White Paper

ImageStation Production Throughput and Capacity

3 December 2020

Contents

Overview

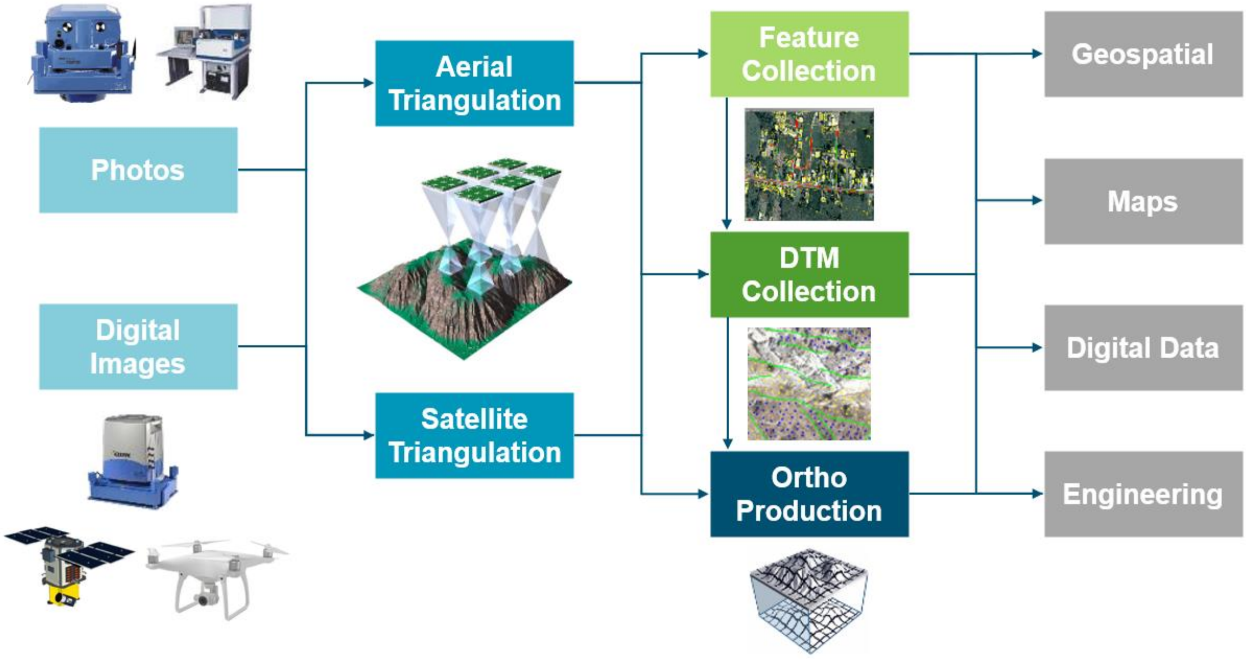
This white paper illustrates the efficient throughput and capacity of the ImageStation suite of products using modern hardware to perform a complete end-to-end photogrammetric production workflow.

Designed from the ground up for high-volume photogrammetry and production mapping customers, ImageStation streamlines and automates processes while still supporting the most comprehensive photogrammetric workflow on the market.

The high-performance algorithms, threaded processing, and distributed processing capabilities of ImageStation running on modern hyper-threaded machines with solid-state disk drives can be used to maximize photogrammetric production throughput and capacity.

The following photogrammetric workflow was performed:

- Aerial Triangulation – automated point matching and bundle adjustment
- DTM Collection – automated DTM surface generation via feature-based matching
- Ortho Production – automated orthomosaic production



System Specifications

The system used for this project is an HP Z840. System specifications are as follows

- Dual Intel Xeon processors E5-2697 v3 (35 MB cache, 2.60GHz), 14 cores each with 28 threads for a total of 56 hyper-threaded cores
- 32GB DDR4 2133MHz RAM

- Two Samsung 500 GB solid-state disk drives (SSD), and two Micron Technologies 1 TB SSD drives. Each pair was combined into a RAID 0 configuration for a 1 TB and 2 TB capacity respectively

In addition, the following hard disk drive (HDD) and HP Z Turbo Drive Quad Pro card configurations were tested for comparison:

- Two ATA ST2000DM001 – 1ER1 SCSI, 7200 rpm HDDs, 1.8 TB formatted capacity each. The drives were partitioned into four 900 GB drives, three of which were used for processing. A RAID 0 configuration was not used.
- Four NVMe Samsung MZVPV512 SSDs installed using an HP Z Turbo Drive Quad Pro card that installs into a PCIe slot on the bus. The disks were configured as one RAID 0 drive with 1.9 TB capacity.

