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3D MODELS TAKE OFF
WITH DRONE TECHNOLOGY





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The use of Unmanned Aerial Vehicles (UAVs) in architecture, engineering and construction (AEC) is an ever- changing frontier. Articles and presentations completed even six weeks ago on the topic may be out of date. Companies are releasing new (smaller, cheaper and more sophisticated) drones in rapid succession. But the regulatory response has been adrift. The Federal Aviation Administration (FAA) currently sets a very high standard for operators in the commercial space. But even if that standard

is met, current regulations strictly limit the use of UAVs such that the locations where they would be of most use to the AEC industry are “no drone zones.” This includes populated areas, which house the greatest density of projects, and areas near airports, heliports, and other restricted air space. Commercial operators who meet all other criteria are unable to fly in these areas. There are enormous efficiencies to be realized by utilizing UAVs to make certain restoration tasks easier, safer and more effective. The hope is that when the



Image captured by GoPro Hero3+ mounted on our DJI Phantom quadcopter. A few hundred photos were used to create a 3D model of our Ithaca office.

FAA settles on firm requirements for commercial operation in these more populated areas, the drone developers will rapidly adapt.

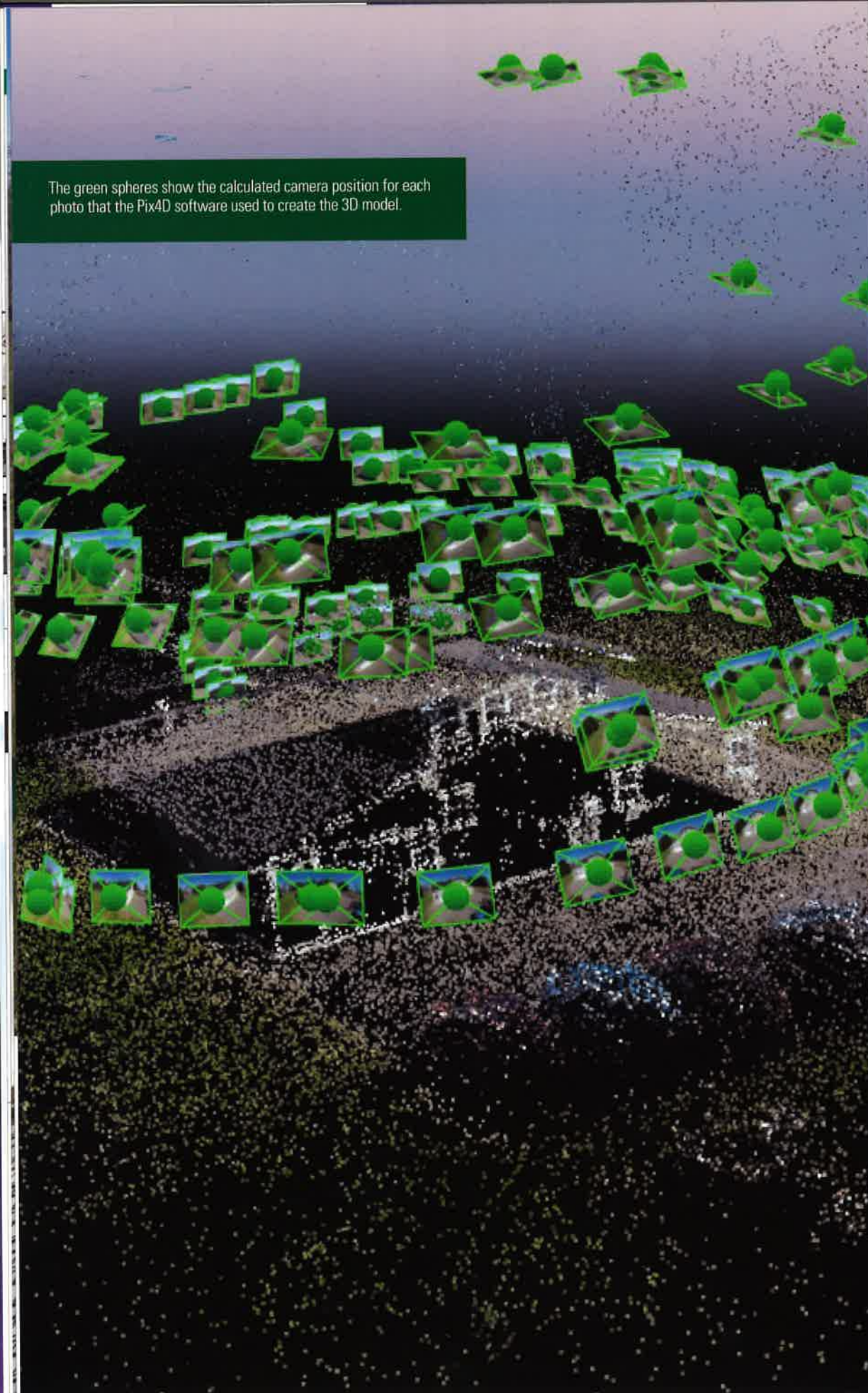
Applications - Rigging

Applications using UAV technology promise to significantly transform critical elements of the practice of restoration. Many of the physical areas that need to be evaluated in a typical restoration project are difficult to access. The two options for evaluating such areas are to "figure out a way to get up there" or to "view remotely." Regardless of the option chosen or required for a particular application, UAVs can help.

