LIESMARS

Course Title

Principles of Photogrammetry
Introduction and definitions

October – December 2016

Brief History

- 1837- photography developed – Daguerre
- 1864 - Laussedat developed concept of mathematics of central projection and digital photogrammetry
- 1900- first analogue instrumentation
- 1914- World War I, development of aerial cameras
- 1923-1980's Analogue instrumentation
  - aerial cameras improved markedly
  - principles of aerial triangulation
  - advancement of photography

Brief History (cont)

- **1950s** Mathematics of modern analytical photogrammetry - Brown, Schmidt, Helava - Analytical plotter
- **1960s** Concepts of digital photogrammetry
- **1970s-1980s** production of analytical plotters decline of analogue plotters
- **1990s** Digital photogrammetry development Decline in use of analytical plotters
- **2000 onwards** Introduction of digital aerial cameras Airborne lidar introduced and achieved significant applications

Definitions

- **Photogrammetry** is the science and technology of extracting reliable three-dimensional geometric and thematic information, often over time, of objects and scenes from image and range data.
- **Remote sensing** is the science and technology of capturing, processing and analysing imagery, in conjunction with other physical data of the Earth and the planets, from sensors in space, in the air and on the ground.

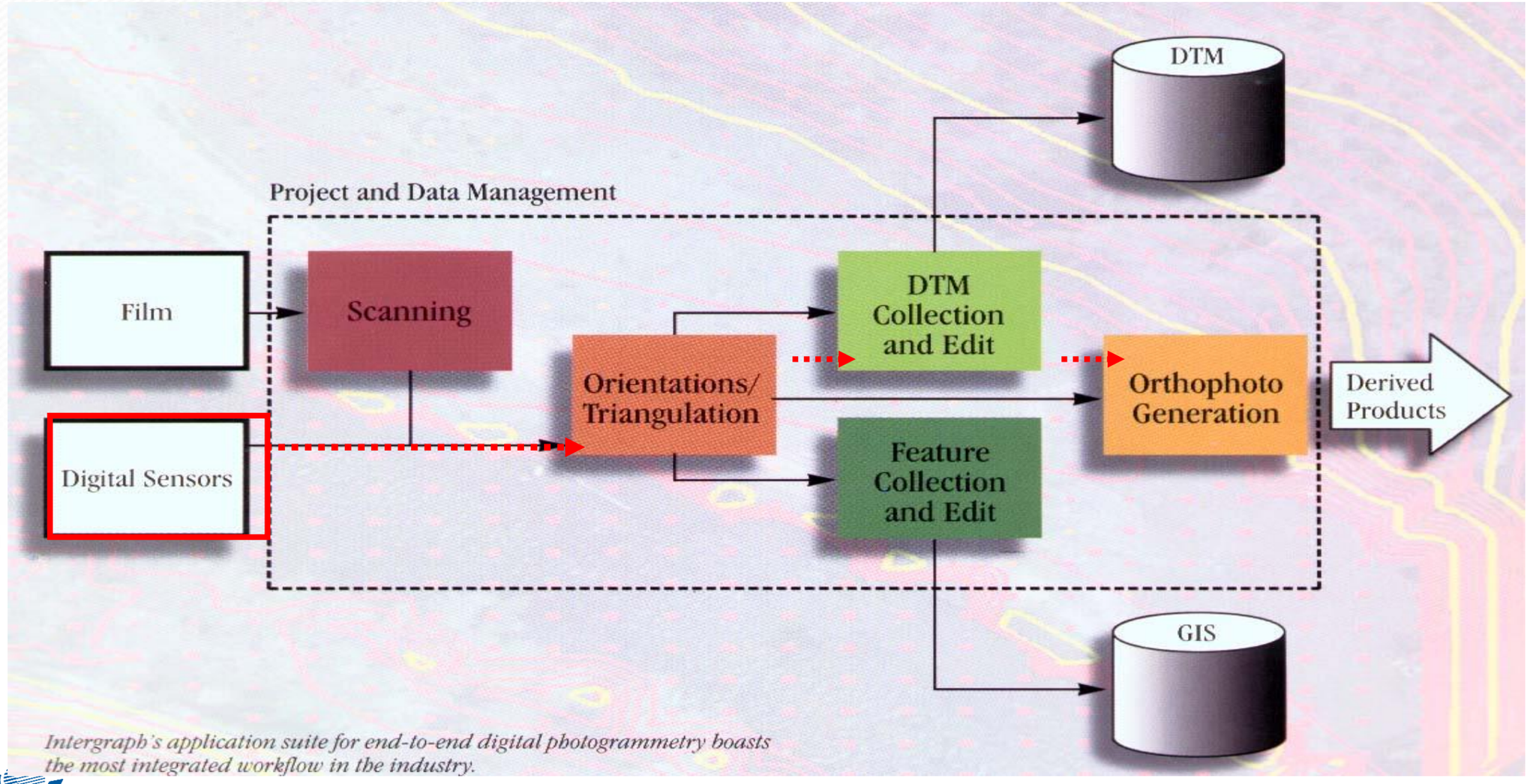
Digital imaging is a core activity in Geomatics

- Aerial photography including UAS (UAV or RPAS)
- Satellite images
- Close range images
- Mobile mapping systems

