Photogrammetric Innovations for Industry Applications

How Image Data and BIM will Modernize the Construction Industry

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Turn images into 3D data

The science of photogrammetry, along with computer vision, is whats behind the process of creating digital 3D models of scenes simply from overlapping images. These images can come from handheld cameras, airplane cameras, or cameras mounted on a drone. Hundreds of images can now be combined to create highly detailed, full color representations of landscapes and structures. The 3D model can also be flattened into a 2D image with orthographic scaling. These maps and models are utilised by the survey, mapping, agricultural, real estate and construction industries to provide complete geometrical and visual information of environments.

How much of a project's cost is spent on mistakes?

Before laser scanners, automated survey equipment, and digital cameras, analyzing a construction site was more basic. Tape measurements helped verify the build, and photos served as a visual reference to site progress. This data wasn't highly comprehensive or shareable, and the construction life cycle saw inherent problems as a result. These could be as simple as delays caused by a late material delivery, or as inconvenient as placing building sections in the wrong place. Industry estimates quote that 15% of a project's costs are typically from rework. These costs can be greatly reduced as a result of new data capture methods and construction processes.

From blueprints, to CAD, to BIM

The construction industry saw a revolution when 2D CAD systems replaced hand-drawn blueprints. Computerization of the design process majorly increased efficiency and allowed more complex projects to be considered, eventually leading to 3D CAD. The BIM process was the next revolution: not BIM software or any one system, but a process that defines how a project is best designed and built. The process is efficient as long as it is carefully monitored, with any deviations addressed. This is where the latest data capture methods become essential.

Reinventing Photogrammetry

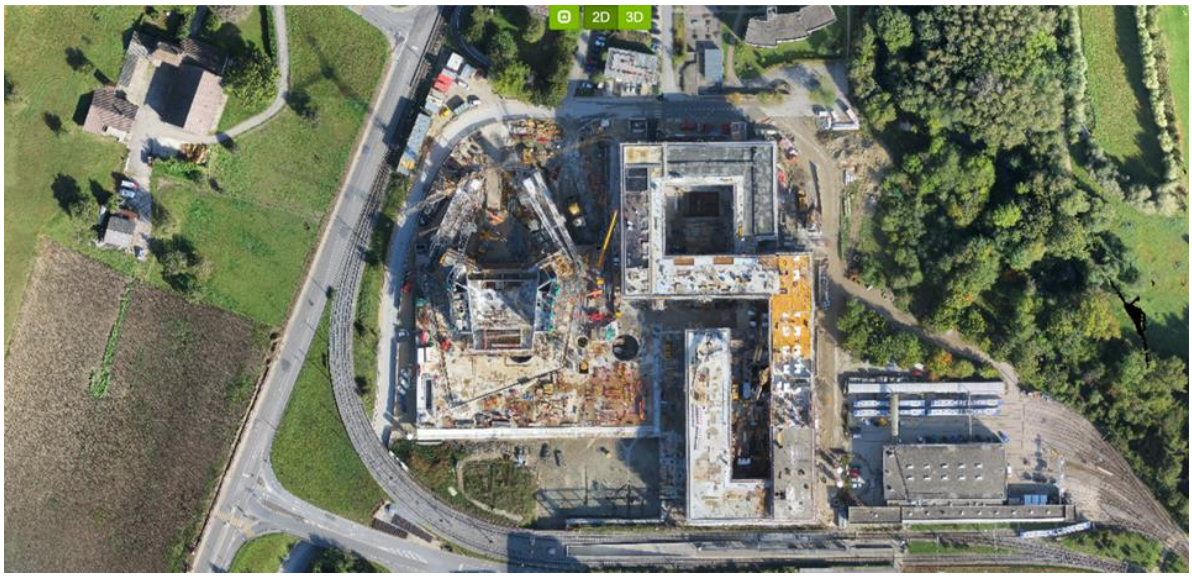
Photogrammetry, the science of creating 3D geometry from photographs, traces its mathematical roots back over three centuries. The science was reborn with the invention of the digital camera: image matching data could now be extracted and analyzed at a much higher level than with previous analog devices.

