VISIONMAP
Digital mapping systems

High Throughput Aerial Photography, Ortho & 3D Processing with VisionMap A3 EDGE mapping system

54th Photogrammetric Week

September 2013

Germany

Total area = 357,021 sq.km;
L ~ 715 km;
W ~ 500 km;
S = 357,500 sq.km;

Orthophoto requirements

- **Digital aerial camera(s)**
  …are allowed only digital, large format aerial cameras, …

- **Forward and side overlap**
  The average forward overlap is 75% and the average side overlap is 30%.

Digital cameras main parameters

Camera	F (mm)	Pixel size (µ)	Frame size (pix)	FOV (deg)
EAGLE 210	210	5.2	20, 010 * 13,080	27.8
EAGLE 80	80	5.2	20,010 * 13,080	66.1
UC-Xp	100	6.0	17,310 * 11,310	54.9
UC-X	100	7.2	14,430 * 9,420	54.9
UC-Xp wa	70	6.0	17,310 * 11,310	73.1
UC-L	70	7.2	9,600 * 6,500	52.6
DMC II 250	112	5.6	17,216 * 14,656	46.6
DMC II 230	92	5.6	15,104 * 14,400	49.4
DMC II 140	92	7.2	12,096 * 11,200	50.7
DMC	120	12	13,824 * 7,680	69.3
ADS 80	62.77	6.5	12,000 * 7,530	63.7
RC30/150	150	15	16,000 * 16,000	77.3
RC30/300	300	15	16,000 * 16,000	43.6

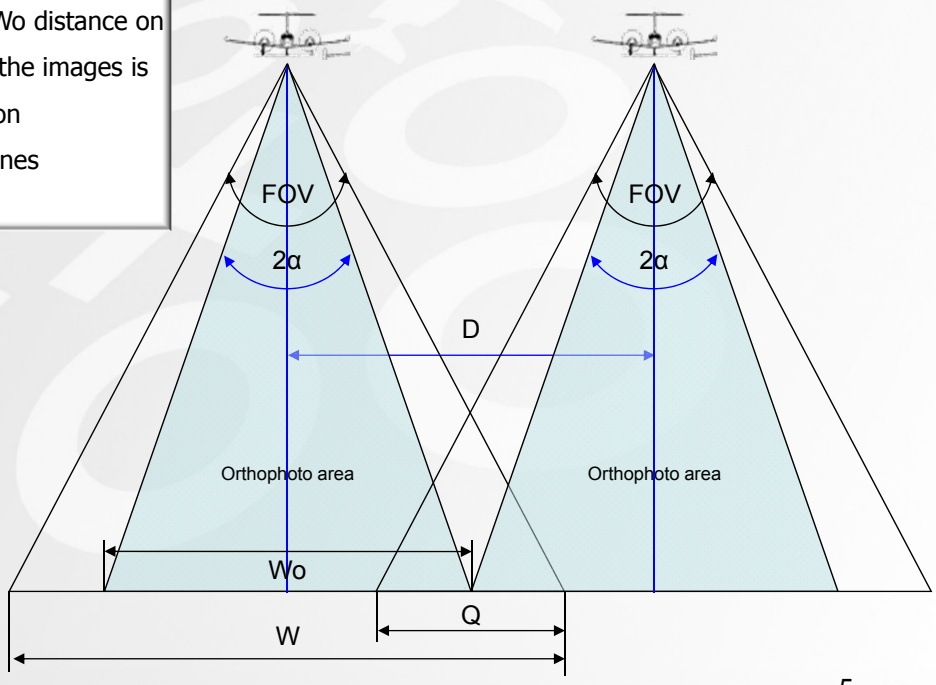
Vertical aerial survey scheme

FOV – field of view

2α – permissible orthophoto angle across flight line. It corresponds to Wo distance on the ground. Only this part of the images is used for orthophoto production

