

ULTRACAM-X TECHNICAL SPECIFICATIONS

Image Product Specification

Image format	Analogous to an aerial film image at a format of 23 cm x 15 cm, scanned at 15 µm
Image data formats	JPEG; TIFF with options for 8, 12 and 16 bits, scan-line, stripped or tiled
Image storage format in level 2	Full resolution panchromatic, separate color channels at color resolution
Color at level 3	Full resolution R, G, B, Near-IR channels, planar or pixel-interleaved

Digital Camera Technical Data (Sensor Unit S-X)

Panchromatic image size	14,430 * 9420 pixels
Panchromatic physical pixel size	7.2 µm
Input data quantity per image	418 Mega Bytes
Physical format of the focal plane	104 mm * 68.4 mm
Lens system	Linor Vexcel Apo-Sironar digital HR
Panchromatic lens focal distance	100 mm
Lens aperture	f= 1/5.6
Angle-of-view from vertical, cross track (along track)	55° (37°)
Color (multi-spectral capability)	4 channels -- RGB & NIR
Color image size	4810 * 3190 pixels
Color physical pixel size	7.2 µm
Lens system	Linor Vexcel Apo-Sironar digital HR
Color lens system focal distance	33 mm
Color lens aperture	f = 1/4.0
Color field of view from vertical, cross track (along track)	55° (37°)
Shutter system	Prontor magnetic 0 – Vexcel
Shutter speed options	1/500 to 1/32
Forward-motion compensation (FMC)	TDI controlled
Maximum FMC-capability	50 pixels
Pixel size on the ground (GSD) at flying height of 500 m (at 300m)	3.6 cm (2.2 cm)
Frame rate per second (minimum inter-image interval)	1 frame per 1.35 seconds
Analog-to-digital conversion at	14 bits
Radiometric resolution in each color channel	>12 bit
Physical dimensions of the camera unit	45cm x 45cm x 60 cm
Weight	~ 55 kg
Power consumption at full performance	150 W

In Flight Data Storage D-X and Data Processing C-X

In-flight storage capacity	Unlimited with use of multiple data units D-X; per D-X unit ~1.7 TB
In-flight capacity to collect uncompressed frames	Unlimited with multiple D-X units; per D-X unit ~ 4700 images
Method of exchanging D-X units in-flight	In less than 3 minute
Configuration of Storage D-X and Computing C-X	C-X with 14 Pentium-M CPUs; each D-X with 28 disks
Redundancy	Storing mirror images of the data
Data transfer into office environment	Removable D-X data units; docking station (optionally mobile)
Physical dimensions	Width 50cm x Depth 36cm x height 65 cm
Weight	< 65 kg
Power consumption at full performance	700 W

Operational Specification

Data collection period at 70% & 20 % overlap, at 20 cm GSD (film scale 1:10,000)	8.5 hours per single D-X unit
Post-processing of collected raw images	OPC Software on UltraMap-Server, Office PC Network, Laptop
Data transfer from aircraft to office	Shipping of D-X, or transfer to high capacity storage medium via Mobile Server
Mounting of the camera	Using adapter ring for all current film camera mounts (PAV-30, Z/I T-AS, GSM3000)
Flight planning support	Compatible with commercial systems (CCNS-4, Trackair, Vega,)
Exterior orientation support	Compatible with DGPS/IMU systems (IGI's Aero-Control, Applanix' POS-AV)
Photogrammetric Production	TIFF-output compatible with Customer's photogrammetric production software
Image geometric accuracy	Approximately ± 2 µm

Data Flow Concept

1. Data Levels

The UltraCam system operates with the following data levels:

Level-00	Raw data; each triggered images consists of 13 sub-images; stored twice.
Level-0	Verified data, same as level-00, but no duplicate copy exists.
Level-1	Internal intermediate format, maintained as 13 sub-images, but radio metrically corrected using calibration files.
Level-2	Deliverable format, per image only one single frame, the sub-images are stitched and geometrically corrected using the calibration files. The panchromatic data are in one file, separate from the 4 color files. Color remains at its input resolution, but is geometrically matched to the panchromatic image. Data are at 16 bits per channel (5 channels).
Level-3	Pan-sharpened color images in R-G-B, in CIR or in R-G-B-NIR. Format in 8 or 16 bits, at the discretion of the user.

