Topcon's ImageMaster

ImageMaster is photogrammetric software recently released by Topcon. This program allows the use of digital photos for various surveying purposes, such as photogrammetric measurements or preparing orthophotos. Originally designed to be used with an imaging total station, it can also be used with a digital camera. The package includes a calibration program for calculating the parameters of a camera lens, which is required to remove the distortion that is inherent in any camera lens. Point clouds from a digital scanner can be used, but this review will concentrate on the photogrammetric uses only. (ImageMaster was formerly marketed as the PI300 software by Topcon.)

How to Use It

ImageMaster uses photogrammetric methods that allow the parallax in a pair of stereo photos to be measured and converted into XYZ coordinates. The process involves several steps:

1. *Calibrate the camera.* You can calibrate the camera by taking five photos of a test pattern from specific angles and processing them with the calibration software. The test pattern is provided with the software, which consists of a grid of dots and diamonds. In my case, I printed them out on 11x17 paper, stuck it to the wall, and photographed it with a Canon Rebel XT digital SLR, which was zoomed out to wide angle. After I loaded the five photos into the software, it automatically identified the patterns in the photos and saved the lens parameters. This calibration needs to be done only once for a fixed-length lens.

2. *Take a stereo pair of photos of the subject* (in my first example, a house). The photos need to be taken a similar distance from the target, with the camera oriented in the same direction and the entire subject included in each photo. Each pair of photos creates one stereo model. If the subject is large, multiple stereo models can be stitched together later.

3. *Measure the coordinates of at least four control points that are visible on both photos and are distinctive.* For my first example, I used a reflectorless total station to measure the points. Good note-keeping is required to keep track of the points. An imaging total station would be very nice for this step, as it records the exact spot the cross hairs were on.

4. *Load the control coordinates, the stereo photos, and the lens parameters* into ImageMaster and designate the location of each control point in both photos. The software will then calculate the parallax of the photos and return the error residual of each point.

5. *Coordinates of any point identifiable on both photos can now be measured.* ImageMaster also has the ability to create a TIN and contours from the points, and the photos can be draped over the TIN to make orthophotographs.

Tests

I experimented with two examples for this review. The first was to take photographs of a house and measure the control coordinates of it. I also measured other photo-identifiable points to use as extra quality control points. After loading the data and processing the ground control, I compared the coordinates generated by the software to the coordinates of the extra points measured with the total station and found they were typically within a tenth of the measured locations. The software also generates the coordinates of where the camera was when it took the photos, so those coordinates could also have been measured and compared as an extra level of checking.

For the second example, I wanted to try a mapping project. Initially I scanned in a stereo pair of photographs for a small photogrammetric project I had mapped by a photogrammetrist a few years prior, but soon realized I could not use them because I did not have the lens parameters for the camera that had taken the pictures. Not to be thwarted, I resorted to

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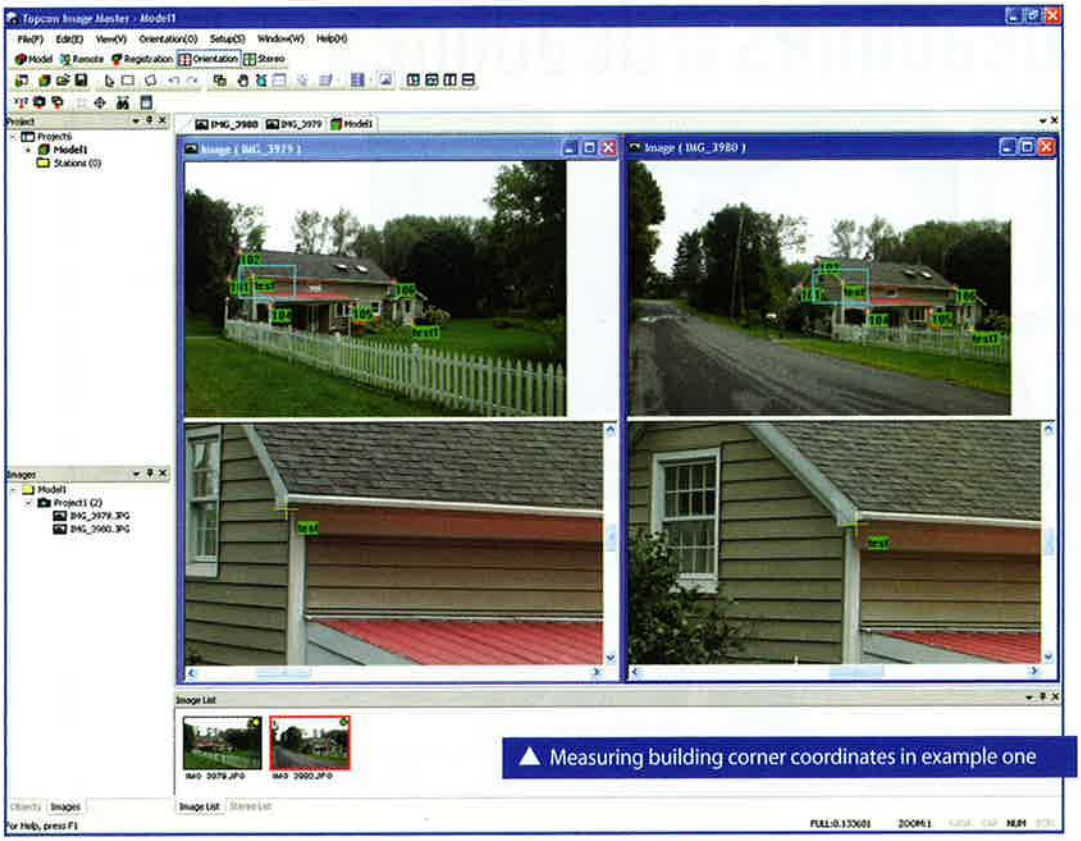