D – distance between flight lines

Q – side overlap



VISIONMAP Digital mapping systems

From side overlap to 2α or building leaning

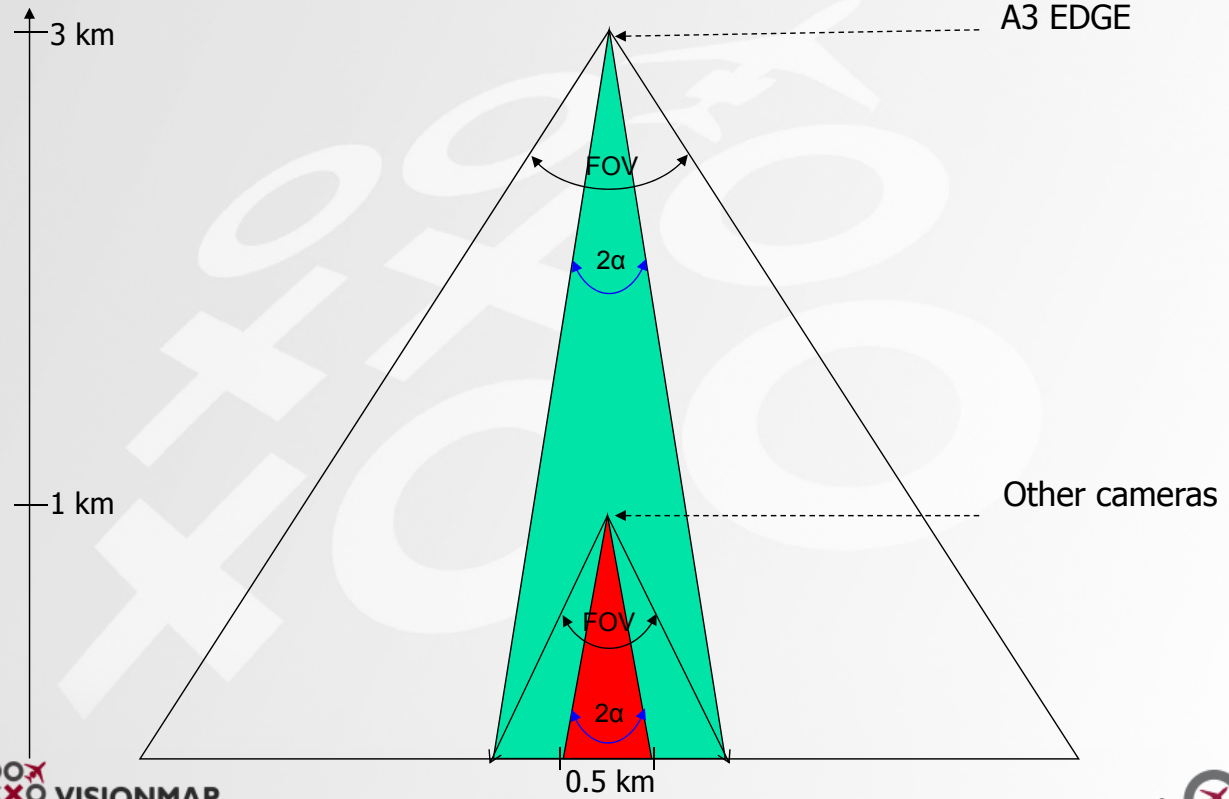
Camera	Side overlap (%)	Orthophoto angle 2α (deg)	Building leaning (%)
EAGLE 210	30	19.7	17.3
EAGLE 80	30	49.0	45.5
UC-Xp	30	40.0	36.4
UC-X	30	40.0	36.4
UC-Xp wa	30	54.9	51.9
UC-L	30	38.1	34.6
DMC II 250	30	33.5	30.1
DMC II 230	30	35.7	32.2
DMC II 140	30	36.7	33.1
DMC	30	51.6	48.4
ADS 80	30	47.0	43.5
RC30/150	30	58.5	56.0
RC30/300	30	31.3	28.0

VISIONMAP Digital mapping systems

From 2α to side overlap

Camera	Orthophoto angle 2α (deg)	Side overlap (%)
A3 EDGE	**55**	**30 - 66**
EAGLE 210	55	No side overlap
EAGLE 80	**55**	**20**
UC-Xp	55	0.1
UC-X	55	0.1
UC-Xp wa	**55**	**30**
UC-L	55	No side overlap
DMC II 250	55	No side overlap
DMC II 230	55	No side overlap
DMC II 140	55	No side overlap
DMC	**55**	**25**
ADS 80	**55**	**17**
RC30/150	**55**	**35**
RC30/300	55	No side overlap

Additional remarks to aerial survey productivity



Intermediate conclusions

- Flying higher with the same 2 alpha angle yields higher productivity
- Flying higher with longer focal length yields the same or even higher image resolution
- Large FOV provides large side overlap which leads to a more robust and accurate photogrammetric solution
- Large FOV provides large variety in orthophoto angle – from very small to very large angles, still maintaining appropriate side overlap.
- Large FOV provides oblique images in the same flight

What have we learned from this exercise?