Applications

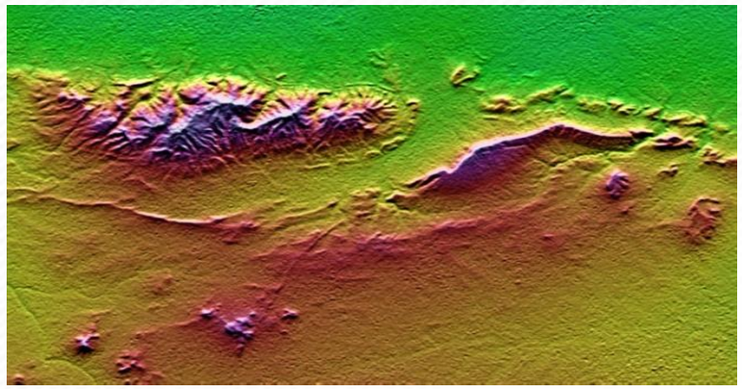
- Aerial photography for mapping
- Digital mapping
- Orthophoto production
- GIS data acquisition
- Laser scanning for DEM determination
- Environmental monitoring
- Close range applications for:
  - Industrial
  - Architecture
  - Aerospace industry
  - Medical
  - Many more

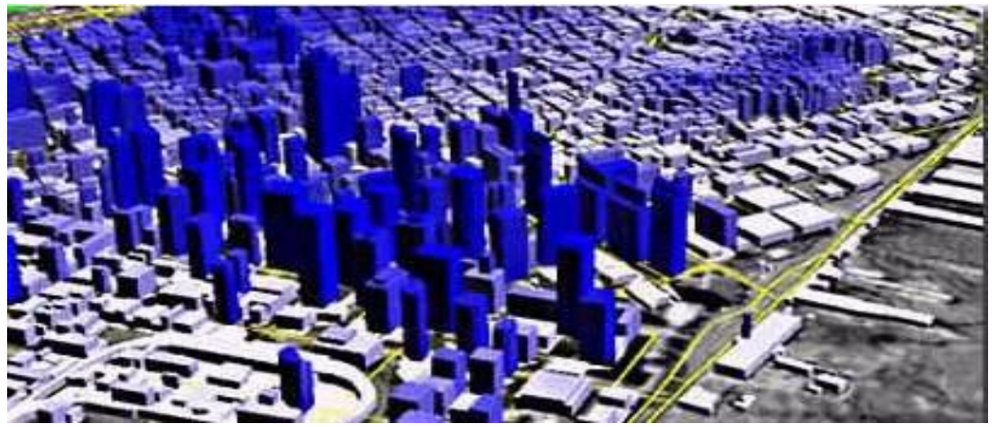
Photogrammetric process for geospatial information collection