In all three tests, the input and output data were staged on separate drives to minimize disk I/O contention.

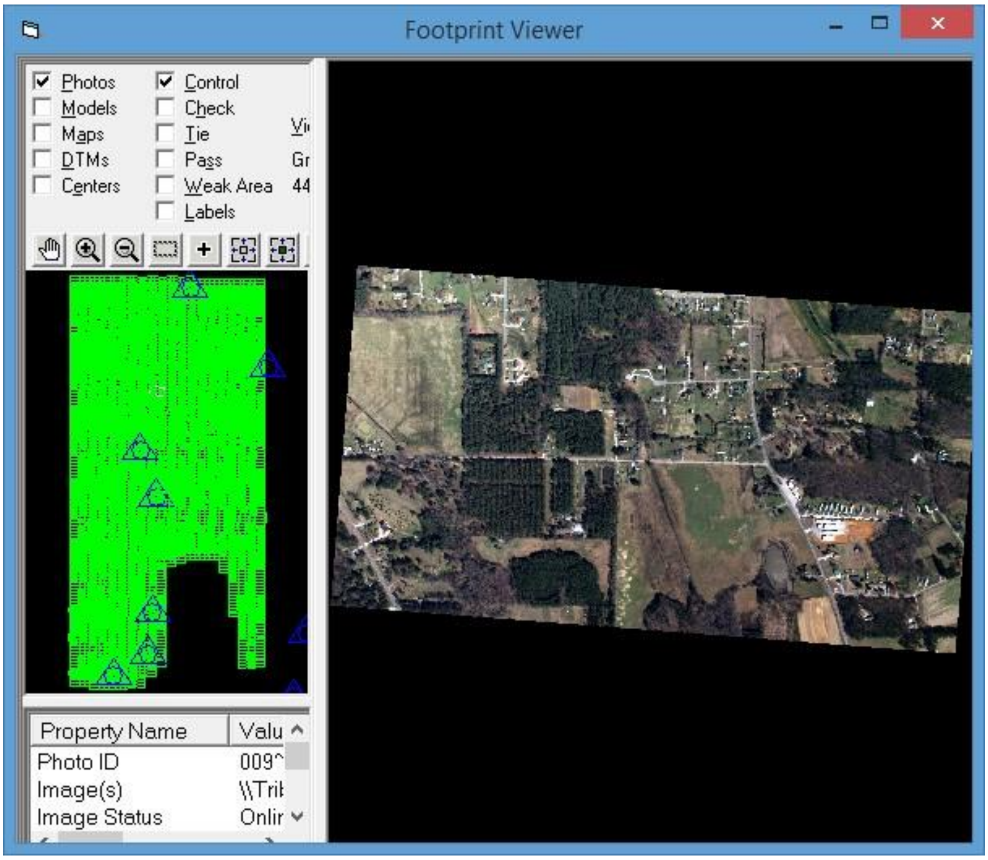
Software

The following ImageStation products were used to perform the workflow:

- ImageStation Automatic Triangulation (ISAT)
- ImageStation Automatic Elevations (ISAE)
- ImageStation OrthoPro (ISOP)

Data Set

The data set used consists of 2,113 photos captured with a Leica Geosystems DMC camera over the western half of Madison County, Alabama, USA. Images were formatted to tiled (256) TIFF, 3 bands, 8 bits per band. The project was flown at roughly 4000 feet AGL with a nominal GSD of 0.4 feet, and used 843 GB of disk space. The number of photos used in this test was limited only by the available disk capacity.



