

EuroSDR project

Digital Camera Calibration

Michael Cramer

michael.cramer@ifp.uni-stuttgart.de

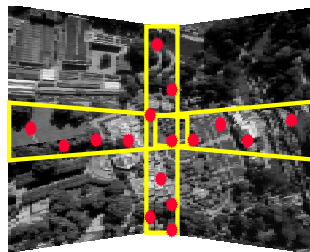
Presentation of project proposal

103rd EuroSDR Science and Steering Committee Meetings
München, Germany, October 15 - 17, 2003

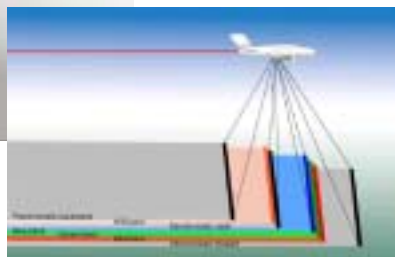
Digital airborne imaging *Systems I*



ADS40 – Leica



DMC – ZI-Imaging



Digital airborne imaging Systems II

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HRSC-A – DLR



UltraCam_D – Vexcel

Digital airborne imaging Systems III

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DSS – Applanix/
Emerge



TLS – Starlabo



IGN – System



DIMAC – Cicade

System architectures

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#	Sensor	Geometry		Sensor head		Image recording	
		Line	Frame	Single	Multi	Synchr.	Syntop.
1	ADS 40	X		X		X	
2	DMC		X		X	X	
3	UltraCam		X		X		X
4	DSS		X	X		X	
5	HRSC-A	X		X		X	
6	DIMAC		X	X	X	X	
7	IGN		X	X	X	X	

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Network “Digital camera calibration” Motivation from EuroSDR steering committee

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- Initiative to investigate future of digital camera calibration driven by following facts
 - availability and growing use of digital camera in production environment
 - no equivalent procedure available compared to standard analogue camera calibration protocol
 - knowledge deficit on users side & national mapping agencies
- Core network established by EuroSDR steering committee
 - core network
 - I. Colomina, E. Gülch, R. Kuittinen, H. Ziemann, M. Cramer
 - initiation of first meeting during Phowo 2003
 - incorporate of camera producers from first project stage
- Focus on
 - technical background of calibration procedures for digital cameras
 - not to go into legal aspects

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Camera calibration

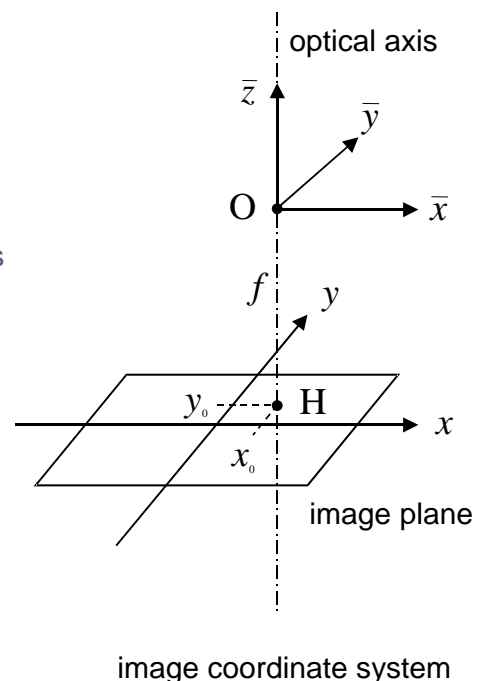
Manual of photogrammetry

- Camera calibration is the process whereby the **geometric aspects** of an individual mapping camera are determined.
- It is performed in the order that the photo obtained with the camera is used to **produce accurate maps**, to allow measurements, whereby ground distances or elevations can be obtained and to make orthophotos.
- It is possible to perform calibration to some order on any camera, but the **cameras used to obtain the most accurate geometric data are specially designed** for that purpose.
- Calibration assumes, that the thing being calibrated is **stable between calibrations**.
- Calibrated values and their accuracy are reported in a **camera calibration certificate** with tables and graphs.