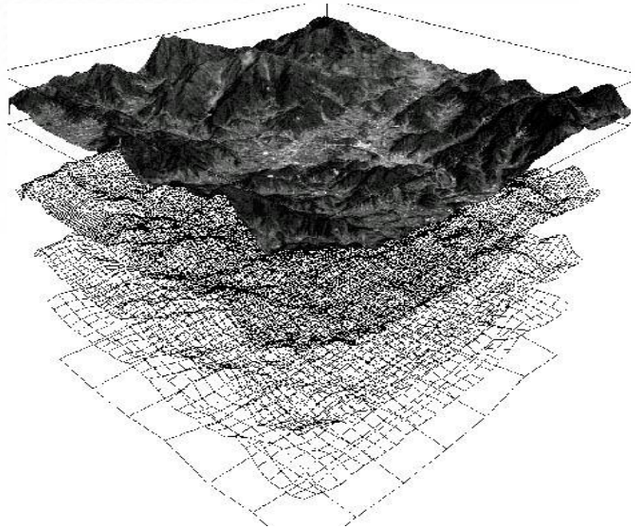


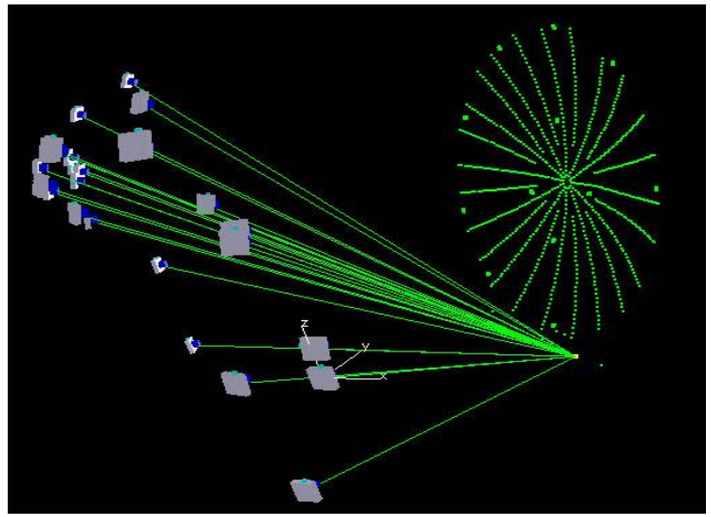
main photogrammetric products

- 3D surface models



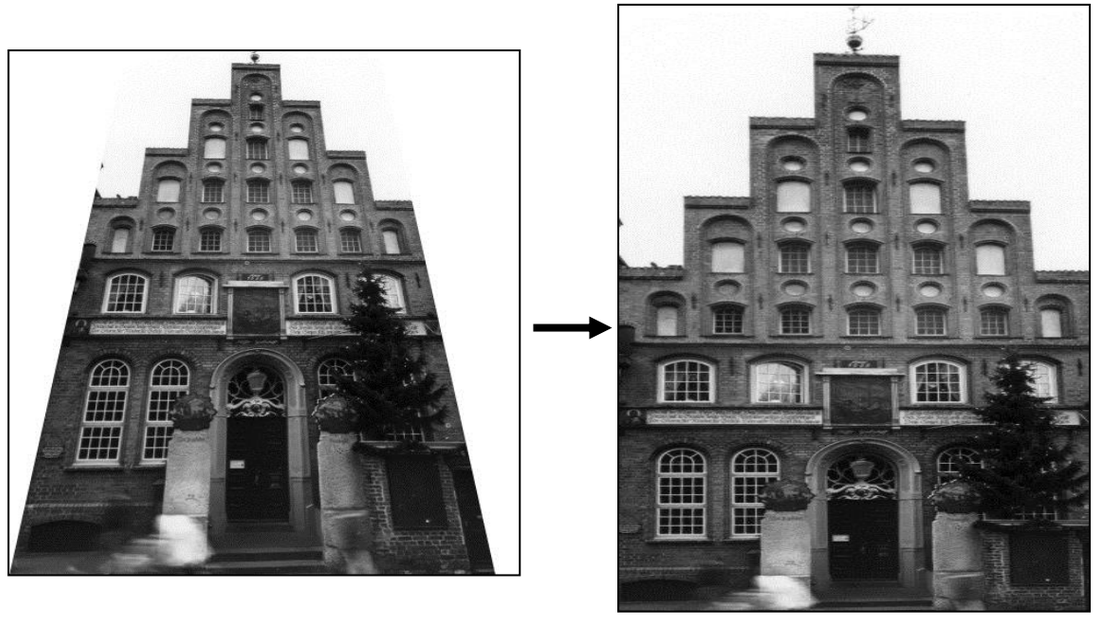






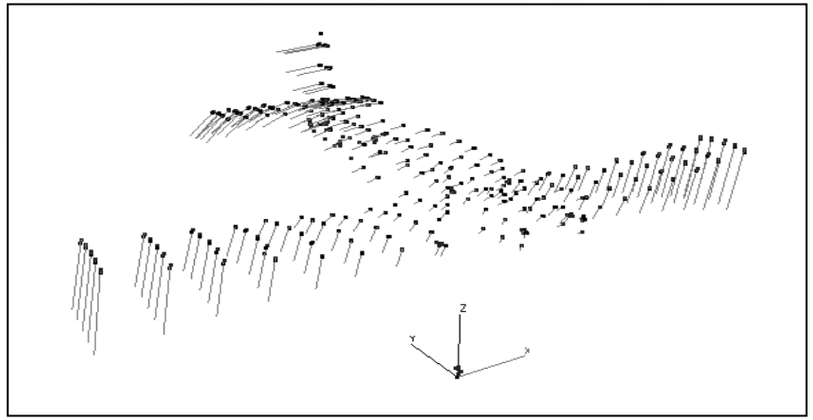
main photogrammetric products

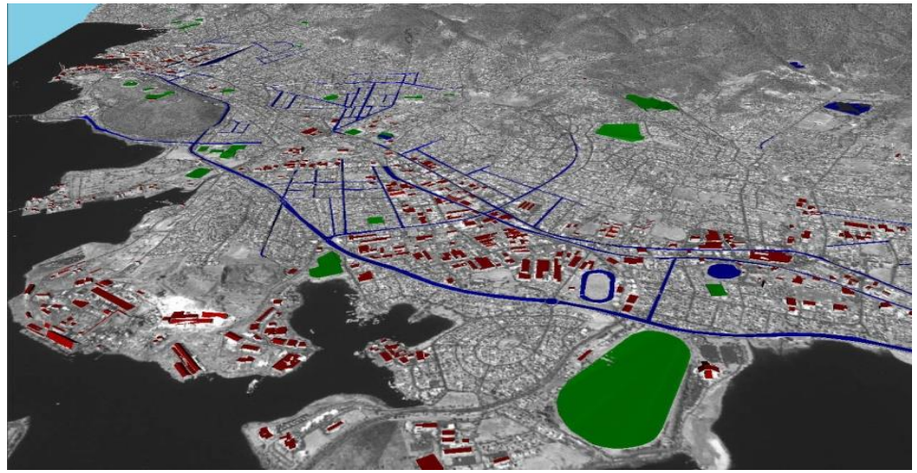
- **Ortho-imagery**



Important photogrammetric products

- 3D feature extraction





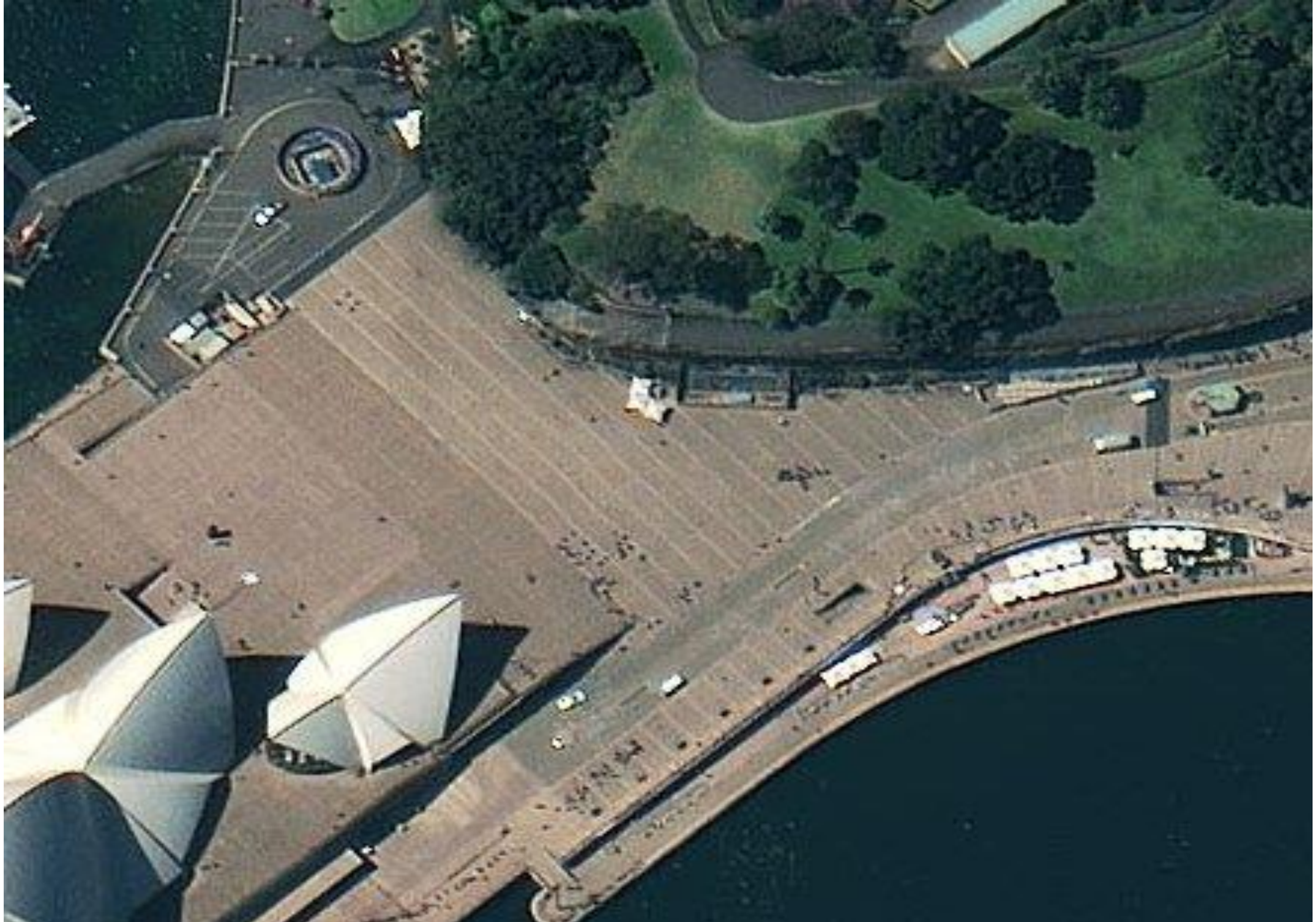
photogrammetric products

- **Visualisations (combination of orthos, surface models & extracted features)**

Animations 1 , 2 http://www.brainpickings.org/index.php/2009/07/31/crowdsourced-3d-cities/_https://www.youtube.com/watch?v=j7PGgrMSi5o
https://www.youtube.com/watch?v=6R8WhMPl-54&feature=youtu.be
https://www.youtube.com/watch?v=-ucLIckILT4

Revolution in Imaging – large area surveys

- **Bing-Maps Initiative with Digital Globe– Global Ortho Project**
  - The Vexcel UltraCam-G with 30,000 pixels cross-track to minimize cost of aerial mapping
  - 10 million km^2 with a 30 cm orthophoto @100,000 km^2/month - 7.5 million km^2 in US, 2.5 million km^2 in W. Europe.
  - Fully automated 3D city models enhanced by ground based images for building facades
  - Each 1° x 1° cell or ~ 10,000 km^2 only requires 4 hours labour for quality control
- **TANDEM-X - InSAR mission for global DEMs with accuracy <2m for slopes <2º available from Astrium from 2016.**