If hands-on access is required, UAVs can replace the "first person up." In the case of a spire, steep roof or tower, a UAV, mounted with simple robotics, can fly a rigging cord up-and-over a structural element allowing for the installation of a fall protection line to be secured prior to personnel attempting to access the feature.

Technology - Software

If hands-on access is not feasible, an affordable drone mounted with a relatively inexpensive camera can quickly gather video and photo documentation. The visual evaluation of the footage is only the beginning. Software programs such as Pix4D, Agisoft PhotoScan, PhotoModeler, ReCap 360, and others can generate photogrammetric



The green spheres show the calculated camera position for each photo that the Pix4D software used to create the 3D model.

When the project demands it, these programs can be used to provide not only scaled background drawings for assessment and construction documents (accurate to within a centimeter) but also a three-dimensional model at a relatively low cost.

models of an architectural element, or even an entire building.

Although these programs can be expensive (Pix4D is currently \$8,700 for unlimited use), flexible monthly or yearly rental costs are far less than the costs of ground-based laser scanning or development of drawings based on hand-measurement. When the project demands it, these programs can be used to provide not only scaled background drawings for assessment and construction documents (accurate to within a centimeter) but also a three-dimensional model at a relatively low cost,



The densified point cloud in Pix4D

which allows consultants to collaborate and link between the office and the site by using BIM programs, such as REVIT.

Photogrammetry programs all operate on the same principles and can process digital photographs or video stills taken by almost any camera. (AutoDesk's free 123D Catch app even allows you to make a shareable, printable 3D model from your computer or smartphone with only a few dozen digital photographs.) These programs work by matching common points across multiple images.

By calculating the camera location from which each shot was taken, the software places each matched point in space to create a three-dimensional point cloud. Vegetation, sky, and clouds show up as noise and can be removed from the point cloud manually.

The model is georeferenced and automatically scaled using GPS data embedded in the photographs or by referencing known ground coordinates. Field measurements can be used to scale the model in the absence of GPS data or to refine the model where

increased accuracy is desired. Highly accurate measurements are then taken directly from the point cloud to aid in the creation of measured drawings.

Applications

More than just a tool for visualizing a structure, the 3D model can be repackaged into file formats that are usable on other software platforms. OBJ, DXF, and other file types allow the model to be imported into programs such as AutoCAD or MicroStation. Orthoimages, in GeoTIFF format, are rectified into planar projections of elevations or

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sections through the model, which can be used as backgrounds images for a visual survey. For site planning and other landscape-scale applications, georeferenced Google and Mapbox tiles can be generated as outputs. Animated fly-throughs and 3D PDFs provide an easy way for project team members to view 3D models without specialized software.

Drone-based photogrammetry solves one of the limitations of ground-based laser scanning, which is the difficulty in capturing surfaces that are outside of the available sight lines from street level or from nearby buildings. And now, even laser scanning is going aerial, with several (very expensive) lightweight scanners on the market that can be carried by a drone. In the future, the full integration of BIM and Revit into work on existing buildings will likely take advantage of the efficient visual and spatial data collection offered by UAVs.

Conclusion

As operators continue to expand the realm of possibilities for UAVs, the regulations governing commercial use are slowly changing. On June 21, 2016, the FAA announced new rules under Part 107 of the Federal Aviation Regulations. The biggest change is that commercial UAV operators are no longer required to be licensed

aircraft pilots. Instead, when these rules go into effect in August, operators will have to pass a test and a background check to receive a remote pilot certificate. The new rules still prohibit drone flights over populated areas. •

About the Authors

Kelly Streeter is a partner at Vertical Access where she leads the specialized tall building investigation teams nationwide. Her experience includes projects on numerous iconic structures including the United States Capitol Dome in Washington DC and the Chrysler Building in New York City. She is a frequent presenter at industry conferences, chairperson for the American National Standards Institute (ASTM) Z359.9

sub-committee on Personal Equipment for Protection Against Falls, and leads the in-house development of inspection technologies including direct-to-digital annotation software (TPAS®), and 3D imaging techniques using unmanned aerial vehicles. She is a lecturer at graduate-level historic preservation university programs, and a SPRAT certified Level III industrial rope access supervisor.

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worked on a variety of investigation and documentation projects, including McKim Mead and White's Manhattan Municipal Building, the Chapel at the United States Naval Academy and the historic campus of Harvard Medical School. She is actively involved in the continued development of the TRAS® direct-to-digital documentation system and the documentation of structures using unmanned aerial vehicles. She holds a Bachelor of Arts from Colby College and a Master of Arts in Historic Planning from Cornell University.