- 30% side overlap permits a 55 degree orthophoto angle or 52% building leaning
- Not all cameras can fly with a 55 degree ortophoto angle
- 55 degree orthophoto angle will be used for further considerations

Aircrafts

Aircraft	Practical Service Ceiling (m)	Practical Service Ceiling (feet)	Cruise Speed (km/h)	Cruise Speed (knot)	Image GSD (cm)
Gulfstream G650	13,213	43,353	904	488	**32.59**
Learjet 23, 25	11,658	38,249	834	450	**28.76**
King Air B200	9,095	29,841	536	289	**22.44**
Cessna 210, 303, 402, 402	6,500	18,128	350	189	**13.63**

Comments: The image GSD is calculated for A3 EDGE aerial camera at service ceiling.

Aerial survey of Germany with A3 EDGE/S

Aircraft	Image GSD (cm)	Altitude (feet)	Ground speed (knot)	Ortho GSD (cm)	Distance between Flight Lines (m)	Number of Flight lines	Aerial Survey Productivity (sq.km/hour)	Total Aerial Survey Time (day)
Gulfstream G650	**25**	33,250	488	**30**	10,024	51	9,060	**9**
Learjet 23, 25	**21**	27,700	430	**25**	8,354	61	6,653	**12**
Learjet 23, 25	**17**	22,200	360	**20**	6,683	76	4,456	**18**
King Air B200	**12**	16,600	270	**15**	5,012	10	2,506	**31**
Cessna 210, …, 404	**8**	11,100	180	**10**	3,341	151	1,114	**68**

Comments:

1. For these calculations the mapping area is presented as a rectangle of size 500 km x 715 km = 357,500 sq.km;
2. $2\alpha = 55^{\circ}$ (it corresponds to 30% side overlap for UC Xp wa and 35% side overlap for RC30/150) ;
3. Forward overlap – 55%; Side overlap – larger than 55%;
4. Aerial survey day – 5 hours;
5. Aerial survey time per one A3 EDGE/S camera including time for turns (5 min) between flight lines;

Aerial survey of Germany with A3 EDGE/S-CIR

Aircraft	Image GSD (cm)	Altitude (feet)	Ground speed (knot)	Ortho GSD (cm)	Distance between Flight Lines (m)	Number of Flight lines	Aerial Survey Productivity (sq.km/hour)	Total Aerial Survey Time (day)
Gulfstream G650	**25**	33,250	340	**30**	7,000	72	4,413	**18**
Learjet 23, 25	**21**	27,700	280	**25**	5,841	87	3,029	**26**
Learjet 23, 25	**17**	22,200	230	**20**	4,673	108	1,990	**39**
King Air B200	**12**	16,600	180	**15**	3,222	156	1,074	**70**
Cessna 210, …, 404	**8**	11,100	160	**10**	1,482	338	439	**169**

Comments:

1. For these calculations the mapping area is presented as a rectangle of size 500 km x 715 km = 357,500 sq.km;
2. $2\alpha = 55°$ (it corresponds to 30% side overlap for UC Xp wa and 35% side overlap for RC30/150) ;
3. Forward overlap – 55%; Side overlap – larger than 55%;
4. Aerial survey day – 5 hours;
5. Aerial survey time per one A3 EDGE/S-CIR camera including time for turns (5 min) between flight lines;

Mapping of Germany with LightSpeed SW

Ortho GSD (cm)	Image GSD (cm)	RGB Processing Productivity (sq.km/day)	RGB Total Processing Time (day)	RGB+NIR Processing Productivity (sq.km/day)	RGB+NIR Total Processing Time (day)
30	25	9,000	**40**	6,000	**60**
25	21	6,250	**58**	4,000	**90**
20	17	4,000	**90**	2,500	**143**
15	12	2,250	**159**	1,500	**239**
10	8	1,000	**358**	600	**596**

