UltraCam and UltraMap – An Update

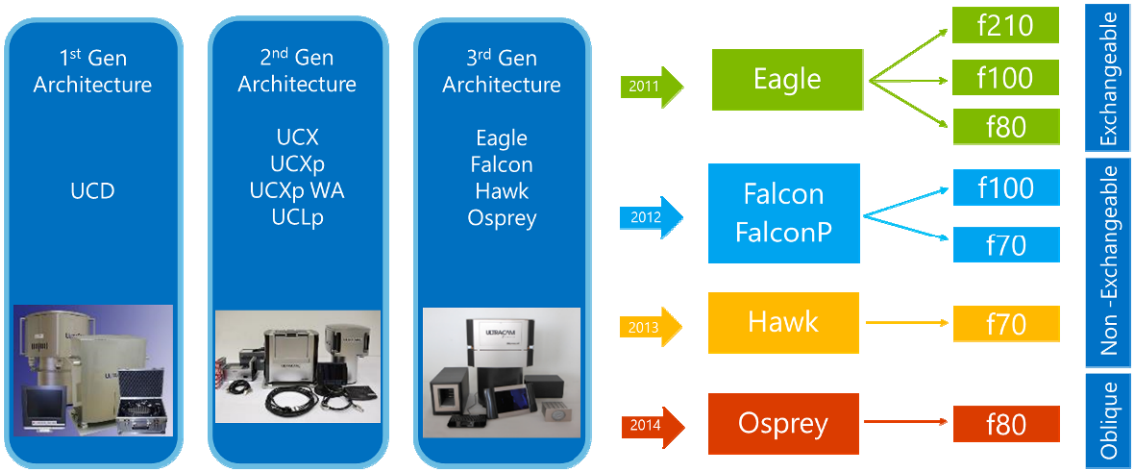
Alexander Wiechert, Michael Gruber, Graz

ABSTRACT

When UltraCam D was presented first at ASPRS 2003 in Anchorage, it was the beginning of an unmatched success story. As a newcomer to the market, UltraCam developed quickly into the world-wide leading large format digital camera system for aerial survey. The UltraCam family today consists of four different photogrammetric nadir cameras UltraCam Eagle, Falcon Prime, Falcon and Hawk and the photogrammetric oblique camera system UltraCam Osprey. In autumn 2015 Microsoft will announce three upgrades or new camera systems: the Eagle Prime, a facelift to the UltraCam Eagle, the UltraCam Osprey Prime II, a facelift of the UltraCam Osprey and a new sensor system, the so called UltraCam Osprey lite. Similar to the cameras, the procesing software UltraMap showed also an impressive roadmap of innovation, culminating in the latest release, UltraMap version 3.9. In autumn 2015, Microsoft will also announce new versions here with outstanding features for automated olique color balancing and automated 3D TIN generation. This paper described the new UltraCam and UltraMap announces.

1. INTRODUCTION

Efficiency is no longer defined by just the footprint size of the camera, efficiency is now defined by the flexibility and capability of the whole solution. Cameras are reaching asymptotically their practical limitations and over-engineering does usually not translate into real customer benefits. Microsoft is focusing on the efficiency of the complete solution to maximize customer benefit in practical scenarios. UltraCam represents the broadest photogrammetric digital aerial camera family. The nadir cameras consist of Eagle, Falcon Prime, Falcon and Hawk. UltraCam Eagle features a unique exchangeable lens system for upmost flexibility and customer benefit. Falcon Prime and Falcon are available in two different sensor configurations, Hawk represents the entry step into the UltraCam family. Osprey is the photogrammetric oblique camera system, combining two cameras in one housing, a photogrammetric nadir camera system including high-resolution PAN, RGB, NIR and an oblique RGB camera consisting of four tilted RGB color cones.