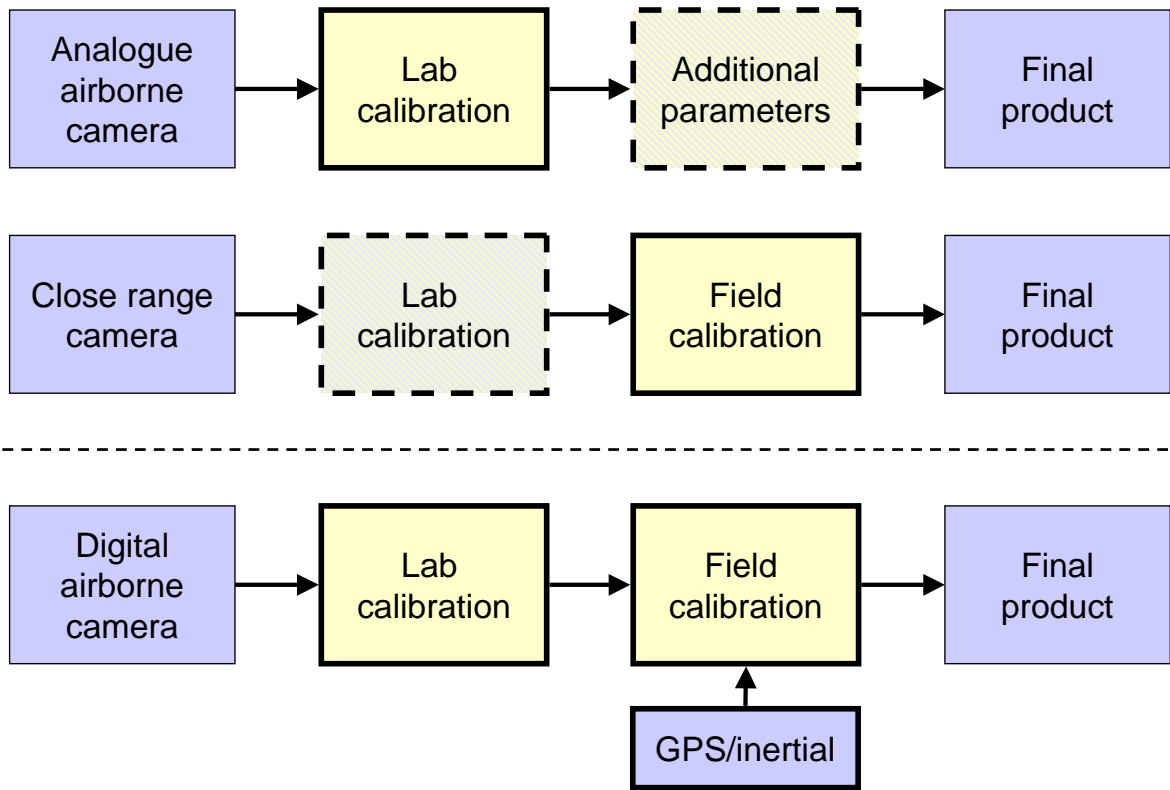
Camera calibration

Interior orientation parameters

- IO of camera refers to perspective geometry of camera
- Parameters
 - calibrated focal length
 - position of principal point in image plane
 - geometric distortion characteristics of lens system, i.e.
 - **radial distortions**
 - **tangential distortions**
 - different models for additional parameters
 - **physical models**
 - **mathematical models, i.e.**
 - polynomials
 - orthogonal polynomials



Calibration steps



Initial meeting Phowo 2003

Addressed organizations



#	Organization	Camera system (concept)
1	Leica Geosystems	ADS 40 (line)
2	ZI-Imaging	DMC (frame, multi-head)
3	Vexcel	UltraCam (frame, multi-head)
4	Applanix / Emerge	DSS (frame)
5	Cicade / Aerophoto	DIMAC (frame)
6	Ohio State University	AIMS (frame)
7	ETH Zurich	TLS (line)
8	IGN	IGN (frame)

Private companies
Academic sector

Initial meeting Phowo 2003

Attendees



#	Organization	Participants
1	Leica Geosystems	P. Fricker, S. Walker
2	ZI-Imaging	C. Dörstel, M. Madani
3	Applanix / Emerge	M. Mostafa
4	ORIMA	L. Hinsken
5	GIP	E. Kruck
6	Vito	C. Evaerts
7	EuroSDR	R. Kuittinen, E. Gülch, H. Ziemann
8	ifp	M. Cramer, N. Haala, R. Reulke



Initial meeting Phowo 2003

Agenda



1 – Status of camera calibration

2 – Concepts for calibration procedures

3 – Experimental research

4 – Miscellaneous & further activities



Initial meeting Phowo 2003

Main results



- ▶ Lack of knowledge about calibration procedures
 - different procedures used from manufacturers
 - different system design
- ▶ Complete system has to be considered, no look on individual components like in traditional calibration
 - multi-sensor system installations (i.e. GPS/inertial components)
 - proposed calibration in 2 steps
 - laboratory calibration by producer
 - calibration by users/certified sites using test field calibration procedures
 - tendency to establish permanent test sites for evaluation of digital camera products (i.e. NASA Stennis test range "certification", only final result checked)
 - major goal: "fit" for job or not
- ▶ Test field calibration enables user to certify system calibration
 - self-calibration solution to increase flexibility
 - available calibration software mature, but training/documentation necessary
 - recommendations on calibration flight design

Initial meeting Phowo 2003

Main results (cont'd)



