A3 EDGE MAPS VAST RUSSIAN AREAS

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ABSTRACT
This paper summarizes the characteristics, features, and unique capture technology of the A3 Edge Digital Mapping System. The paper analyzes two large-scale mapping projects – urban and forestry - executed in Russia using the A3 Edge System, and summarizes the performance of the system in each case.

1. Introduction

A3 Edge [2,3], VisionMap's newest digital mapping system, has gained attention for the high productivity, resolution, and accuracy it provides. The camera is based on a unique technology of two "sweeping" telescopes. The telescopes capture single frames while sweeping perpendicular to the flight direction. By doing so, they generate a wide field of view.

Coupled with the A3 LightSpeed automatic processing suite, A3 Edge provides a complete end-to-end mapping solution. A3 LightSpeed automatically performs aerial triangulation and produces orthophotos, stereo pairs and DSM from A3 camera images. As VisionMap customers take on larger and larger projects, A3 LightSpeed has to deal with an incredibly large amount of imagery. It does so successfully, with the complete A3 Digital Mapping System meeting all industry standards.

Mathias Lemmens [1] highlighted the system's unique capture and processing methods in his 2014 article "Digital Oblique Aerial Cameras" published in GIM International. Lemmens describes A3 Edge's high productivity and efficiency compared to other large format systems on the market.

2. The challenge

Baltaeroservice, a Russian aerial survey and mapping company, specializes in aerial survey and mapping of linear infrastructure objects and large forest areas for the Russian Forest Agency. Over the years, the company has used various aerial survey and mapping technologies. They own Cessna P210 aircraft and have access to other aerial survey planes in the area.

With an increase in demand for constantly updated mapping products, for higher resolution, for vertical and oblique images of urban areas, and for regular mapping of very large areas of Russia, the company decided to purchase the A3 Edge Digital Mapping System, due to its meeting all of these requirements in a single system.

In 2014 the company used A3 Edge for two projects – mapping of very large forest areas and mapping of St. Petersburg.

The forest mapping project was commissioned by the Russian Forest Agency to cover large forest areas by aerial survey and produce color (RGB) and color infrared (CIR) orthophoto.

The urban project presented several challenges: minimal flight altitude restrictions, the need to use vertical and oblique images for orthophoto and 3D City model creation, and year-round scarcity of good flying weather in this part of the world. This project required a system that would be able to fly at high altitudes while meeting large scale mapping resolution and accuracy requirements, and being able to capture the area quickly and efficiently.

3. Aerial survey of vast forest

Russia contains over 8 million square kilometers of forest. The inventory of the forest area and forestry taxation is taken place every year. Typically, the inventory is taken by use of satellite images, and the taxation – by ground survey. A3 Edge technology, due to its extremely high aerial survey and processing productivity, successfully competes with satellite technologies. The high ground resolution and image quality of its RGB and NIR images enables replacing a labor-intensive ground survey for taxation with a simple and highly efficient aerial survey.

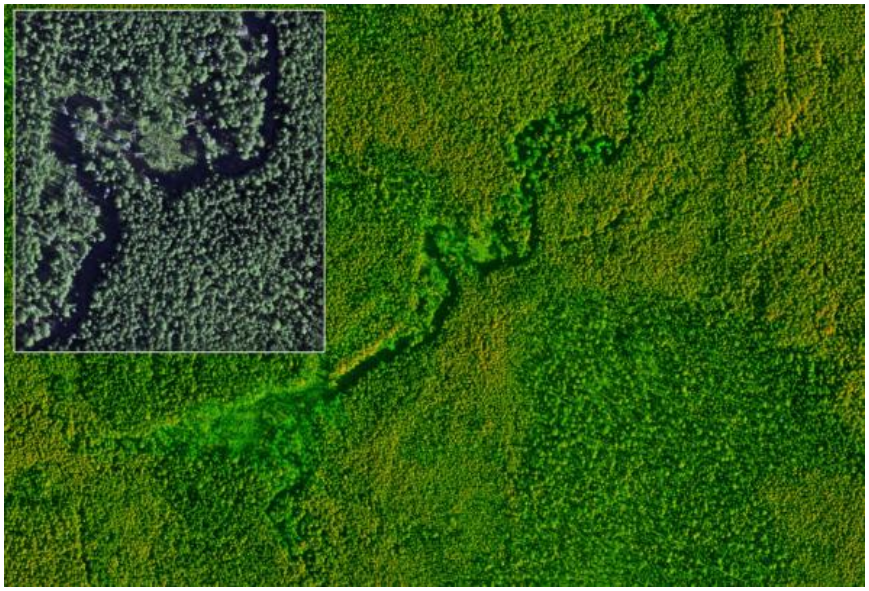

Image 1. Forest area. CIR orthophoto and RGB image.