▲ Measuring building corner coordinates in example one

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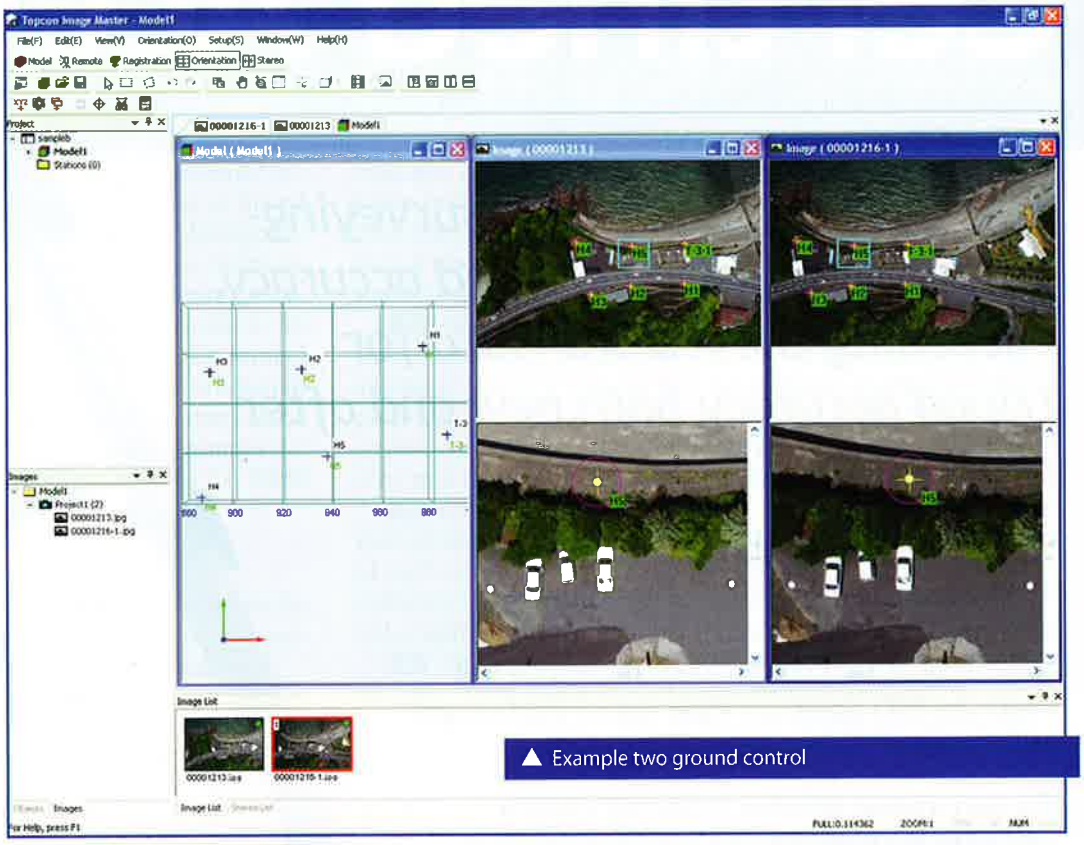
a pair of sample photos that are provided with the software (the control coordinates and camera parameters were also provided).

Once again, I loaded the stereo photos, parameters, and control coordinates. In this case, the ground control targets were circular, so I used the optional center location routine to more accurately pick the control points on the photos. I then generated XYZ coordinate of various features on the photos such as utility pole bases and pavement stripes that were obvious on both photos.

This process showed me quickly how precise each of the points must be, as the difference of one pixel on the screen could make a noticeable change in elevation. This emphasizes the fact that on a fairly flat site, where the ground control points generally fall in one geometric plane, although it is fairly easy to get good XY coordinates the photos must have a very high resolution (each pixel covering a small amount of ground) to achieve a reliable Z measurement.



▲ Example two ground control

The sample data included in the software also included a point cloud, which when integrated into the models allows for the preparation of a more accurate TIN of the site. The example also continues on to produce an orthophoto of the site.

▲ The original photography for example two

Many Possibilities

An extensive manual is provided in PDF form for the software. Although it assumes the reader has a fair degree of knowledge of the terms used in photogrammetry, it is still useful in figuring out how to use the software effectively. ImageMaster also has a large number of other options and tools (that I did not experiment with) that can be used as a comprehensive tool to stitch together multiple stereo models and form complex 3D models of a subject.

I found ImageMaster to be a useful tool for generating models from stereo photos. My first experiment with it showed that it can effectively and accurately map 3D features of objects such as buildings, industrial plants, or quarry faces from remotely gathered photos and ground control, while not requiring direct access to them. The second example showed that it is also a useful mapping tool, especially for planimetric projects, but can also gather good topographic information when careful consideration is given to the ground control and photo's ground resolution. If combined with an RC helicopter or something like the Microdyne UAV flyer to obtain digital aerial photos of a site, this software could open many interesting possibilities for new methods of mapping sites.

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