Comments:

1. Total area – 357,500 sq.km;
2. Processing time is calculated per one standard A3 LightSpeed processing system ;
3. Processing time does not include DSM/DTM processing and manual processes like cut-line editing and QA;

A3 EDGE mapping system

Aerial survey camera

Ground processing system

VISIONMAP Digital mapping systems

Aerial cameras: A3 CORE, A3 EDGE

VISIONMAP Digital mapping systems

Technical characteristics of A3 CORE & A3 EDGE

Camera Model	A3 CORE	A3 EDGE
Weight (kg)	38	
Size (cm)	50*60*60	
Focal length (mm)	300	
Color	RGB or RGB+CIR	
Color Depth (bit)	12	
Image motion compensation	Forward, Roll, Vibration (FMC, RMC, VC)	
Max FOV (°)	**72**	**110**
Vertical aerial survey	Yes	Yes
Oblique aerial survey	No	Yes
CCD pixel size (μ)	7.4	7.4
Maximal footprint (pix)	49,000 x 9,600	78,000 x 9,600
Maximal image volume (Mpix)	457	718
On-board storage capacity for continues acquisition (hours)	6 - 9	6 – 7

Aerial Survey Productivity

	Orthophoto GSD (cm)	5	10	15	20	25	30
	Image GSD (cm)	**4.17**	**8.33**	**12.50**	**16.67**	**20.83**	**25.00**
A3 CORE/S	**Altitude (feet)**	5,542	11,084	16,626	22,168	27,709	33,251
	Ground speed (knot)	160	250	350	400	450	500
	Permissible orthophoto angle 2α (deg)	25	35	38	38	38	38
	Distance between flight lines (m)	712	2,024	3,315	4,420	5,526	6,631
	Aerial Survey Productivity (sq.km/hour)	**223**	**941**	**2,149**	**3,275**	**4,605**	**6,140**
A3 EDGE/S	**Altitude (feet)**	5,542	11,084	16,626	22,168	27,709	33,251
	Ground speed (knot)	160	250	310	360	430	490
	Permissible orthophoto angle 2α (deg)	25	35	45	55	60	65
	Distance between flight lines (m)	712	2,024	3,988	6,683	9,265	12,268
	Aerial Survey Productivity (sq.km/hour)	**211**	**937**	**2,290**	**4,456**	**7,378**	**11,133**

Comments:

1. 2α = 65° corresponds to 20% side overlap for RC30/150 ;
2. For A3 EDGE: forward overlap – 55%; side overlap – larger than 55%;

LightSpeed – Automatic Ground Processing System

Take the fast lane from image acquisition to final products

VISIONMAP Digital mapping systems

A3 LightSpeed Cluster Hardware Configuration

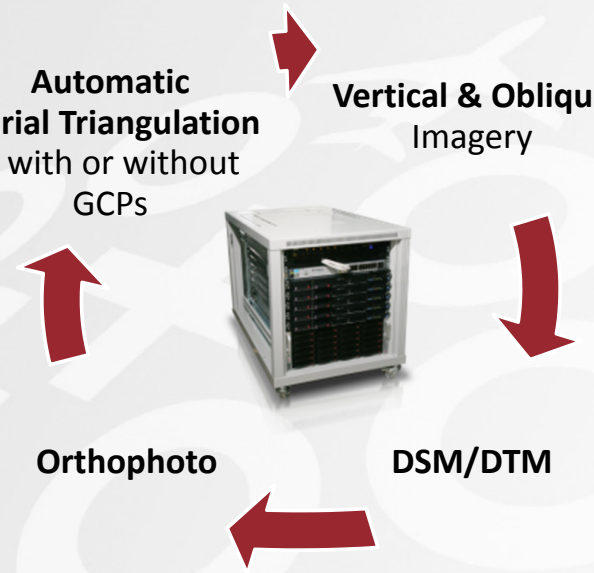
- 1 x Manager Server
- 4 x Multi Core Processing Servers, 12 cores each, 96 GB RAM
- High Capacity Storage (48 TB)
- Fast network switch (10 GB)
- 1 x Working station

VISIONMAP Digital mapping systems

A3 LightSpeed Server Hardware Configuration

- 1 Server with 12 Cores
- 96 GB RAM
- Up to 36 TB storage

A3 LightSpeed Products



LightSpeed is the **only** software that solves oblique imagery photogrammetrically, and provides a multi vertical/oblique block with very high uniform accuracy.