High Resolution Digital Aerial Cameras

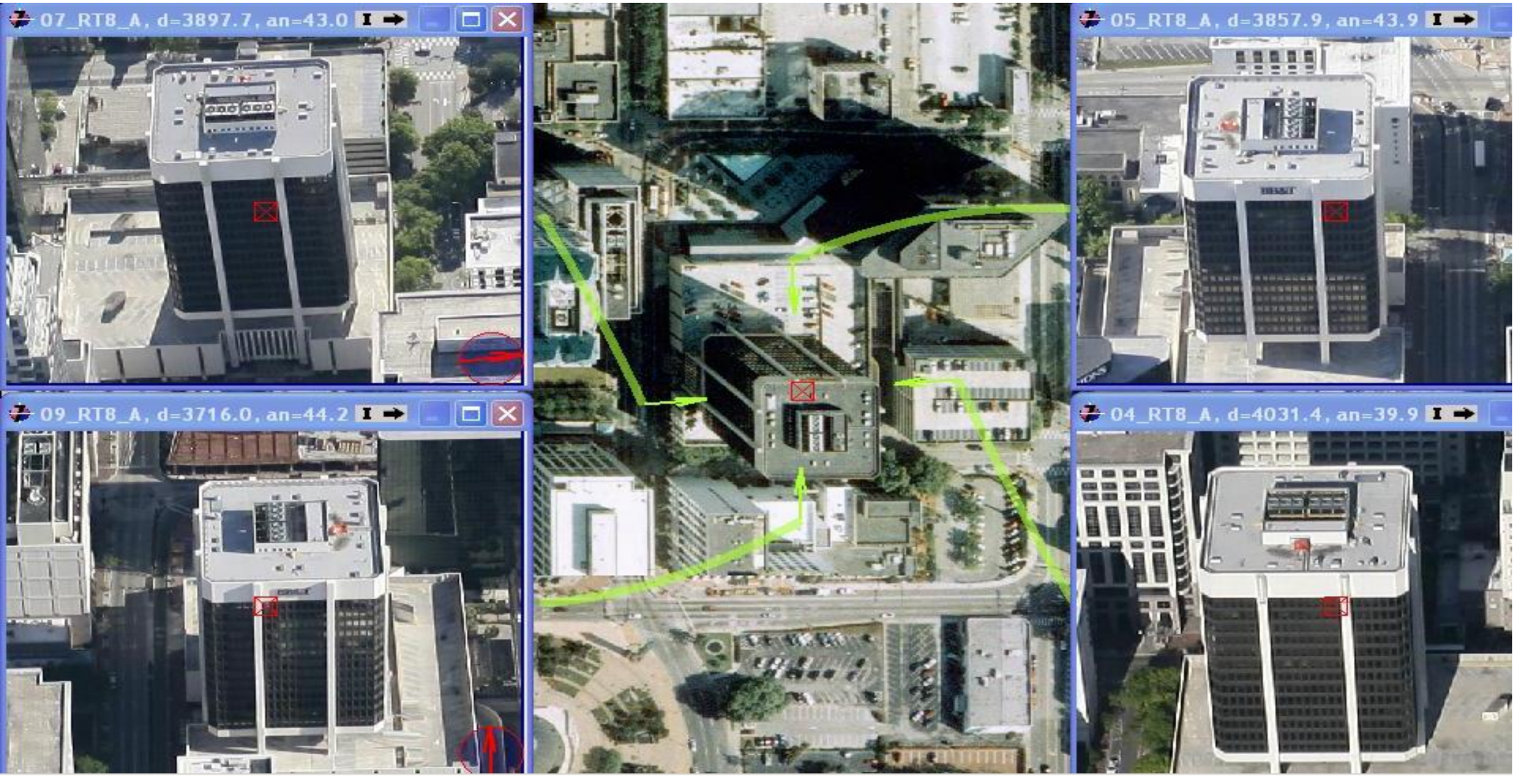
- **Two solutions for development of digital aerial camera now available**
  - **Three linear arrays** (‘push-broom’) look forward, vertically and backwards to form three separate images as the aircraft moves over the terrain surface.
    - Images not perspective projections
    - System must include GPS/INS
  - **Images from smaller area arrays** are stitched together to form a larger frame image, which will have similar dimensions to a frame aerial film camera
  - **Monolithic area arrays** of up to 390Mpixels

DATA ACQUISITION BY LEICA GEOSYSTEMS ADS100


NOERDL_~Photo21_pan.tif
Panchromatic
NOERDL_~Photo21_rgblr.tif
Original Color
NOERDL_~Photo21_rgb.tif
Pan-sharpened Color

Multi-Camera Imaging

- **Pictometry International (U.S.A.)**
- **Leica Geosystems (Switzerland)**
- **IGI (Germany)**
- **Others**
  - Multiple cameras mounted in aircraft
  - Imaging built up areas from 4 directions
  - Large number of images taken for homeland security, asset management
  - Imaging is an essential aspect of a modern city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05_RT8_A, d=3857.9, an=43.9
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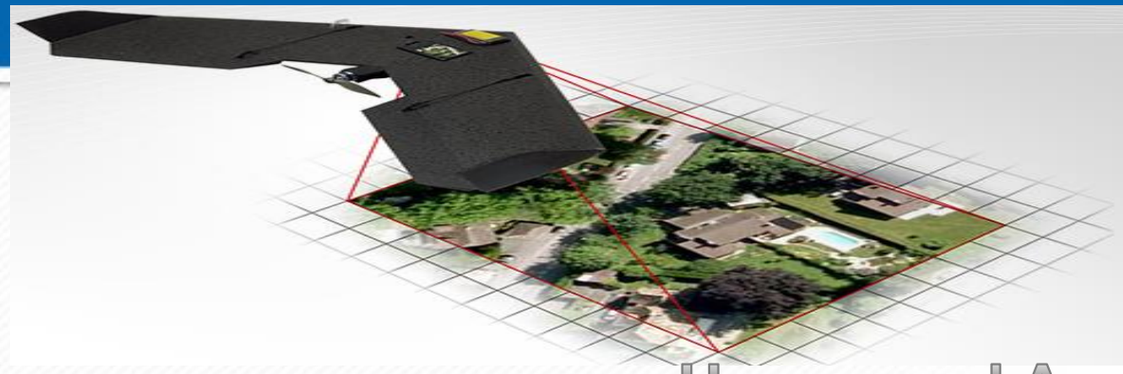
04_RT8_A, d=4031.4, an=39.9

Unmanned Aerial Systems



swinglet CAM
senseFly

Professional GIS tool

Collects aerial imagery up to1.5-6sqkm in a single flight.
The swinglet CAM has a flight time of up to 30 minutes allowing to cover areas of up to 4sqkm in a single flight. With its 16MP camera it can shoot aerial imagery at down to 3cm/pixel resolution. The images can then be used to create maps and elevation models with a precision of 5cm.