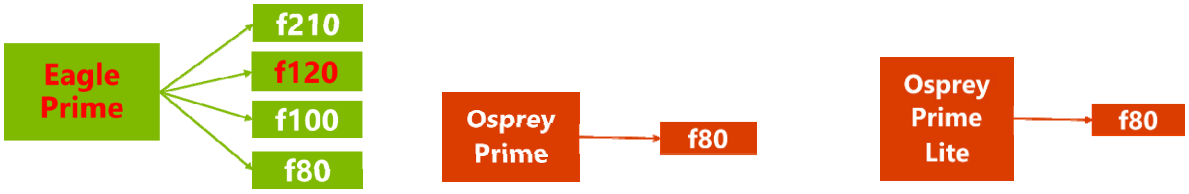


All cameras are supported by the UltraMap workflow for a consistent data processing of all UltraCams, including AT, Oblique AT, Dense Matching and Ortho Image generation. UltraMap

allows also the processing of projects flown with different UltraCams for upmost flexibility and thus customer benefit.

2. ULTRACAM

In autumn 2015, three new cameras are being announced: Eagle Prime, Osprey Prime II and Osprey Prime lite and also a new lens system for Eagle and Eagle Prime with 120mm focal length in PAN and 40mm focal length in multispectral.



2.1. UltraCam Eagle Prime

The Eagle Prime represents a facelift to the UltraCam Eagle. Key modifications are a newly developed CCD sensor, based on the new 4.6µ technology. Thanks to the latest sensor technology and further improved camera electronics, it was possible to maintain the high radiometric dynamic of 7,600 grey values and achieve an even faster frame rate and keep the forward motion compensation by TDI.

Further improvements are: increased storage system, reduced weight, and reduced power consumption. Upgrade from Eagle is possible by refurbishment.

Key specifications are:

PAN pixel across	23,010		PAN focal length	80mm, 100mm, 120mm, 210mm
PAN pixel along	14,790		b/h (f80, f100, f120, f210)	0.34; 0.27; 0.23; 0.13
Max. frame rate	1.8 s		AGL for 5cm GSD (f80, f100, f120, f210)	870m; 1,090m; 1,304m; 2,283m
Pan-sharpening ratio	1:3		Max. speed for 5cm/10cm GSD @ 80% frontlap	159kts / 318kts
FMC	Non mechanical, TDI		Max. speed for 5cm/10cm GSD @ 60% frontlap	318kts / 637kts
Lens system	Exchangeable w/o calibration		Max. frontlap for 5cm/10cm GSD @ 140 kts	82% / 91%

With the Eagle Prime, a new lens system for Eagle and Eagle prime is also introduced, a 120mm PAN focal length system. That fits well in between the current series of f80, f100 and f210. It closes the gap between f100 and f210 and optimizes usable footprint if building lean is restricted while maintaining an acceptable b/h ratio and a convenient flight altitude.

2.2. UltraCam Osprey Prime II

The Osprey Prime II is an upgrade to the Osprey Prime. It has a bigger nadir PAN footprint with 13,470 pixel across and an increased oblique footprint of 80MP per oblique cone.

The nadir PAN channel with f80mm lens system and 13,470 pixels across provides photogrammetric grade accuracy and image dynamic, in addition, RGB and NIR is collected for nadir. This makes the nadir part of the camera a fully usable photogrammetric aerial camera system. The oblique cones are equipped with a 80 MP RGB Bayer pattern sensor and the lenses have a focal length of 120mm. That leads to a well-balanced system as the GSD of the nadir PAN part and the GSD of the oblique images match together for a seamless transition between nadir and oblique without resolution inconsistency.