In this project, A3 Edge collected RGB and NIR images of a 33,490 km^2 area at 14 cm GSD. The aerial survey of these vast areas was completed in less than 48 hours.

Region (Oblast)	Area (km^2)	Distance from the base (km)	Aerial survey time (hour)	Total flight time (hour)
Novgorodskaya (two areas)	10,780	250/330	16.0	36.1
Pskovskaya 1	1,290	200	2.4	3.8
Leningradskaya	4,660	170	6.4	10.9
Karelia	8,750	550	11.9	25.7
Pskovskaya 2 (two areas)	1,110	340/320	2.1	5.8
Archangelskaya	6,900	530	8.9	20.6
Total	**33,490**		**47.7**	**102.9**

The flights were executed with the following aerial survey parameters:

- Flight altitude – 17,700 feet
- Ground speed – 150 knot
- Forward and side overlap – 55% - 70%
- Distance between flight lines – 3,000 m

4. Processing of the forest imagery

Automatic processing of the imagery consisted of two main photogrammetric processes – aerial triangulation (AT) and orthophoto creation. An existing DTM was used for the orthophoto creation. The orthophoto was produced as 4-band (RGB and NIR) orthophoto at 30 cm GSD. The A3 LightSpeed photogrammetric software was used for the automatic processing. The processing was completed in 52 days.

A3 LightSpeed software features several powerful capabilities. LightSpeed's latest version supports up to 250,000 single images in a single block. The significance is that for GSD = 30 cm with a forward overlap of 55% and a side overlap of 60%, the area of the block can reach 55,000 sq. km. This efficiency enables the processing of very large areas as a single block, providing high homogeneous accuracy in the block and eliminating manual processes of connecting single blocks between them. Needless to mention is automatic tie point creation even in dense forest area and automatic creation of cut lines. Without these powerful features, the automatic photogrammetric workflow simply would not have been possible. Very high accuracy of the aerial triangulation has been ensured by multiple overlaps between images and by large amount of tie points. Such processes as automatic brightness, color and contrast adjustment, and haze removal provide the high visual quality of the final products.

The following table demonstrates processing productivity in each area of the project:

Regions (Oblast)	Area (km^2)	Processing time (day)
Novgorodskaya (two areas)	10,780	14
Pskovskaya 1	1,290	5
Leningradskaya	4,660	8
Karelia	8,750	12
Pskovskaya 2 (two areas)	1,110	5
Archangelskaya	6,900	8
Total	**33,490**	**52**

As a result of the project, the following final products were delivered to the Russian Forrest Agency:

- RGB and CIR Super Large Frames (SLF) which are used mainly for stereo taxation and stereo vectorization,
- RGB and CIR orthophoto of the entire forest areas for various purposes including forest inventory.

Image 2. Forest area. CIR orthophoto

5. Aerial survey of Saint Petersburg

Due to its long focal length, A3 Edge can be flown at high altitudes while providing very high ground resolution and aerial survey productivity. Furthermore, the camera’s simultaneous collection of vertical and oblique imagery makes it ideal for 3D city modeling.

The purpose of the project was to provide an orthophoto of the entire city, and prepare vertical and oblique accurately oriented images for the visual investigation of the area and for further 3D City modeling. During the course of the project, RGB vertical and oblique images were captured of the city, spanning a total area of 2007 sq.km.

Image 3. Peter and Paul Fortress, Saint-Petersburg, A3 Edge vertical and oblique images.

The aerial survey flight was executed at an average altitude of 13,300 feet, providing a ground sample distance (GSD) of 10 cm. The ground speed of the aircraft was about 140 - 150 knots. The city was covered by means of crisscross flight lines, providing further capability for 3D City modeling. The flight was executed with the following aerial survey parameters:

- Forward overlap – 60%
- Side overlap – 80%
- Side oblique overlap – 30%

- Distance between flight lines – 1,500 m
- Maximal oblique angle – 55°

The aerial survey flight took 11 hours and the total flight time was 14 hours. During the flight, 450,000 vertical and oblique images were captured.

6. Processing of the St.-Petersburg imagery

The A3 LightSpeed photogrammetric software enables automatic processing of aerial triangulation (AT), DSM creation and orthophoto production. In this project, a previously created DTM was used for the orthophoto creation.
In the first stage, all images, vertical and oblique, were simultaneously adjusted in AT receiving very accurate orientation parameters. In the second stage, only the vertical images were used for the orthophoto creation.

The total processing, AT and orthophoto, was done automatically over 15 days. All of the mapping products met the accuracy requirements of a 1:2,000 mapping scale.