Unmanned Aerial Systems

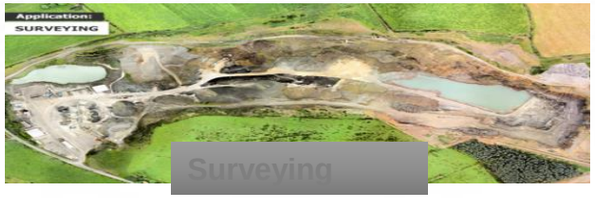
1. Plan flight path

2. Launch the UAV

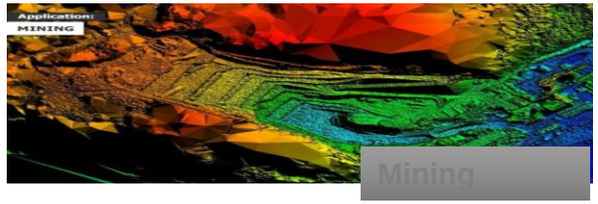
3. Take aerial images

4. Create 3D Products

Applications - unlimited:



Surveying



Mining

Mapping

Aerial photographing

Agriculture

Conservation

Environmental Management

Different UAVs:


swinglet CAM
+
Download at no extra charge
eMotion 2
Flight planning & control software
+
Download at no extra charge
Postflight Terra LT*
Geotags & Quick check
*powered by Pix4D

Aibot X6 V2 (A Hexagon company)

Mobile Mapping Systems

digital cameras for close range photogrammetry: 3 basic types

- **Amateur** ***<$US500*** **<1:20,000 accuracy**

- **Professional** ***approx. to $US2,000*** **<1:100,000 accuracy**

- **Photogrammetric** ***$US 50,000*** **1:200,000 accuracy**

Bayon Temple

- The Angkor Site in Cambodia: Hindu and Buddhist monuments listed in the UNESCO World Heritage List
- Project goal: Image-based reconstruction of one of the many complex Buddha-faced towers of Bayon Temple in Angkor Thom

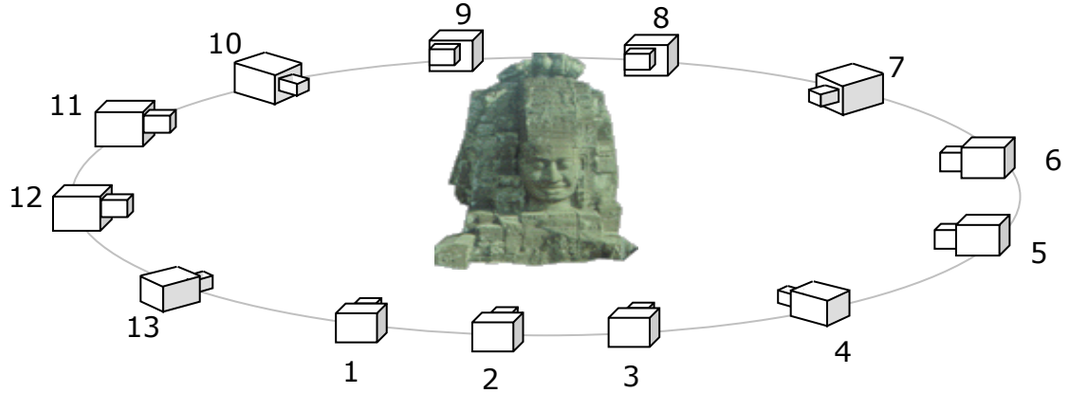
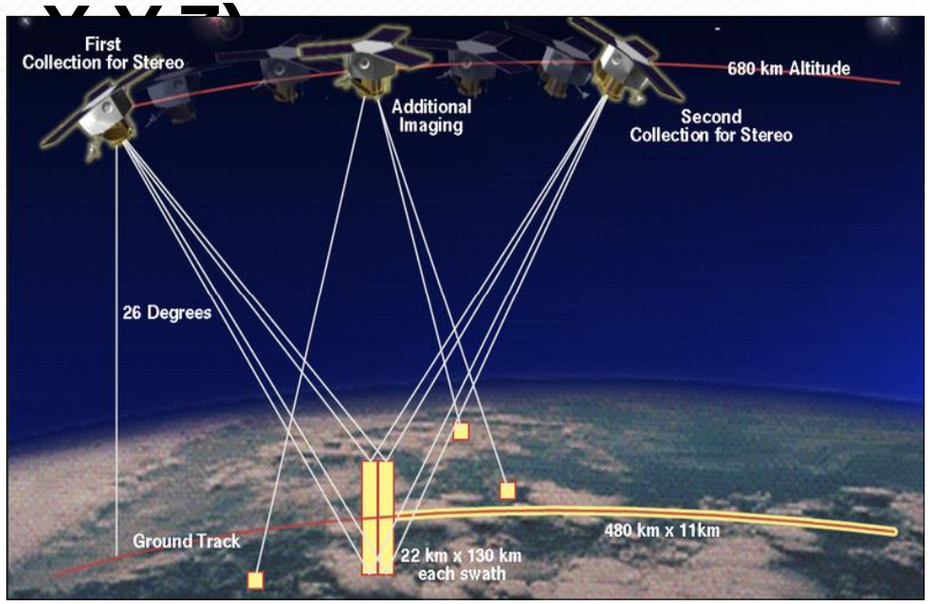