Aerial Triangulation (AT)

The AT process was performed using ImageStation Automatic Triangulation (ISAT). The product provides three main methods for automatic point matching:

- Do Not Use GPS/INS – This method indicates that any given exterior orientation parameters are approximations and therefore has a larger search range for finding matches between images. It also performs matching for more levels through the overview pyramids of the images. This is the slowest method but is the most forgiving in terms of input parameters.
- Use GPS/INS – This method indicates that the given exterior orientation parameters were provided from a calibrated GNSS/INS system and therefore are assumed to be quite accurate. The search range for matches between images is limited to +/- 2 rows of pixels along the epipolar axis of the images, and one less overview level is processed than when using the *Do Not Use GPS/INS* method.
- GPS/INS QC/QA – This method processes with the same constraints as the *Use GPS/INS* method, but processes even fewer levels. Also, the number of pass/tie points produced is automatically thinned to a minimal amount, but enough to calculate a bundle adjustment to eliminate residual parallax that is typically seen even with highly calibrated GNSS/INS systems.

Testing was performed using all three methods to demonstrate differences in processing times. *Point Thinning* was used to reduce the number of matched points to a level of points suitable for AT work, and *Stringent Matching* was used as a post-process for the first two methods to add geometric strength to the block, as these are considered best practices for ISAT users.

Test Results using SSD Drives

Method	Thinning Parameters	Stringent Matching	Total Time	Seconds Per Photo
Do Not Use GPS/INS	9x9 grid	Yes	**02:16:59**	3.9
Use GPS/INS	9x9 grid	Yes	**02:31:04**	4.4
GPS/INS QC/QA	Automatic	No	**00:32:22**	0.9

Test results using the HDD drives took approximately 3 times longer. Test results using the Turbo Drive card were approximately 1.2 times faster.

DTM Collection

The DTM surface generation process was performed by using the feature-based matching method provided by ImageStation Automatic Elevations (ISAE). *Blockwise Matching* was used to digitize a polygon over the model footprints that generates non-overlapping surface boundaries for the DTM extraction process. This reduces time by eliminating redundant processing of overlapping model areas.

Elevation Collection Parameters were set to *Hilly*, which set the *Parallax Bound* to 15 pixels and the *Epipolar Line Distance* to 3. The default *Grid Width* of 13 feet was used as was the default value of *Low* for the *Smoothing Filter*. The *Output Parameters* were set such that only the DTM surface files were output.

Test Results using SSD Drives

After some experimentation to determine the optimum system load, jobs were submitted using HTCondor distributed processing on the one test system such that ISAE would process up to 8 models at a time in parallel. All models (2098) completed in 2 hours and 24 minutes.

Process	Total Time
DTM surface generation	**02:24:00**

Test results using the HDD drives took approximately 4.6 times longer. Test results using the Turbo Drive card were slightly (1.1x) faster.

Ortho Production

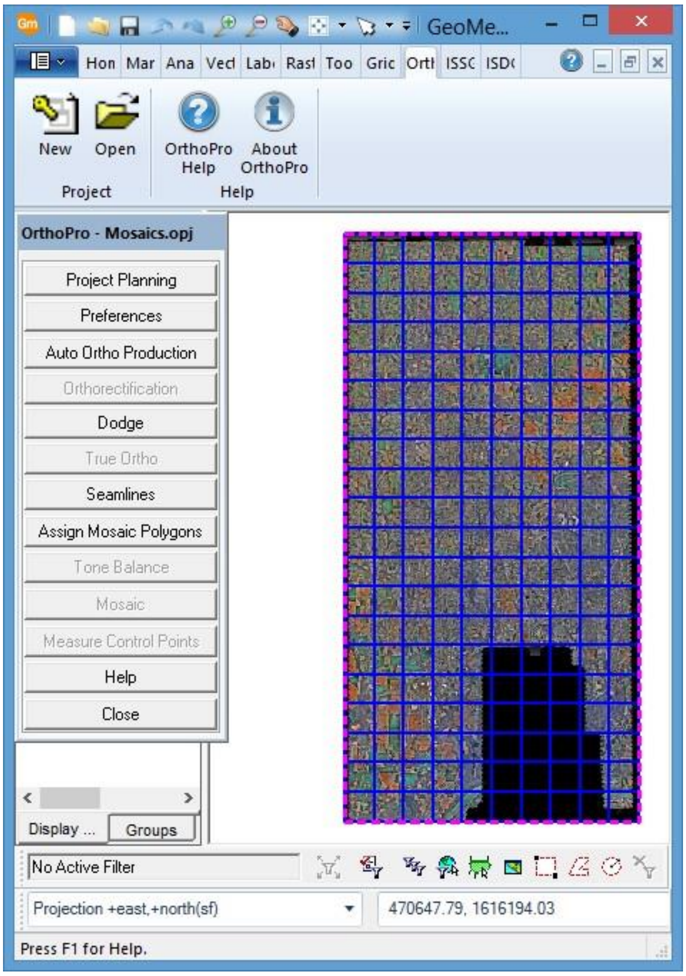
ImageStation OrthoPro (ISOP) was used to perform orthorectification, dodging, automatic dynamic range adjustment (ADRA) image enhancement, seamline generation, tone balancing, and mosaicking as an automated process.

Rectification was performed using *Cubic Convolution* interpolation method. *Dodge*, *Dehaze*, and *ADRA* were enabled. Surfaces were sampled every 32 pixels. Because the surface files from ISAE abutted one another, the option to interpolate between surfaces was enabled. Files were output in TIFF format with a 512 pixel tile size, JPEG compressed with a Q-factor of 2, and with a full set of averaged overviews. After some experimentation to determine the optimum system load, jobs were submitted such that ISOP would process 8 orthos at a time, and mosaic 28 products at a time. In total, 2113 dodged/enhanced orthos were produced, as well as 200 end mosaic products (8000x8000 pixels each).

Test Results using SSD Drives

Process	Method	Total Time
Orthorectification	Dodge, dehaze, ADRA	**01:40:00**
Seamline generation	Smart Seam method 32 pixel sample	**00:12:00**
Total balance calculation		**00:20:00**
Mosaicking		**00:42:00**
Total		**02:54:00**

Test results using the HDD drives took approximately 4.6 times longer. Test results using the Turbo Drive card were approximately 1.25 times faster.



Conclusion

The high-performance algorithms, threaded processing, and distributed processing capabilities of ImageStation running on modern hyper-threaded machines with SSD drives can be used to maximize photogrammetric production throughput and capacity. For this 2,113 photo project, the total processing time when using SSD drives was less than 6 hours[1] (5 hours and 50 minutes). The total processing time when using HDD drives was 4.5x longer. The total time when using the Turbo Drive card was 5 hours. Production users should expect some extra time for review and editing of results.

Test Results using SSD Drives

Process	Total Time hh:mm:ss
Automatic AT, DTM extraction, and orthomosaicking	**05:50:00**

[1] Using the GPS/INS QC/QA method of point matching

While it is clear that using SSDs to reduce the disk I/O bottleneck with HDDs greatly improved the performance of these processes, it should be noted that further gains are expected by adding additional drives to each RAID 0 configuration. We also saw that new drive technologies such as the HP Z Turbo Drive card can further improve overall performance. However, the performance gains seen using the Turbo Drive card were less than expected so we do not consider those results to be conclusive until we can test with 2 separate cards for input and output data. To think that the AT process, DTM surface generation, and ortho production for half a county could be completed in a single work shift is rather remarkable.

With ImageStation, Hexagon's Geospatial division demonstrates its commitment to providing an efficient, integrated photogrammetric platform for geospatial content producers such as commercial mapping firms, national mapping agencies, and other production mapping customers. Such organizations rely on ImageStation's automation features and optimized tools for manual processing to quickly transform large volumes of incoming data into exploitable spatial information to drive smarter decisions.

Contact Us

https://go.hexagongeospatial.com/contact-us-today

About Hexagon

Hexagon is a global leader in sensor, software, and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous — ensuring a scalable, sustainable future.

Hexagon's Geospatial division creates solutions that visualize location intelligence, delivering a 5D smart digital reality with insight into what was, what is, what could be, what should be, and ultimately, what will be.

Hexagon (Nasdaq Stockholm: HEXA B) has approximately 21,000 employees in 50 countries and net sales of approximately 4.4bn USD. Learn more at hexagon.com and follow us @HexagonAB.