2. In-Flight Collection of Raw Level 00 Data

In a customer's standard aerial operation, one will collect level-00 images. Each triggered image consists of 13 sub-images of 16 Mega-Pixels each (was 11 Mega-Pixels in the UltraCam-D). Level-00 images get stored twice by "mirroring" the data on 2 disks on two separate D-X data units (was 2 disks on one Storage and Computing Unit SCU in the UltraCam-D system).

The number of such images to be collected depends on the size of the disks in the data unit D-X. The current version of the data unit operates with 120GB disks and can therefore store ~3700 images.

Because the low-cost D-X units can be easily exchanged during flight, with an exchange not taking more than 1 minute, the number of images to be collected in the air is limited only by the number of DX-units one is taking along for an aerial mission.

3. Checking the Aerial Coverage

The aerial coverage is in principle defined in the flight preparation and flight management system, thus outside the actual UltraCam-system. As the survey flight proceeds, the camera operator can monitor the collected data on the graphical user interface by means of so-called "in-flight quick-views".

These quick-views are stored for later use. On the ground (or in the air during turns or while flying to the mission base), the completed flight can be replayed via the stored quick-views at an interval of about 0.5 seconds per image. If sovereignty and security are an issue, then a completed flight can be checked right after the mission is completed, and individual images can be marked for "confidentiality". Use of the quick-looks is being constantly enhanced as new software versions get published (example: denied area censorship).

4. Verification and "Off-Loading" of Level-0 Data from Airplane

A "verification" run gets started on the CDX (the combination of the computing unit C-X and data unit D-X) to ensure that the level-00 data are not compromised and a complete and verified data set is on both data units (DX-A and DX-B).

The verified raw data can be "off-loaded" by removing one of the DX data units off the airplane and transporting it to an office processing unit.

This completely eliminates any elapsed time for data export. By removing both DX-units, the verification of data units A and B might also become office work.

5. Back-Up of Down-Loaded Data to Maintain Data Security

Maintaining of redundancy as a basic principle of data security is reduced to the work with a pairs of DX-units. However, DX-units employ multiple disks and are therefore more expensive than a single

large disk or a tape would be. Therefore the customer has the option in the field of copying the DX-contents onto a single disk or tape and shipping this lower cost medium to the home office, in lieu of the DX-units. The DX-units remain in the field for use aboard the airplane.

To support the in-the-field copying of the data one will employ a sufficiently configured laptop computer ("Mobile Server").

6. The DX Data Units and Image Post-Processing into Higher Level Data

A DX unit is connected to the office processing environment via a docking station based on SATA technology. This is a much simpler process than the operations with fire wires in the UltraCam-D system.

The docking station can be connected to

- A single computer, like a laptop or Mobile Server;
- An office computer network;
- The UltraMap Server

In the event that a backup has been made of the DX-contents to a single disk or tape, that disk or tape is loaded to a postprocessing computing environment.

7. Performance Issues

7.1 Data Copying

When using normal desktop computers or the Mobile Server the data transfer rates in pixels are about the same as for the UCD. It is to be noted that the images in the UC-X are 1.5 times larger.

However, the new SATA approach provides better integration with computers and servers via PCI-Express or PCI-X, and this in turn can accelerate the transfer of the images to disk-RAIDS. This is especially relevant in connection with the use of the UltraMap Server.

7.2 Data Postprocessing

We can expect an acceleration of the post-processing throughput as a result of faster data transfer. For the time being, however, one should plan with rates of the UltraCam system, namely about 4 minute per image per computer.

8. Multiple Survey Flights per Day

Multiple flights in one day are supported by the use of multiple DX-units. There no longer exists a need for the survey airplane to land between missions for data downloads.