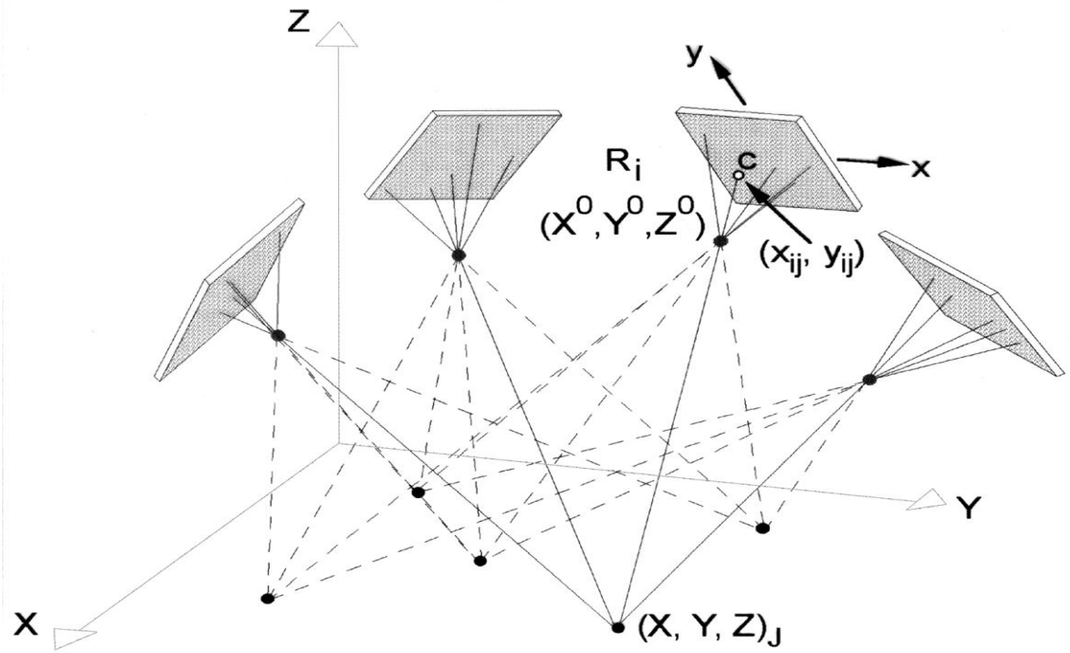
Image acquisition

photogrammetric sensor orientation process

- 2D image measurements to 3D object space data (x,y `
  Y, Y, Z)