As computer storage and processing power grew, photogrammetry's founding math principles were supercharged to process image datasets. Software like Pix4D can now process hundreds of overlapping images of a site and produce centimeter-accurate, full-color 3D models and 2D orthophotos in a matter of hours.

New ways to collect images on a construction site

Typically, images from an airplane camera rig or handheld camera were used for photogrammetry. Now drones are offering quick and useful ways to collect aerial images, which are less intrusive to construction sites than hand capture. However, sometimes to get all of the detail required for a project, aerial images are not enough. A different camera may be necessary if data from difficult-to-view areas or the interior is needed.

One interesting option is to create 3D data by using images from a 360° full panoramic camera. By simply walking around these areas to capture overlapping images, the indoors and hard-to-reach sections would be reconstructed for the BIM verification process.



2D map generated from multiple drone-captured images. This map is orthographic, meaning perspective-free, fully scaled and measurable, and georeferenced. It is typically used to verify the as-built site status and provide up-to-date visual and survey data.

Images from UAVs at the construction site

Collecting survey data using traditional on-site methods such as total stations and laser scanning is expensive, inconvenient and intrusive. It is therefore clear that collecting images from a UAV flown over a site that can produce survey data remotely is a big advantage. The flights do not interrupt the site operations and can be repeated, even on a daily basis, for regular updates.

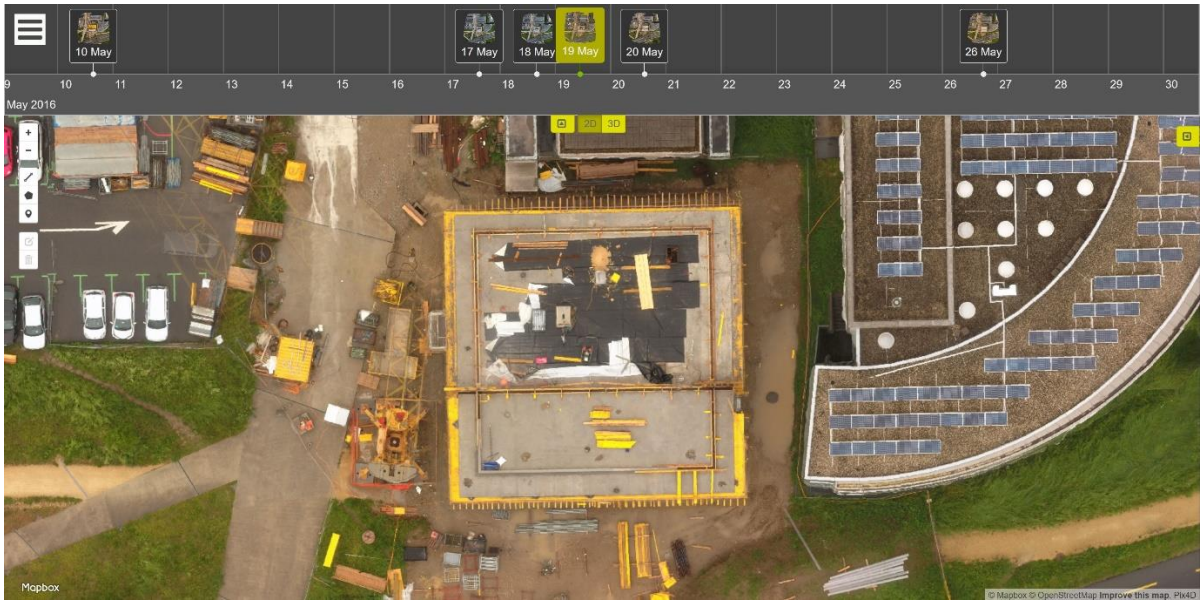
3D computer model, created from multiple drone images. This data is geometrically correct and used to compare the as-built status of the site with the design models. Custom videos of the model can be made for project review and publicity.

Tower crane cameras: An automated and non-intrusive solution

A new solution from Pix4D combines a camera mounted on a tower crane with the power cloud processing offered by Pix4D. The camera captures high-resolution images automatically while the crane is completing its normal operations. When sufficient images are captured to create a 3D and 2D model of the site, the images are transmitted via the cell-network to the Pix4D cloud and automatically processed. The results are then stored on a web browser application, and can be accessed remotely by anyone who needs to review the current status of the site. Capturing images from a tower crane is a truly remote and unintrusive way to get the data. Because of the automatic nature of the image capture and processing, no human intervention is required to get a daily visualisation of the site status. What better way to verify the BIM process than to have automatic daily updates of the site.