Key specifications are:

PAN nadir pixel across	13,470		Oblique RBG	10,300 x 7,700
PAN nadir pixel along	8,670		Oblique RGB focal length	120mm
PAN nadir focal length	80mm		Oblique RGB pixel size on CCD	5.2µm
PAN nadir pixel size on CCD	5.2µm		Oblique cones tilt	45 degree
Nadir RGB	6,735 x 4,335		Oblique image orientation	Portrait
Nadir NIR	7,613 x 4,900		Oblique GSD at base for 5cm nadir GSD	5cm
Pan-sharpening ratio	1:2		TDI (all cones)	Non mechanical, TDI
Max. frame rate	2.0s		Max. speed for 5cm/10cm GSD @ 80% frontlap	72kts / 146kts
AGL for 5cm GSD nadir	770m		Max. frontlap for 5cm/10cm GSD @ 140 kts	62% / 81%

2.3. UltraCam Osprey Prime Lite

The UltraCam Osprey Prime Lite is a new camera system which is being announced in autumn 2015. It represents the entry camera system into the UltraCam oblique camera series. It features five 80 MP camera cones, all consisting of RGB Baer pattern CCDs. One Camera cone is oriented nadir, the other have the typical oblique configuration, looking forward, backward, left and right. Optionally a nadir looking NIR cone with 40 MP can be integrated. All cones are integrated into a photogrammetric grade housing with SSD storage and UltraNav as an option. Image processing of Osprey Prime lite is also embedded into UltraMap for a seamless processing with other UltraCams.
That makes the Osprey Prime Lite the perfect camera system if no panchromatic cone for photogrammetric application is required.

The nadir RGB has a 70mm focal length lens, the oblique cones have a 120mm focal length so that GSD is aligned.

Key specifications are:

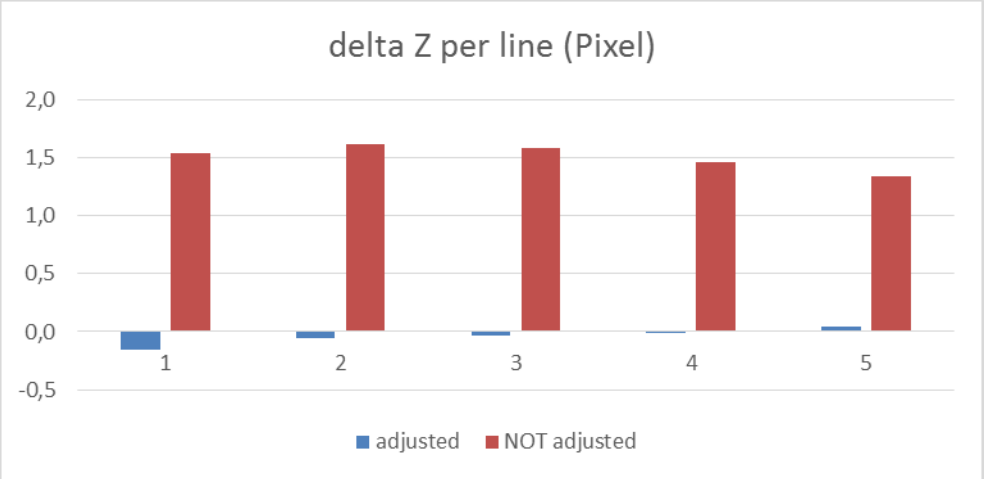
RGB nadir pixel across	10,300		Oblique RBG	10,300 x 7,700
RGB nadir pixel along	7,700		Oblique RGB focal length	120mm
RGB nadir focal length	70mm		Oblique RGB pixel size on CCD	5.2µm
RGB nadir pixel size on CCD	5.2µm		Oblique cones tilt	45 degree
Optional Nadir NIR	7,613 x 4,900		Oblique image orientation	Portrait
Pan-sharpening ratio	1:2		Oblique GSD at base for 5cm nadir GSD	5cm
Max. frame rate	2.0s		TDI (all cones)	Non mechanical, TDI
AGL for 5cm GSD nadir	770m		Max. speed for 5cm/10cm GSD @ 80% frontlap	74kts / 148kts
			Max. frontlap for 5cm/10cm GSD @ 140 kts	62% / 81%

3. GEOMETRIC ACCURACY

A key element of the UltraCam design is the stitching of the PAN image out of several sub-images, mainly nine sub-images. That has several key benefits such as flexibility of design, radiometric dynamic, frame rate and footprint size compared to large single sensors of same technology.

Over the years a lot of improvements in software and hardware have been introduced to also obtain upmost geometric accuracy and stability. That has reached a level which make the geometry of the stitched PAN image comparable to single large sensors.

The geometric processing is one important function of the UltraMap software system and works fully automated. Based on parameters from the laboratory calibration as well as from image measurements the software was enhanced by integrating temperature readings from sensors which

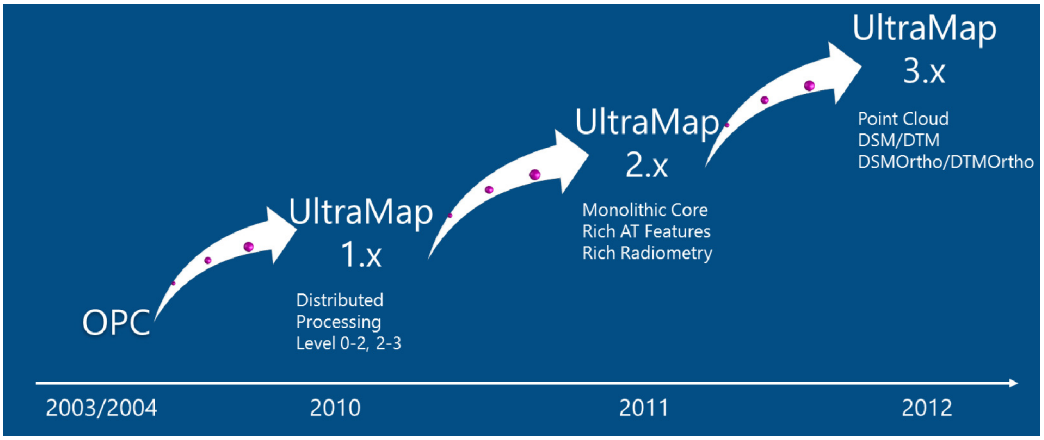


are attached to each lens cone of the camera. This temperature readings are available from each shot position and allows to introduce a lens specific parameter which is then used to improve the geometric quality of the individual image. The most important benefit of this additional information is a stabilization of the vertical accuracy even if the camera is being operated under changing environmental conditions. In order to investigate the effect of this enhanced modelling concept we compared data sets from aerial triangulation projects where results have been obtained without the temperature model and based on one and the same set of images but then processed including the temperature model. The following figure shoes the reduction of the vertical displacement from a magnitude of approximately 1.5 GSD to 0.2 GSD or less for 5 individual flight-lines.

4. ULTRAMAP

The camera hardware with cameras such as the UltraCam Eagle Prime is asymptotically reaching its practical limitations such as footprint size, usable pixels across footprint, acceptable perspective view combined with suitable flight altitudes, the processing software already became and continue to be a key differentiator of the overall solution.

Since its introduction in 2010, UltraMap made significant contributions and was setting the standard with highly innovative features such as the automated distributed processing, automated project based color balancing, the automated dense matching or the automated ortho image processing.



In autumn 2015, Microsoft will announce a new versions: the Version 4.0 (release date December 2015) and will also show a preview to the Version 5.0 (release date March 2016).

The Version 4.0 covers among other features a new solution for the project based color balancing. A completely new approach has been implemented with a modified workflow and improved algorithms. As a result, the automatically achieved color balancing result has improved and it requires even less manual interaction for faster automated processing of big blocks.

Furthermore, the color balancing now includes the automated color balancing of the oblique images. That is a break-through in oblique image processing. It resolves a huge bottleneck and highly manual task in the production, reduces production time and production costs, increases quality, and will help utilizing oblique image capture for any applications.

The Version 5.0 will mainly implement the 3D algorithms which have been developed by Microsoft researchers for the automated 3D TIN generation for BING maps. That is again a spin-off from

BING maps into the commercial UltraMap software suite which empowers the UltraCam community to benefit from significant developments Microsoft has undertaken for its own map and 3D city model generation.

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