A3 LightSpeed - Fastest Processing

LightSpeed processes hundreds to thousands of km² per day

- ✓ Fully automatic Aerial Triangulation, Dense DSM, Orthophoto Mosaic, Oblique, Stereo Models
- ✓ Solves 250,000 frames in a single block
- ✓ High accuracy with or without DGPS stations and/or GCPs
- ✓ Significantly lower operational costs

GSD (cm)	Block Area (sq.km)
5	1,138
10	5,037
15	12,182
20	23,030
25	38,432
30	56,855

Orthophoto GSD (cm)	5	10	15	20	25	30
LightSpeed Orthophoto Processing Speed (km²/24 hrs)	250	1,000	2,250	4,000	6,250	9,000

Note:
1. Processing productivity is calculated for a fully automatic A3 processing not including DSM calculation and common manual processes like cut-line editing and QA.
2. Processing productivity is calculated for the VisionMap LightSpeed standard cluster, optimal aerial survey parameters and assumes parallel processing of several projects.

Stuttgart University Accuracy Certification

Camera	Forward overlap (p%)	Side overlap (q%)	Strips	GCP	RMS East (m)	RMS North (m)	RMS Z (m)	RMS-E/GSD (%)	RMS-N/GSD (%)	RMS-Z/GSD (%)
A3 (Case 5b)	52%	86%	8	5	0.020	0.023	0.052	33%	39%	87%
A3 (case 6b)	52%	86%	8	10	0.015	0.018	0.030	24%	30%	50%
A3 (Case 7b)	52%	73%	5	5	0.017	0.023	0.050	28%	39%	84%
A3 (Case 8b)	52%	73%	5	10	0.016	0.017	0.035	27%	28%	58%

Notes:

- Average altitude: 1972 m
- Flight line direction: east-west, bi-directional
- Average ground speed: 113 knot
- Difference in ground speed in two directions: 23 knot
- GSD: 6 cm
- Number of flight line: 8
- Average forward overlap: p = 52%
- Average side overlap: q = 86% (when all 8 flight lines are considered) or 73% (when 5 flight lines are considered)
- Number of check points: 136

The complete report can be found on www.visionmap.com/files/IFP_Visionmap_A3_Report.pdf.

Highly Accurate Aerial Triangulation (AT)

GSD (cm)	5		10		15		20		25		30	
	RMSxy	RMSz	RMSxy	RMSz	RMSxy	RMSz	RMSxy	RMSz	RMSxy	RMSz	RMSxy	RMSz
AT (internal, pix)	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0
AT - PPP without GCP (abs. in cm)	20.0	22.5	25.0	30.0	35.0	40.0	40.0	45.0	45.0	50.0	50.0	55.0
AT - DGPS without GCP (abs. in cm)	10.0	12.5	15.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5
AT - DGPS \ PPP with GCP (abs. in cm)	4.0	5.0	6.0	7.5	7.5	10.0	10.0	14.0	12.5	18.0	15.0	21.0

Notes

- Assuming PPP accuracy: RMSxy and RMSz – not more than 18 cm / Assuming DGPS accuracy: RMSxy and RMSz – not more than 8 cm.
- Forward overlap - not less than 55%; Side overlap - not less than 60%.
- Number of strips in one AT block - not less than 2; Number of sweeps in one strip - not less than 20.
- GCP - signalized points with coordinates in WGS84; GCP placement - every second strip every 15th sweep;
- Accuracy assessment - in WGS84; Accuracy assessment on GCPs- regarding check points which are located between outside strips of the block.
- AT (internal) - AT accuracy assessed on tie points.
- Check Points Accuracy: RMSxy and RMSz - not more than 2.5cm.

VisionMap's Global Operation

Some of Our Customers

Roslesinforg

Air Bashkortostan, Russia

Thank You

VISIONMAP
Digital mapping systems

Disclaimer

The information contained in this publication is provided for general guidance only and forms no part of the contract and shall not in any circumstances constitute a trade description. The Company reserves the right to change or amend specification without prior notice.