Why this data is valuable in construction

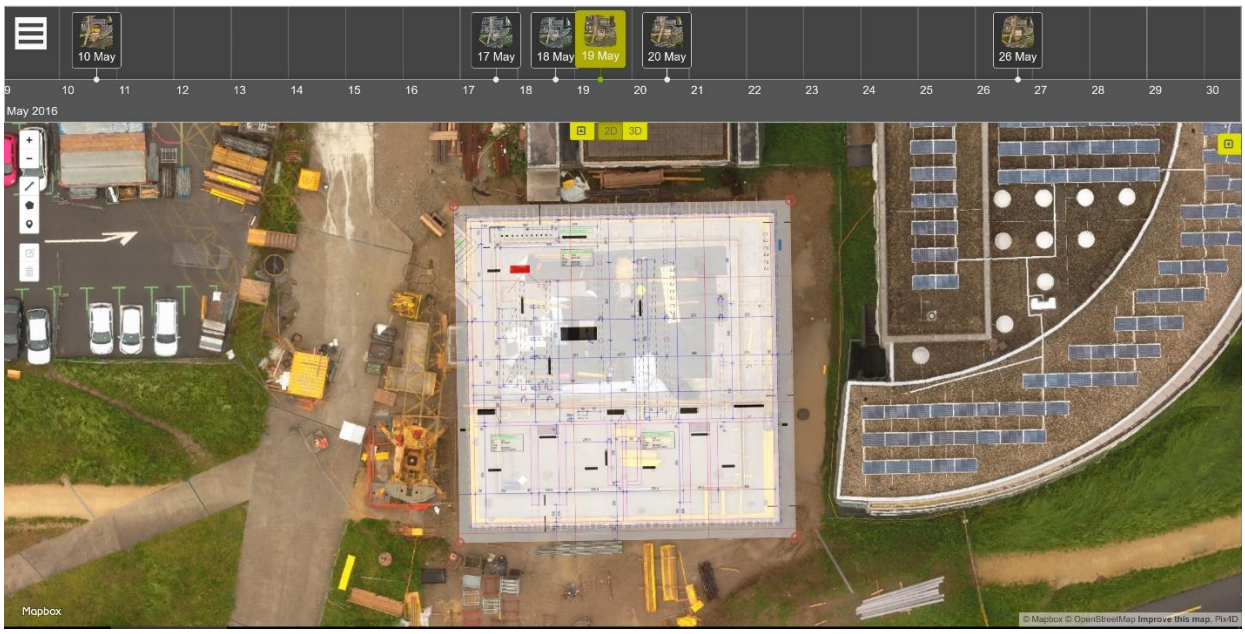
During the build phase of a construction project, it is often necessary to collect survey data. In the early stages, this can be a pre-build site survey that gives important data to the earthwork contractors. During the build, routine surveys of the as-built status of the project are compared to the design to ensure that everything is proceeding correctly. Spotting any construction errors early can avoid unnecessary and expensive rework at later stages. Also, checking the progress of the build against the schedule provides a valuable check that everything is on-track: especially important if the project is following a BIM process.



A time-series of 2D maps generated by a mosaic of multiple images. These images are orthographic: perspective-free, fully scaled, measurable and georeferenced. This time-series provides important information on the progress of the project, and can help detect scheduling problems.

How this system supports the BIM process

For the BIM process to be successful, the scheduling devised by the BIM application must be strictly adhered to. Any deviations from the schedule that are caused by errors can only be compensated for if these errors are spotted early enough and then fed back into the BIM process. Having image data collected and processed in an automatic and regular way will provide the BIM process with the error checking and verification information required to keep it on track. The crane camera solution provides just this: an automatic, autonomous workflow that can deliver daily updates directly to a web server, with no human intervention and minimal cost.



A 2D as-built map compared to the as-design drawing taken from the BIM application. This allows the as-built status of the project to be understood, and any errors spotted early. Also, the scheduling can be verified.