Autodesk ReCap Photo, and high-core-count Intel Xeon processors. Businesses in these sectors can take advantage of the new speed, ease, and availability of 3D modeling based on photogrammetry to meet more deadlines, speed construction time, improve design through better visualizations, and gain competitive advantage.

To learn more about Autodesk ReCap Photo, visit autodesk.com/products/recap/overview.

To learn more about Intel Xeon processors and workstations, visit intel.com/content/www/us/en/products/processors/xeon.html and intel.com/workstations.

Local Workstation Recommendation for 3D Modeling

The compute-intensive 3D model reconstruction phase of photogrammetry is performed in the cloud, which scales with Intel® Xeon® processor cores. To optimize performance of all other tasks in the 3D modeling workflow, it is recommended that you use a workstation based on an 8-to-10 core Intel Xeon W processor or Intel Xeon Gold processor with higher frequencies (4+ GHz), along with fast PCIe® or SATA Intel® SSD storage.