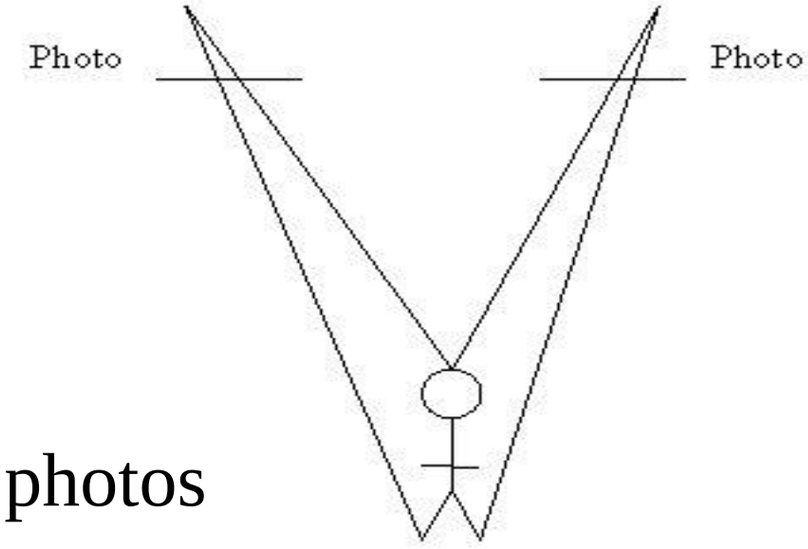


satellite imagery

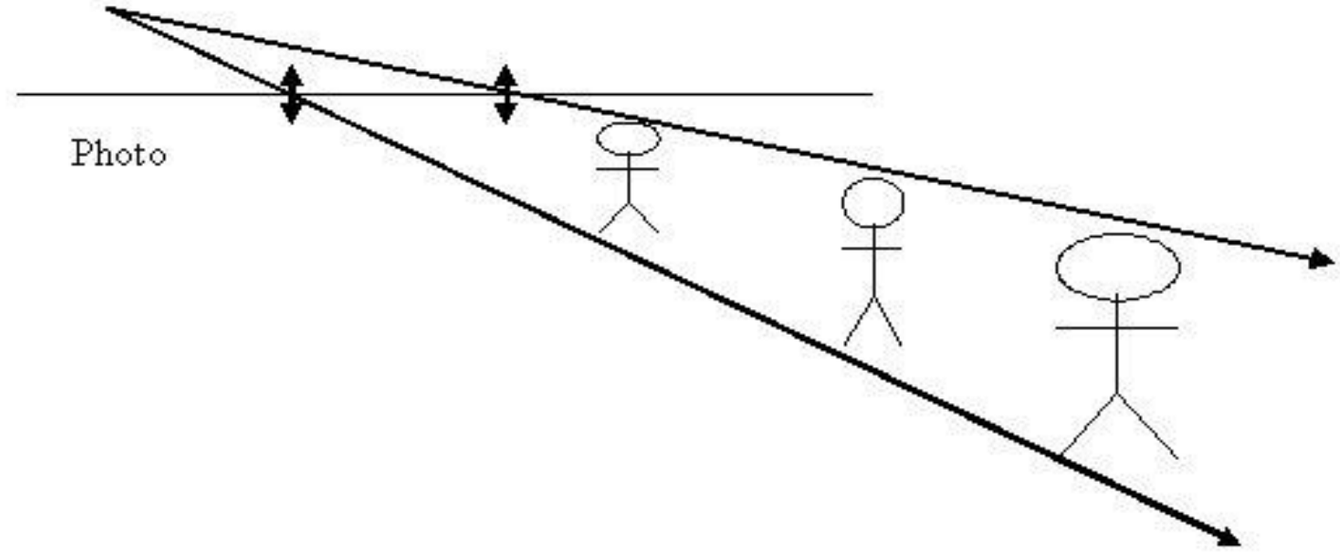


close-range images

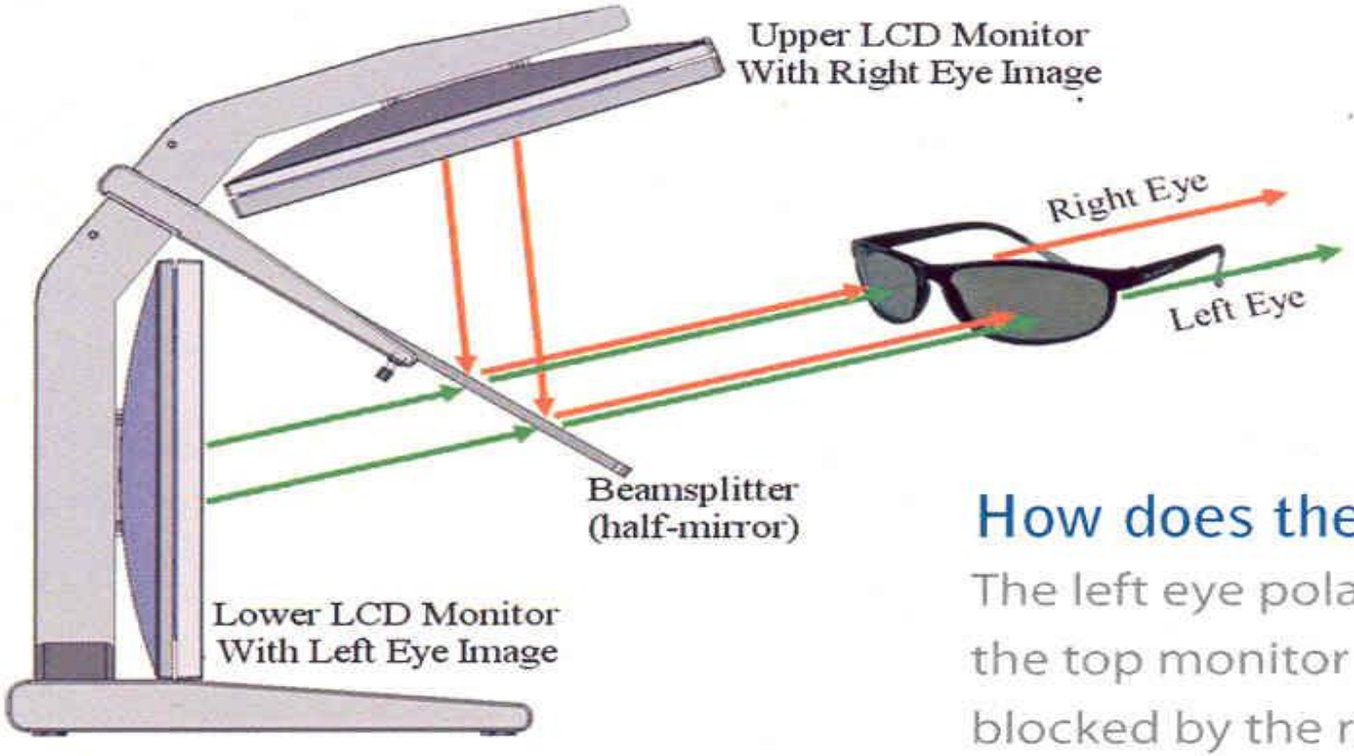
Measuring an object on one and two photos



Two photos



One photo



How does the StereoMirror work?

The left eye polarized lens of the glasses blocks light from the top monitor while light from the lower monitor is blocked by the right eye lens.

Subject matter

- Introduction to Photogrammetry. Definitions
- Chapter 1: Cameras, Aerial Photography, Close Range, Photography, other Image Sources.
- Chapter 2: Geometry of photography, stereovision and stereoscopy
- Chapter 3: Principles of analytical photogrammetry
- Chapter 4: Digital Photogrammetry and software operations
- Chapter 5: Processing of airborne laser scanner (ALS) or lidar data
- Chapter 6: Aerial mapping and project planning
- Chapter 7: Close range photogrammetry

Exercises and Assessment

- **Exercise 1: Close range photogrammetry exercise**

  to be completed by 9 November.

- **Exercise 2: Exterior orientation of digital photographs DEM computation and orthophoto production**

  to be completed by 23 November.

- **Exercise 3: Compute ground coordinates of a point by intersection**

  to be completed by 30 November.

Exercises and Assessment - revise

- **Assessments**
- Weekly tests 50%
- Successful completion of practical exercises 25%
- and assignment
- Presentation 25%
- **Total 100%**