LIESMARS

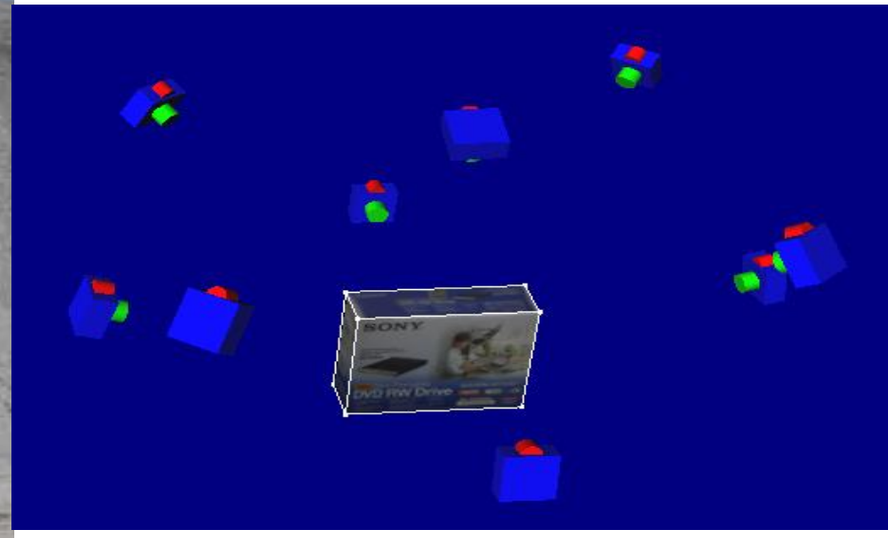
Course Title

Principles of Photogrammetry

EXERCISE 1 - BRIEFING

Close Range Photogrammetry (CRP)

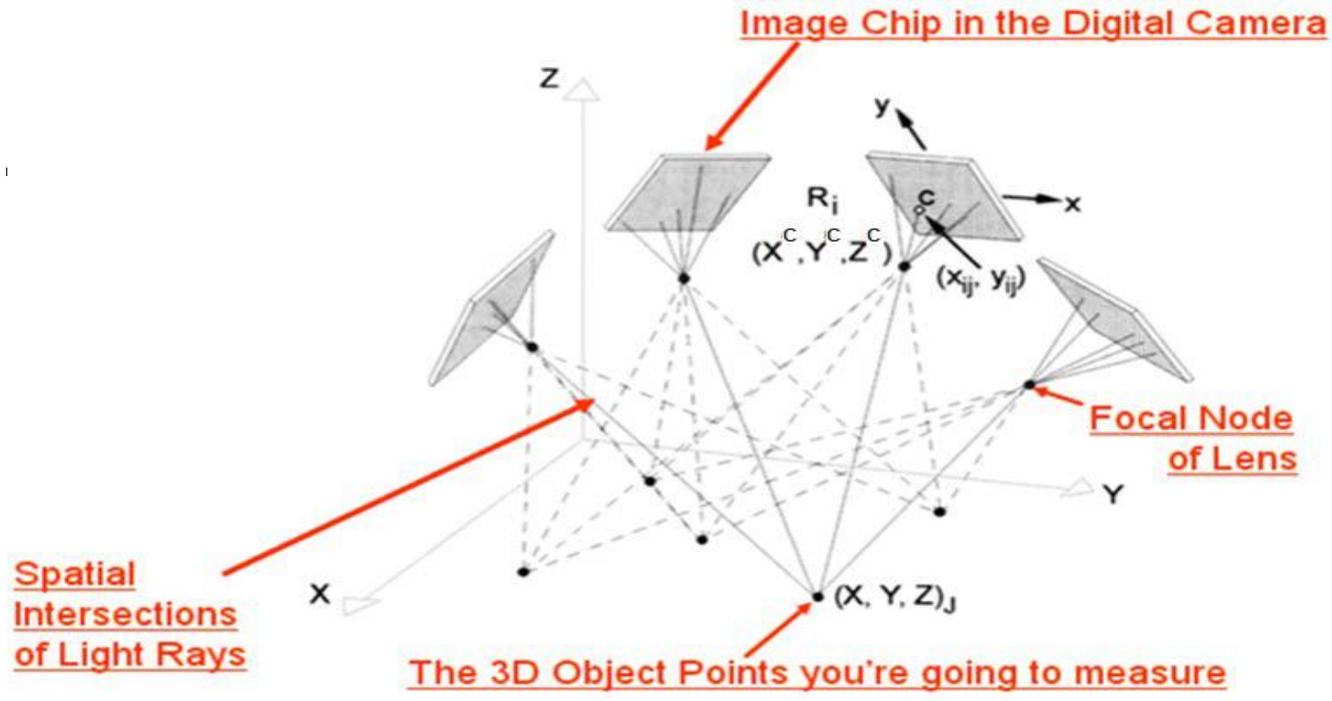
Taking convergent images close to the object to generate 3D models or measure the coordinates of interest points



How CRP works?

1. Camera calibration
2. Image acquisition
3. Determine camera's position (x^c, y^c, z^c) and orientation (α,θ,κ)
4. Calc. coordinates of interest points

In reality, the steps 3 & 4 are processed simultaneously by photogrammetry software Bundle Adjustment (spatial triangulation)



Equipment required

A digital camera (multi cameras needed for dynamic subject)

A computer

Photogrammetry software

- Photomodeler,
- iWitnessPro
- and Australis

Digital camera (High resolution suggested - eg12 megapixel)

CRP Accuracy depends on:

- Image sensor and lens quality
- Image resolution
- Object size
- Geometrical layout of pictures

The possible precision with coded targets:

- 1/10,000 with compact cameras
- 1/100,000 with professional DSLR cameras
- 1/200,000 with metric cameras

CRP Applications (www.photomodeler.com)

Industrial & Engineering

Accident Recon & Forensics

Architecture & Preservation

Geology & Terrain

Film & Animation

Archaeology

Engineering Applications

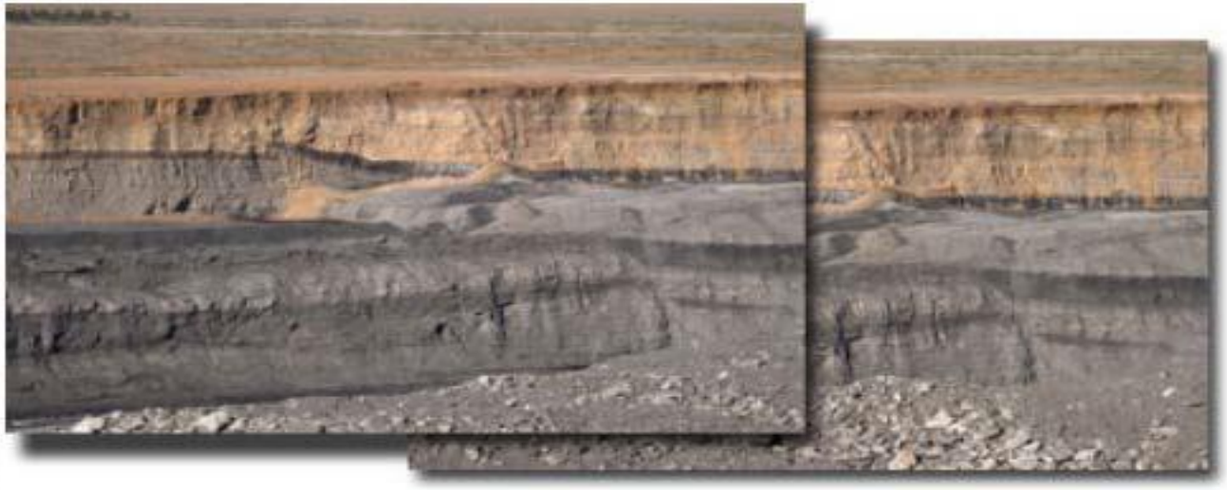
Structural modelling
Deformation monitoring
Mining site analysis
Reverse engineering modelling
……

Source: http://connect.in.com

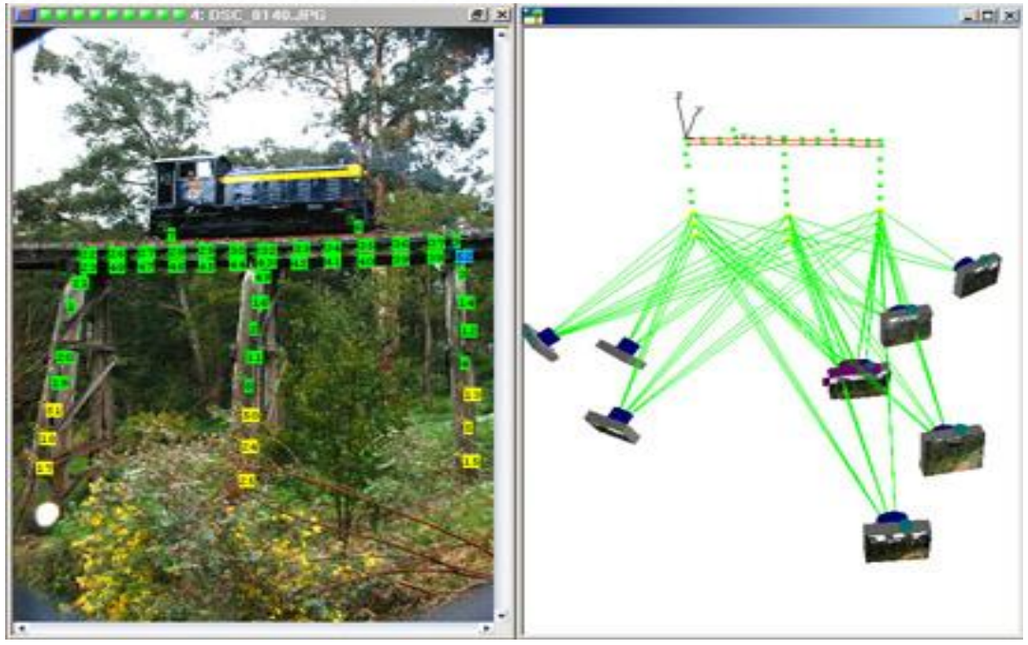
Use of photogrammetric mapping techniques for slope stability

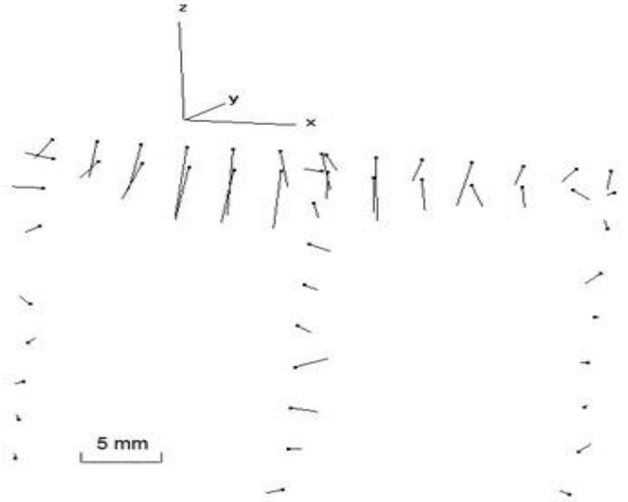
Source: http://srk.com

Geotechnical analysis in mining



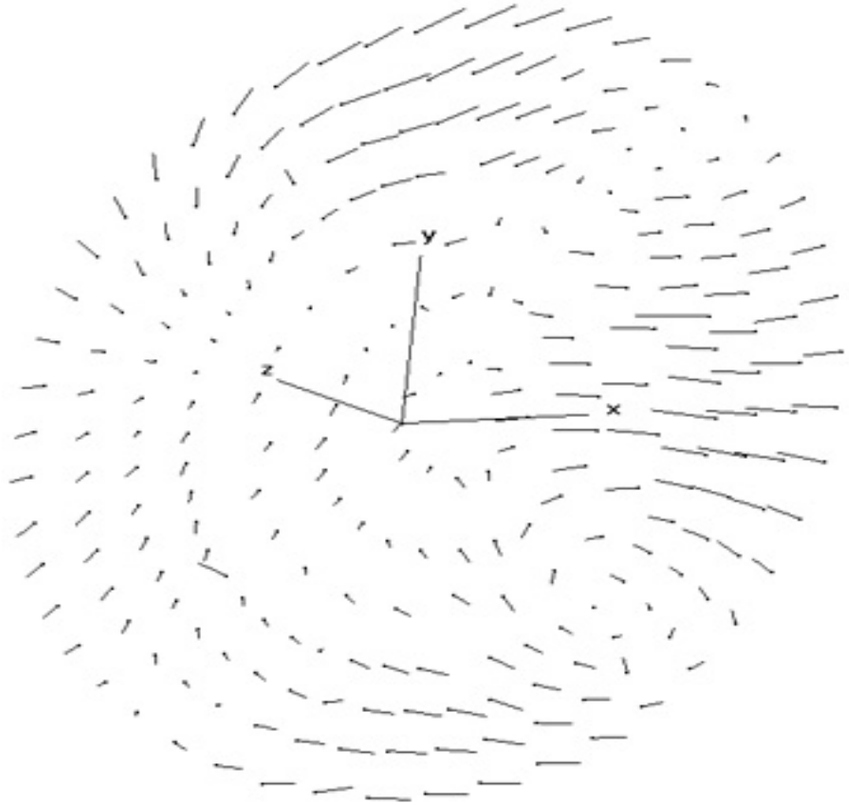
Railway bridge deformation survey



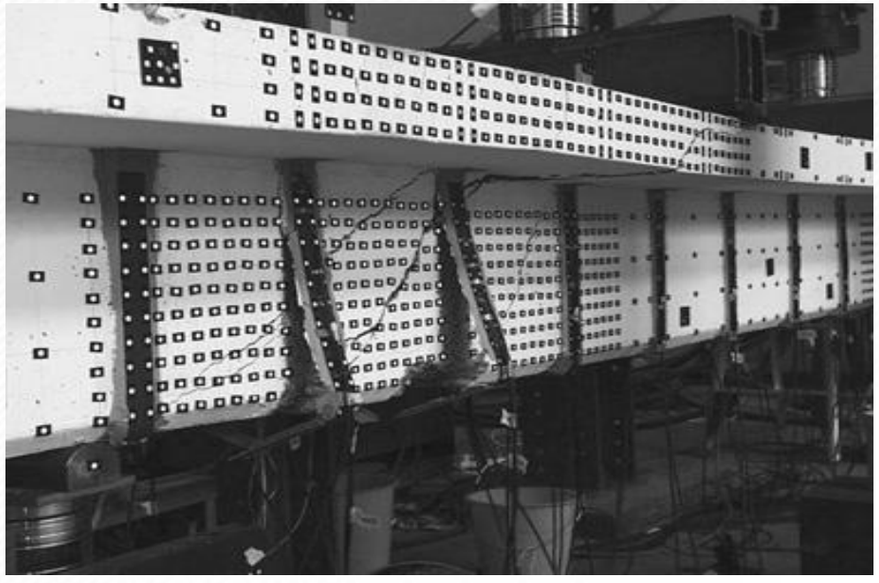


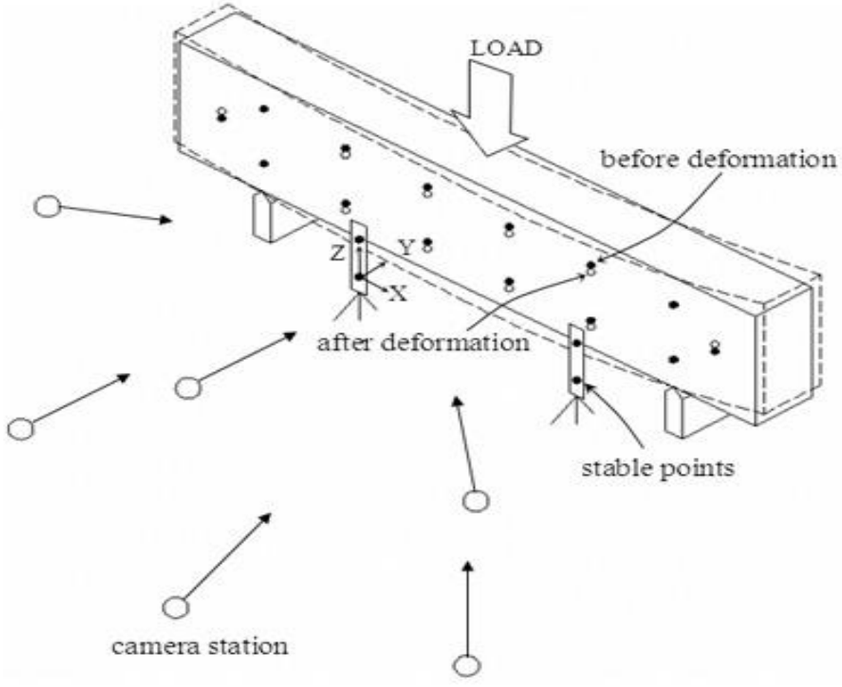
Radio telescope surface deformation measurement

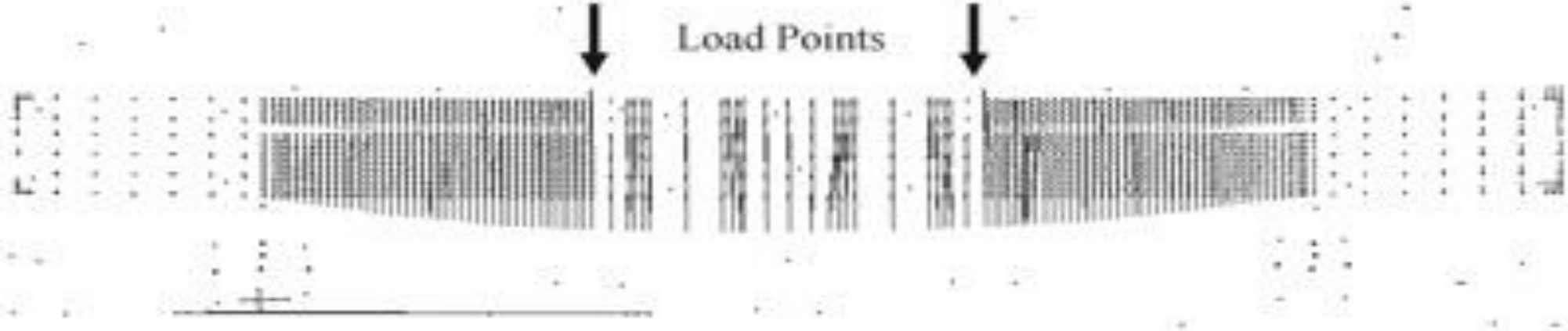
The 26 m diameter Hobart radio telescope surface deformation/displacement monitoring Accuracy ±0.1mm



Concrete beam deformation and shear failure under load







Land slide monitoring

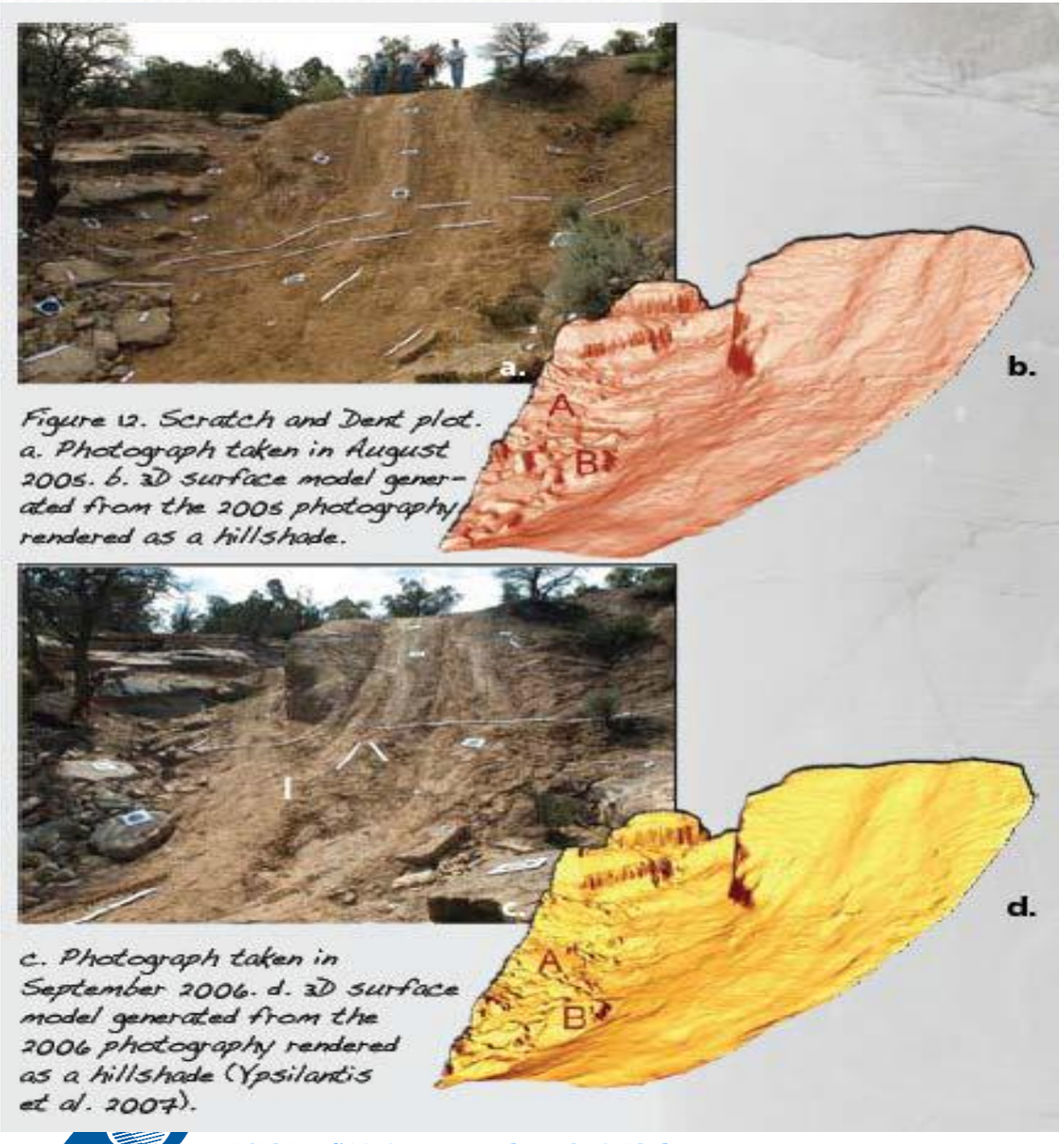
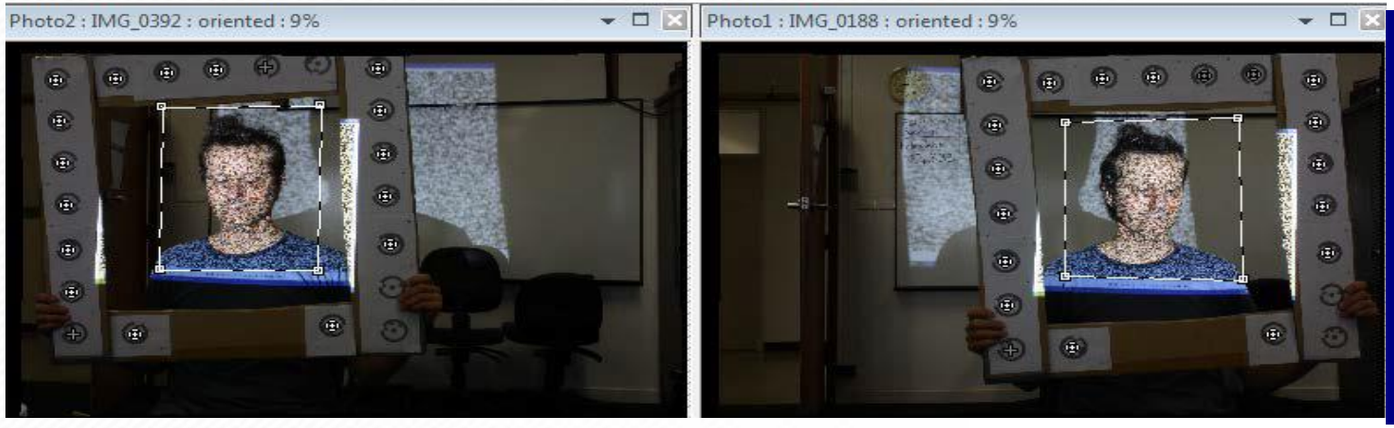
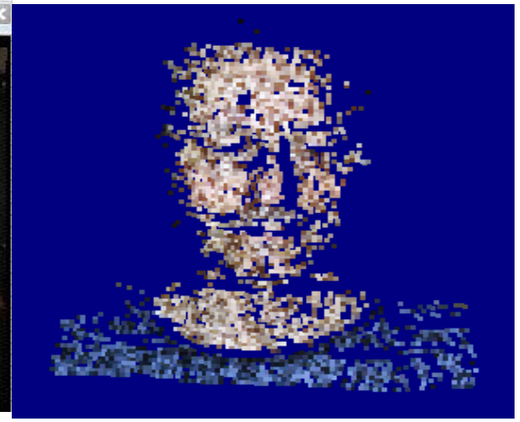


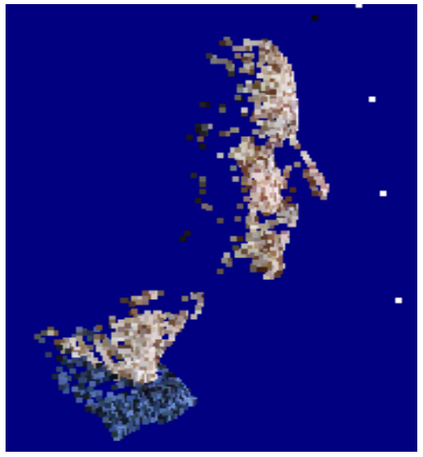
Figure 12. Scratch and Dent plot. a. Photograph taken in August 2005. b. 3D surface model generated from the 2005 photography rendered as a hillshade.

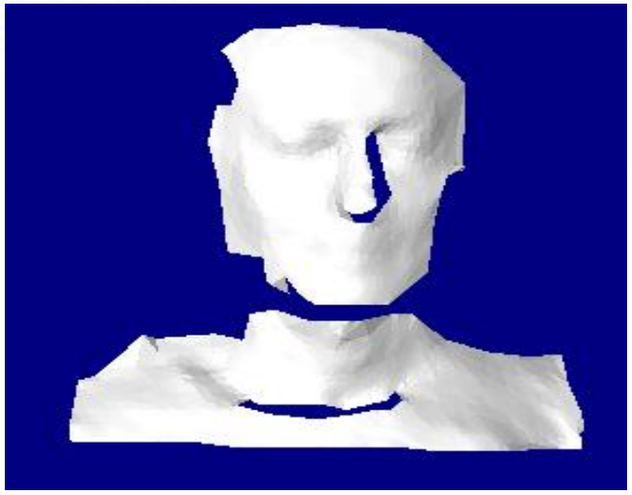
c. Photograph taken in September 2006. d. 3D surface model generated from the 2006 photography rendered as a hillshade (Ypsilantis et al. 2007).

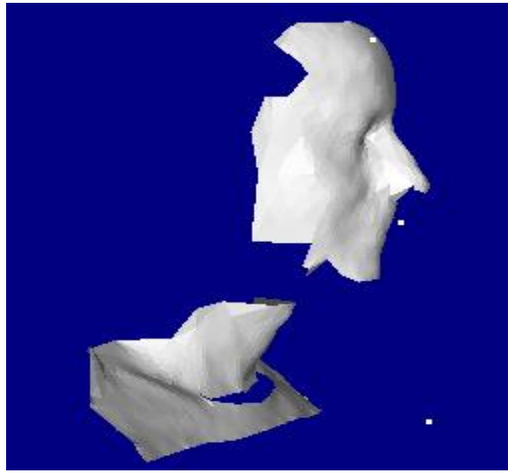
3D surface modelling

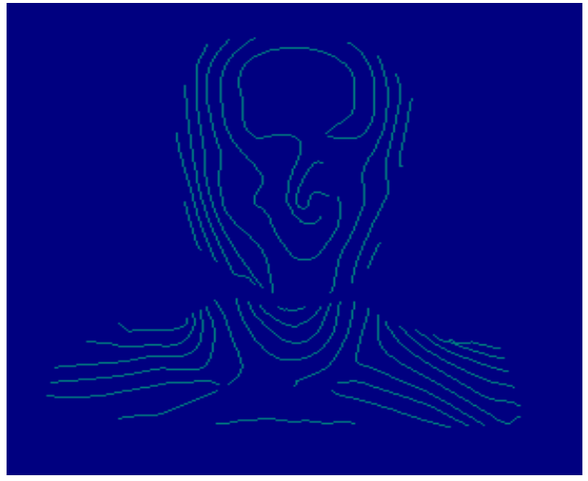


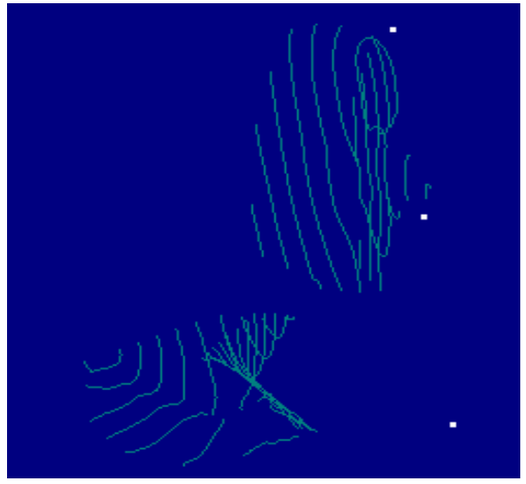








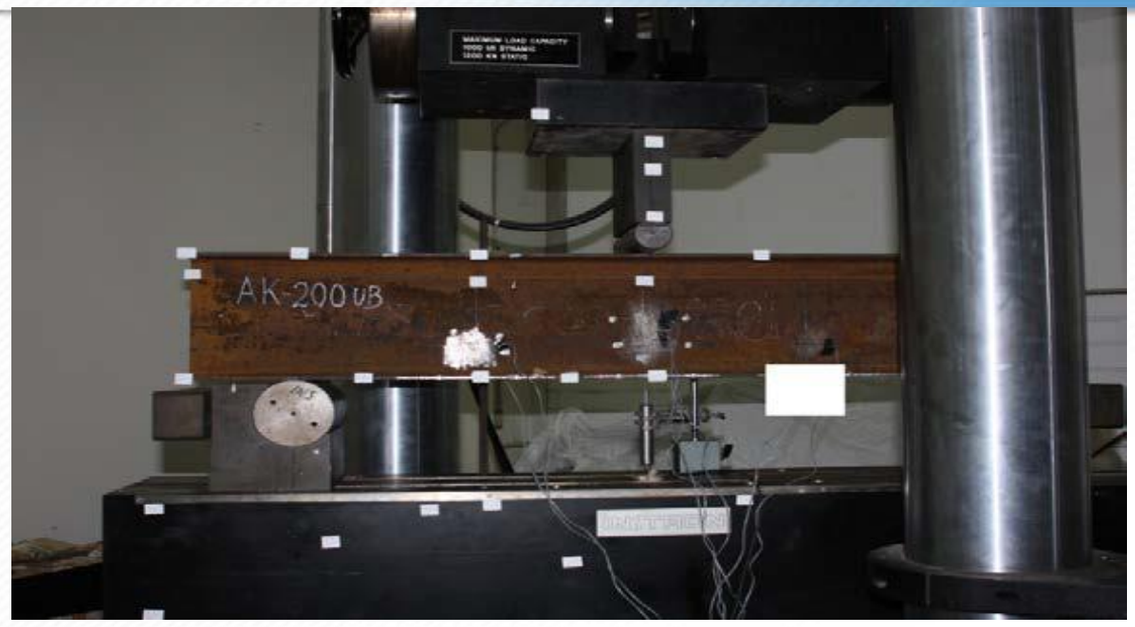




BioMech applications

Locomotion

Other applications



Cameras for CRP Projects

- Digital Single-Lens Reflex (DSLR) cameras tend to give better results than compact digital cameras.
- The number of megapixels is important with high resolutions providing more information.
- High quality lenses provide better sharpness and clarity, and less lens distortions.
- Fixed focal length lenses are easier to model and maintain.
- Wide angle lenses allow for better triangulation results, but extremely wide angle lenses reduce accuracy due to extensive radial lens distortions.
- Anti-shake (image stabiliser) mechanisms potentially reduce accuracy.

Image Acquisition

- Quality of images will greatly determine the accuracy of the results, so develop your photographic technique for photogrammetry.
- Find the sharpest aperture setting for your lens (often f/8-f/11) and calibrate with this setting.
- For most projects infinity focus can be used; keep the lens fixed to this focus & calibrate with the true infinity setting.
- Use the fastest shutter speed to the conditions & available light.
- Increase ISO as necessary if additional sensitivity is needed in lower lighting conditions.
- If necessary in very low light, use a tripod and mirror-lockup to avoid any camera movement;
- Although flash can be used, it is best to avoid utilising the “in-built” camera flash. Different shadows generated from different camera locations can confuse automated image matching.
- Take extra images to increase data redundancy.

Camera Calibration

To derive accurate spatial data using consumer grade digital cameras, it is necessary to define several critical parameters which model distinct geometric characteristics of the imaging system.

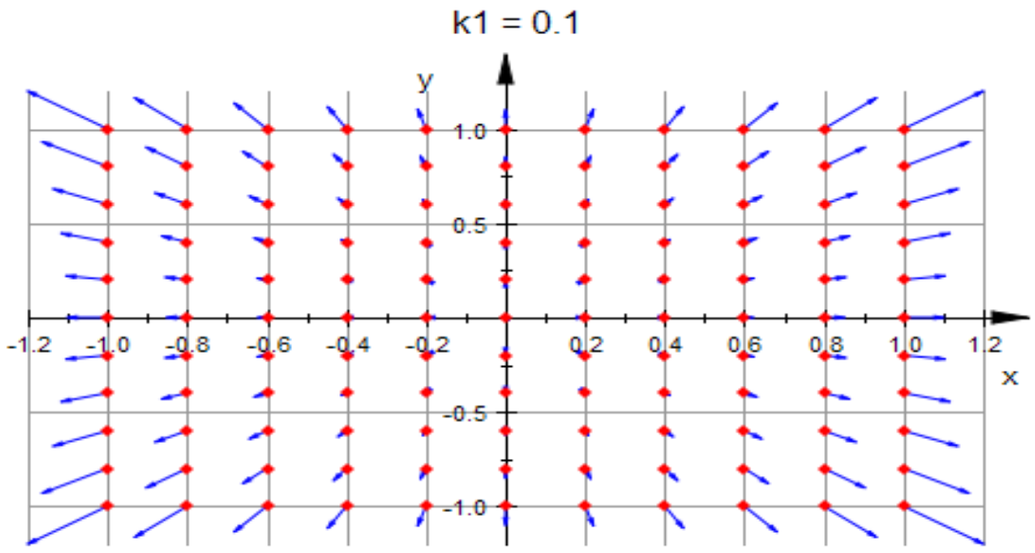
The prime parameters normally recognised include:

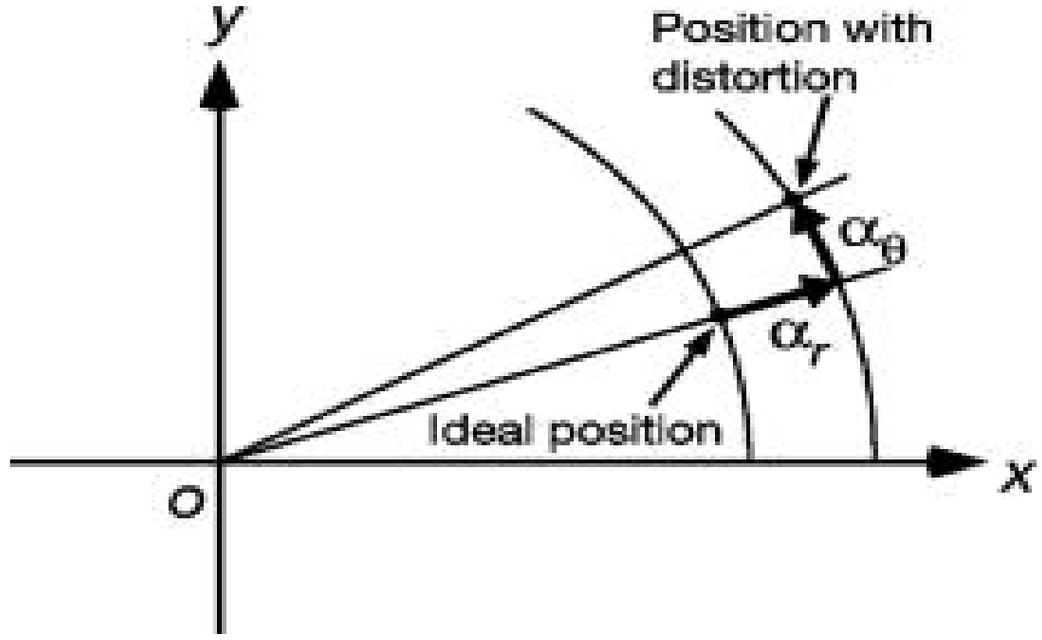
camera focal length (f)

principal point offset (x_o, y_o)

radial lens distortion (K_1, K_2, K_3)

tangential distortion (P_1, P_2)





General principles for camera setup

- Lens – Manual Focus + Infinity + Disable Stabiliser.
- Mode – AV (Aperture Priority) – set it to F8.
  (*Small F# leads to short Depth of Field. Large F# leads to Diffraction which causes less sharpness or even blurry.)*
- Shutter Speed depends on the light condition
- WB (White Balance) – set to Auto
- ISO – set to 100-400 (depends on light condition.
- Larger ISO leads to more noise on images)
  In the MENU:
  - Quality – Fine
  - Red-eye – Off
  - Auto Rotate – Off

Exercise 1 – Close Range Photogrammetry

1. **Preparation**
    1. Groups of 2 students – choose your partner
    2. Select the building to be imaged
    3. Select your camera
2. **Fieldwork**
    1. Undertake photography
    2. Measure the 2 distances using a measuring tape
3. **Laboratory**
    1. Download software after the photography is completed, view videos
    2. Calibrate your camera (optional)
    3. Undertake the digital photogrammetry using the camera calibration data

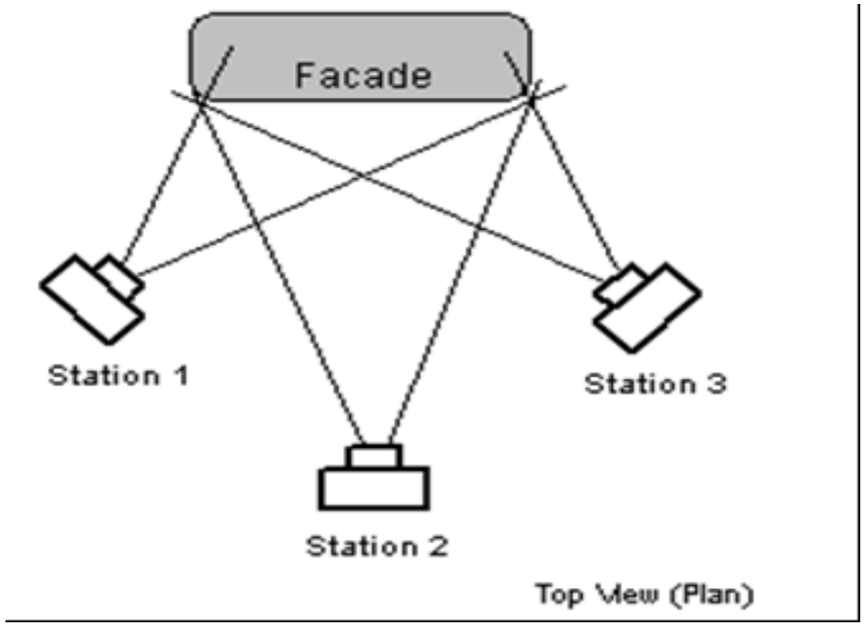
Field Work

- Any building on Campus can be selected but there should be space to take at least 3 images from 3 different directions without obstruction and adequate overlaps

- 2 options are suggested
  - The Cafeteria west of the LIESMARS building
  - Building housing the ‘Old Street BBQ’ north west of LIESMARS.

Field Work

- Take at least 3 images of the building façade.
- No need to model the whole building.
- Use tripod if available and if not sunny.
- Each image should show the area of the building façade to be displayed in the final product



Field Work

- Select the image stations for acquiring 3 images with adequate overlaps between images
- All points to be measured should occur on the 3 photos
- Take more than 1 photo from each station
- