United States Department of Agriculture Forest Service

FOREST SERVICE REMOTE SENSING TIPS
METHODOLOGY AND ADVANCED TECHNOLOGY

Enterprise Photogrammetry Software Overview: Imagine Photogrammetry and Agisoft PhotoScan

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Overview

Aerial imagery is an invaluable source of data within the Forest Service. However, before aerial imagery can be fully used for project work, it must be processed with photogrammetric software to derive such products as ortho-mosaics, stereo models, and 3-D elevation data. This document includes information about the two photogrammetric software applications selected as enterprise software solutions by the Forest Service: Imagine Photogrammetry and Agisoft PhotoScan.

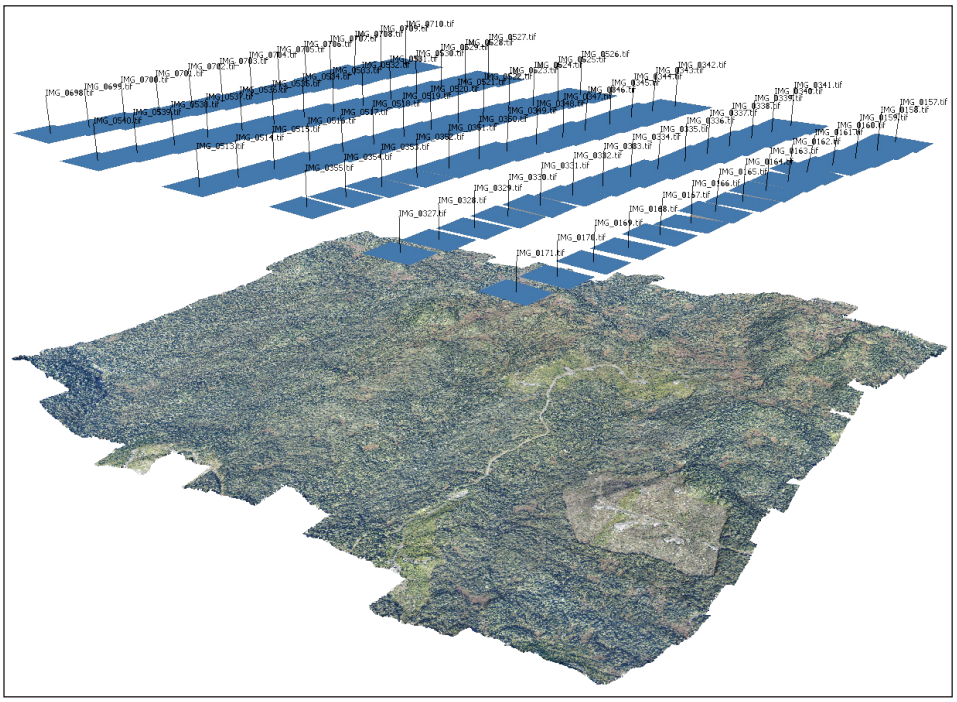

Figure 1—A 3-D surface model created using AgiSoft PhotoScan. The blue rectangles above the surface model represent the camera location for each of the images.

Introduction

This investigation was funded by the USDA Forest Service, Remote Sensing Steering Committee (RSSC) to support a proposal submitted by the Forest Service Alaska Regional Office. The original proposal was to specifically evaluate Agisoft PhotoScan. However, the timing of this project coincided with an enterprise photogrammetry software request for proposal (RFP) solicitation so we broadened the scope of our evaluation to include all photogrammetry software submitted in response to the RFP. This report, however, will only discuss the two software packages that received awards resulting from the RFP: Imagine Photogrammetry and Agisoft PhotoScan.

One of the main uses of photogrammetry software is to convert digital aerial images into digital image maps. This means that each pixel and imaged feature has a geographically defined map location such that distances, areas, and bearings can be measured accurately and directly from the image. The typical input for photogrammetry software is a set of partially overlapping (i.e., stereo) aerial photos, and the typical output is a color-balanced, ortho-mosaicked, image-map with few apparent seam lines. Other potential products include 3-D stereo models (which are required to view the imagery in stereo), 3-D point clouds (similar to lidar point clouds), and 3-D surfaces of the canopy cover and of the ground (figure 1).

Current Enterprise Photogrammetry Software

Since the early 2000's, Leica Photogrammetry Suite (LPS), now called Imagine Photogrammetry, has been the enterprise photogrammetry solution for the Forest Service. In the late fall of 2015 Agisoft Photoscan was added to provide additional capabilities. Imagine Photogrammetry represents the traditional and rigorous photogrammetry software package while PhotoScan is a highly automated, but specialized software package that includes structure-from-motion (SfM) capabilities. The SfM technique enables PhotoScan to align images and calibrate the camera with minimal input. Together, these two applications make a very complete photogrammetry software solution for the Forest Service. Each has strengths and weaknesses that align with the type of imagery used: current digital and film-based metric cameras with reference information, film-based metric cameras without a camera report, and non-metric cameras.

Digital and Film-based Metric Cameras with Reference Information

Digital and film-based metric cameras, which are designed specifically for photogrammetric purposes, have been used for decades to capture aerial imagery of the national forests. Two reference sources that have greatly facilitated the processing of aerial images are camera calibration reports (implemented in the early 1970's) and GPS and Inertial Navigation System (INS) data (implemented in the early 2000's). Imagine Photogrammetry is specifically designed to process aerial images that contain these reference sources. Since this type of imagery represents the bulk of photogrammetry work currently performed within our agency, Imagine Photogrammetry has been, and will likely remain, the enterprise photogrammetry workhorse, despite being a complex program with a relatively steep learning curve.

The initial output product from Imagine Photogrammetry is a project file (called a block file) that defines the camera's interior geometry, its orientation in space, and how the imagery is tied to the ground. The block file is used to create other outputs including the ortho-mosaic and elevation files (figure 2), and is used as input in stereo viewing and analysis software (such as Summit Evolution—the Forest Service enterprise stereo software).

Film-based Metric Cameras without a Camera Report

Historical aerial images acquired prior to the 1970s typically do not have camera reports. Imagine Photogrammetry can accurately and effectively process such images; however, a pseudo-camera report is required and the overall process is complicated. PhotoScan appears to be better suited to process this type of imagery since a camera report is not required—and the software is simpler and easier to use than Imagine Photogrammetry. Within PhotoScan, the user is able to generate ortho-mosaics, 3-D PDFs, point clouds, and surface models (figure 3). However, PhotoScan does not produce a project file that is directly ingestible by the stereo viewing and analysis software. If tools other than those found in PhotoScan are needed, the project file can be converted to a block file and used in Imagine Photogrammetry and Summit Evolution.

Figure 2—A 3-D point cloud of an access road and trees located in Medicine Bow National Forest—derived from metric imagery processed with Imagine Photogrammetry.

Non-Metric Cameras

Non-metric cameras include amateur and professional handheld cameras, which are not specifically designed for photogrammetric purposes. Aerial imagery from non-metric cameras is expected to become more common as Unmanned Aerial Vehicles (UAVs) become more widely used. Imagine Photogrammetry struggles with imagery from non-metric cameras. Fortunately, this is where PhotoScan excels. PhotoScan requires very few inputs apart from the image files. It then automatically handles most of the processing. PhotoScan enables the user to create accurate ortho-mosaics, point clouds and surface models from imagery captured with a non-metric camera (figure 4). And again, if tools other than those found in PhotoScan are needed, the PhotoScan project file can be converted to a block file, which can then be used in Imagine Photogrammetry and Summit Evolution.

Additional Image Types

In addition to processing traditional aerial imagery, Imagine Photogrammetry and PhotoScan can be used to process other image types. Imagine Photogrammetry can be used to process satellite imagery with associated rational polynomial coefficient (RPC) files to produce products such as ortho-mosaics, surface models, point clouds, and stereo project files. PhotoScan, on the other hand, excels in the digital reconstruction of objects using terrestrial imagery as can be seen in figure 5.

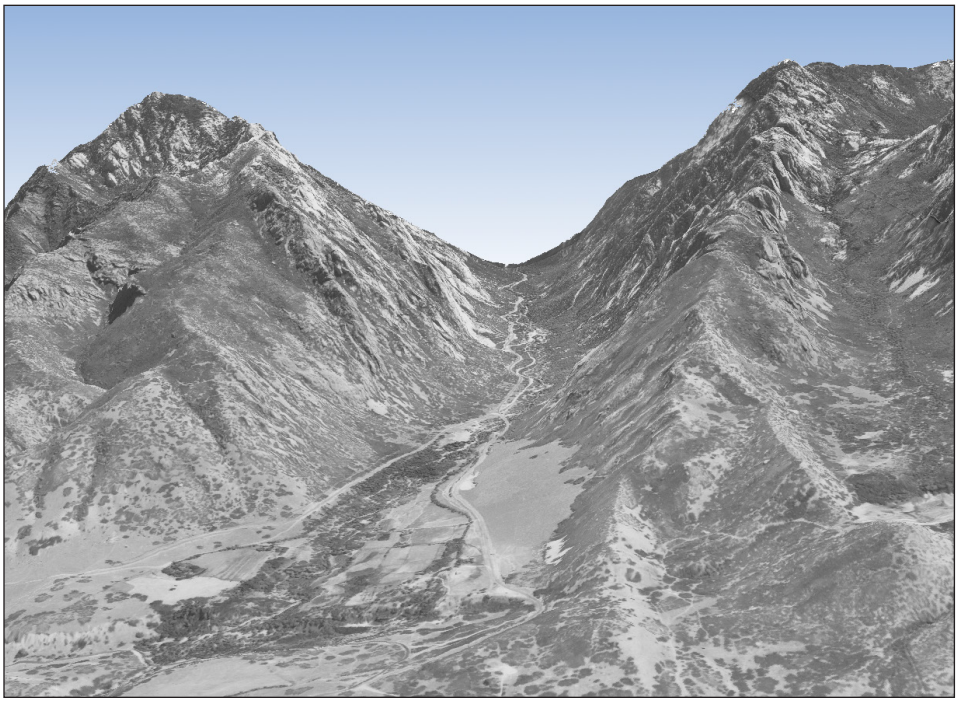

Figure 3—A 3-D surface model of a canyon located in the Wasatch National Forest. PhotoScan was used to orthocorrect the 1940 aerial imagery and to produce the 3-D surface model.

Conclusion

Together, Imagine Photogrammetry and Agisoft PhotoScan make a very complete photogrammetry software package for the Forest Service. Imagine Photogrammetry continues to be the main photogrammetry software solution for processing imagery from current digital and film-based metric cameras, as well as satellite imagery (figure 6). With the addition of PhotoScan, Forest Service personnel will now be able to more easily process scanned imagery that lacks a camera report and imagery from non-metric cameras. In addition, PhotoScan opens up new capabilities for Forest Service personnel to process terrestrial imagery. For projects that require stereo viewing or more control while creating orthomosaics, Imagine Photogrammetry is the software to use. Fortunately, datasets that are processed with PhotoScan can be imported into Imagine to take advantage of some of these additional image processing and visualization tools.

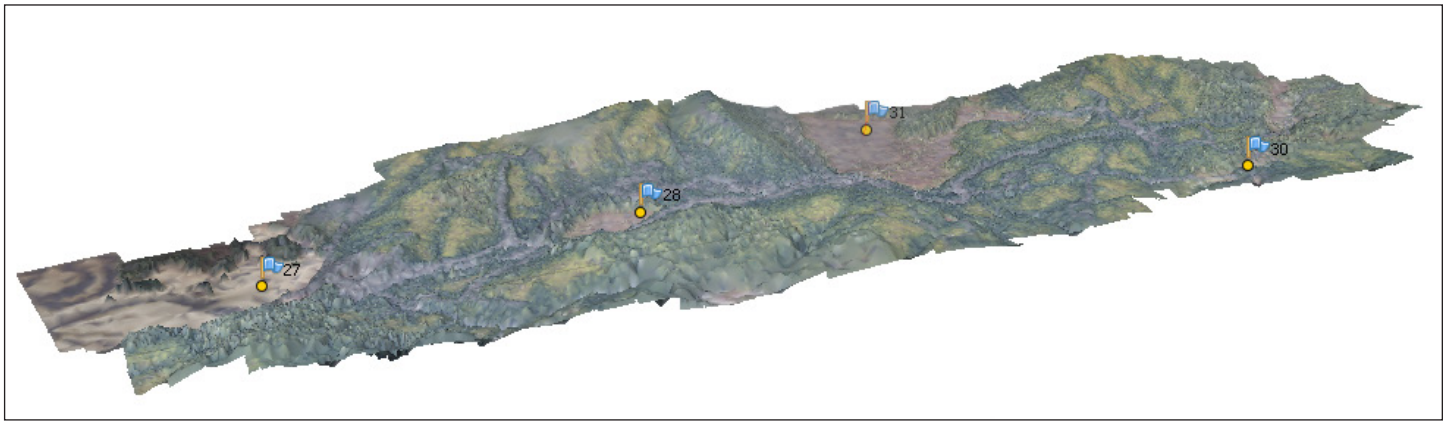

Figure 4—A 3-D surface model of a stream located in the Tongass National Forest. PhotoScan was used to orthocorrect the non-metric imagery and produce elevation data for a stream restoration project. The imagery was taken from a fixed-wing plane using a Canon 5D Mark II camera.

Figure 5—A 3-D digital model of a bridge located just south of Anchorage, AK. PhotoScan was used to process both aerial and terrestrial imagery for a bridge inspection project. The imagery was taken using a Sony Nex7 camera mounted on a UAV and a handheld Nikon D800E camera.

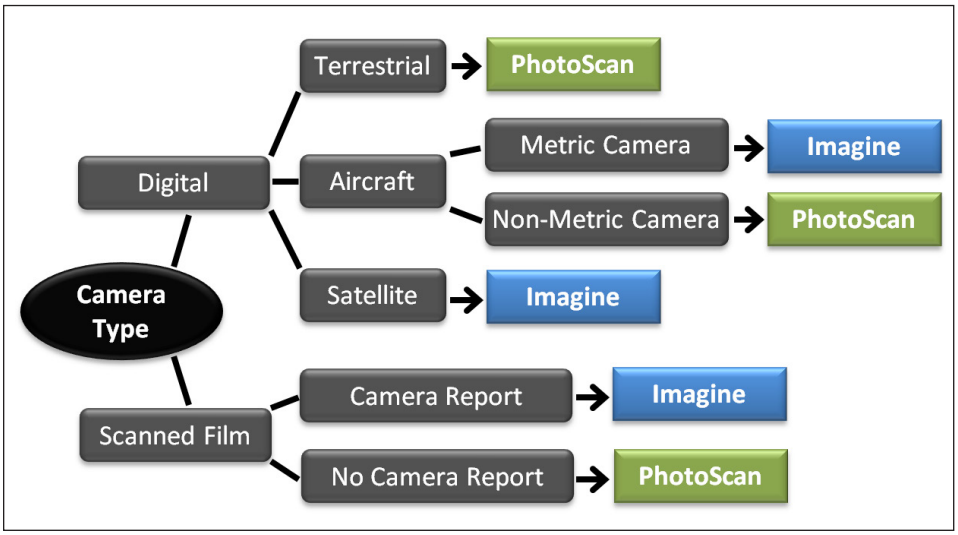

Figure 6—This decision tree navigates the user to the most applicable software solution for a given type of imagery. Many types of imagery can be processed with either Imagine or PhotoScan; however these recommendations are based on the results of example datasets used in this study.

Additional Resources

To learn more about Imagine Photogrammetry and PhotoScan, please use the following link to access the Georeferencing Aerial Imagery online tutorial: http://fsweb.geotraining.fs.fed.us/www/index.php?lessons_ID=3039

If additional assistance is needed with the software applications, please contact the Remote Sensing Helpdesk by calling 866-945-1354 or by visiting http://fsweb.chd.fs.fed.us/.

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