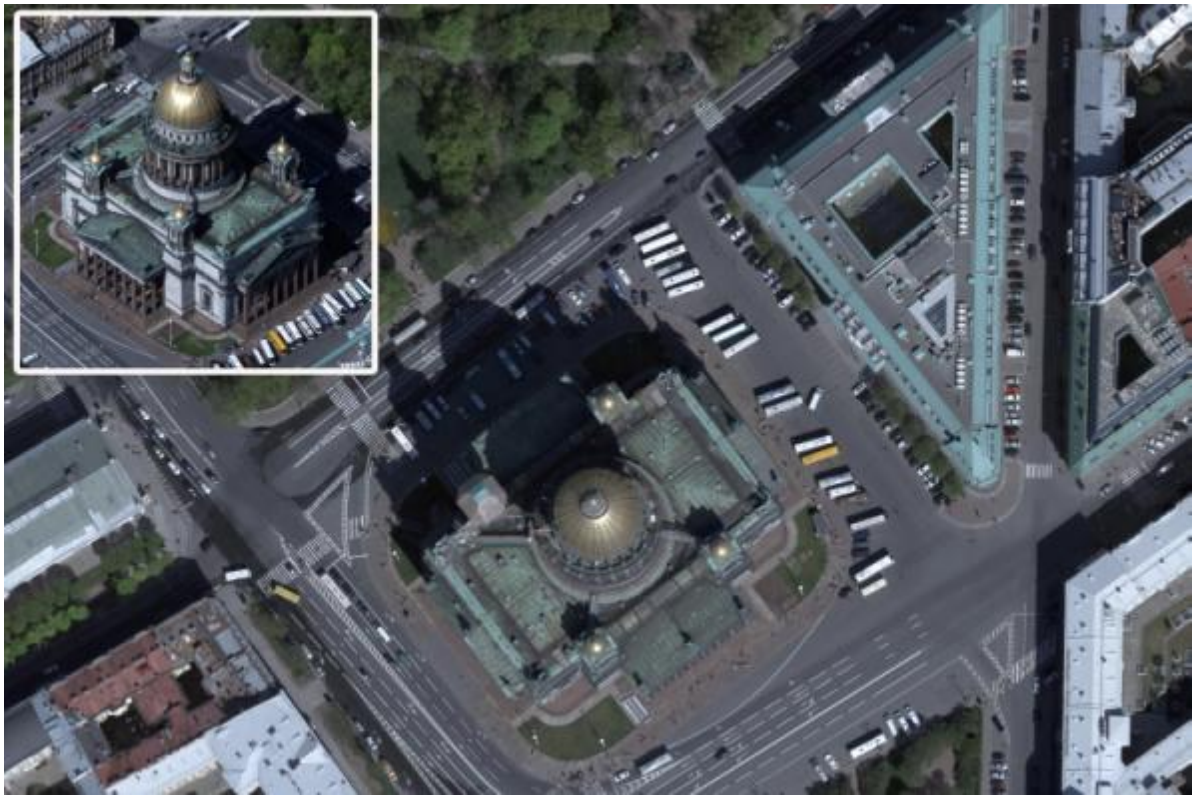

Image 4. Saint Isaac's Cathedral, Saint Petersburg, A3 Edge vertical and oblique images.

For comparison, in 2011 the same company was contracted to survey the exact same urban area. The camera used at the time was PhaseOne, and processing was performed by Talca 4.0 photogrammetric software. It took five operators six months

to do the job. This time, with A3 Edge, the entire project took only 15 days with one operator.
As a result of the aerial survey and processing, accurately oriented vertical and oblique RGB images, and orthophoto from the vertical images were obtained. All of the images will be used for the creation of a 3D model of St. Petersburg.

7. Conclusion

After selecting the A3 Edge Digital Mapping System for their recent projects, Baltaeroservis successfully completed the mapping of St. Petersburg as well as vast forest areas across Russia. The aerial survey of St. Petersburg took 11 hours, and automatic processing took 15 days, while the forest survey took less than 48 hours, and automatic processing was completed in 52 days. The mapping company was pleased with the system’s high productivity, resolution and image quality. The final products met and even exceeded all of their client’s requirements.

After completing these two projects, the mapping company noted that they were very pleased with the performance of the A3 Edge system, which has already performed a significant amount of work for them in the short time since they acquired the system.

REFERENCES

1. Mathias Lemmens, "Digital Oblique Aerial Cameras (2)", GIM International, May 2014.
2. Yuri Raizman, Adi Gozes, "High Throughput Aerial Photography, Ortho & 3D Processing", Photogrammetric Week, 2013.
3. Yuri Raizman, "Leaning instead of overlap: Flight Planning and Orthophotos", GIM International, June 2012.

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