- ▶ Geometric, radiometric and image quality aspects to be considered
 - geometrical aspects addressed first
 - radiometry influenced by outside world conditions, more difficult to investigate
 - facilities, type of test plates to be investigated
- ▶ Parts of calibration outside governmental agencies, but certified also
 - increase flexibility, ensure applicability in governmental projects
 - Due to speed of development in new digital cameras (avoid potential delay of adapted procedures at agencies)
 - calibration available for all types of digital sensors (i.e. sensors for high and less high accuracy requirements)
 - consistent with accepted standardization procedures
- ▶ Project on performance of digital versus film based cameras (H. Ziemann)
 - no mixture with current project proposal recommended
 - different objectives
 - relevant for users and camera producers

Informal meeting at FHT Stuttgart

Additional insight into US situation by T. Schenk



- ▶ USGS activities in camera calibration
 - digital technologies considered
 - calibration centres to take over present USGS tasks and digital sensor calibration
 - OSU & USGS project headed by D. Merchant (formerly OSU)
- ▶ ISPRS Com. I/2 workshop in US
 - close cooperation with North-American community aspired
 - K. Jacobsen (IPI) will inform on EuroSDR activities
- ▶ Panel discussion on establishment of international test fields
 - meet standard requirements
 - cover variety of terrain and ground cover illumination
 - available for calibration overflights by authorized organizations

ISPRS Commission I/2
International Workshop on
Radiometric and Geometric Calibration

Sponsored by: NASA, USGS

Commission I, Working Group 2, of the International Society for Photogrammetry and Remote Sensing (ISPRS) in collaboration with the Committee of Earth Observing Satellite Working Group on Calibration and Validation (CEOS/MCOV), is pleased to announce an International Workshop of Radiometric and Geometric Calibration.

The purpose of this workshop is to:

1. Review best practices for post-launch calibration of commercial satellite and small satellite imagery for government users.
2. Explore possibilities for standardizing calibration practices and
3. Present these results to the ISPRS General Assembly at a Joint ISPRS/CEOS/MCOV report.

Where:
Feb. 1-5, 2003

Where:
Langport, Grand Cayne
Langport, Mississippi,
USA

Agenda
Letter of Invitation
Registration
Travel Info
Lodging
About Outpost
Joint Task Force

<http://www.edudevweb.com/isprs/>

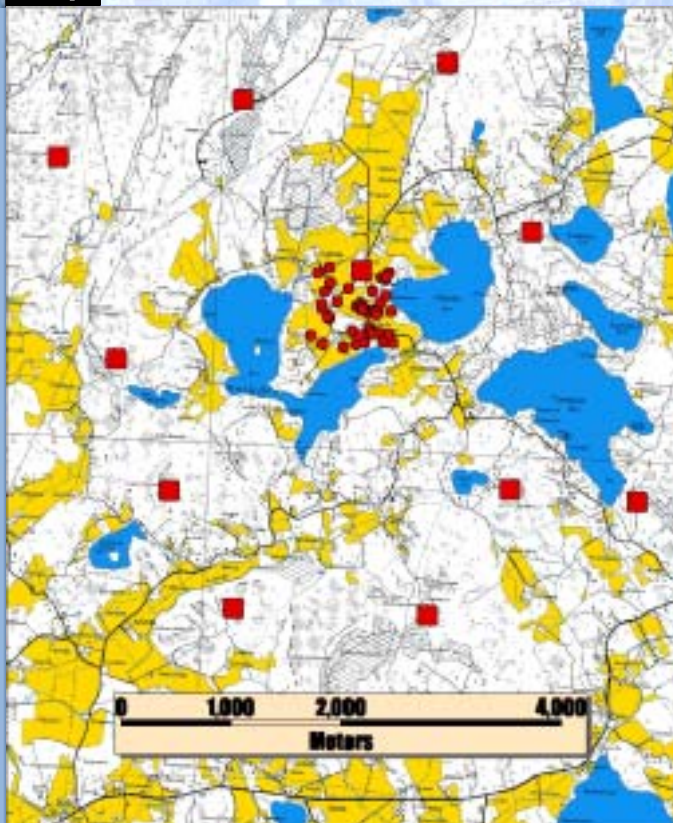
ifp Test site Vaihingen/Enz – Germany



FGI Test site Sjökulla – Finland

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Permanent resolution targets

Control point locations

Project “Digital camera calibration”

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Phase 1

Oct '03

- Collection of publicly available material
- Recommendations of camera producers and other experts
- Compilation and distribution of report on currently used practice and methods of digital camera calibration

Apr '04

- Evaluation meeting of core network
- Presentation of results of Phase 1 at 104th EuroSDR meeting Denmark and ISPRS congress Turkey

Jul '04

- Experimental test and investigations
 - final road map based on results of Phase 1, i.e.
 - testing and development of accepted procedures
 - design for optimal calibration flights
 - geometry, radiometry and image quality
 - stability and repeatability aspects

Phase 2

Jul '05

- Compilation of final report on results of empirical test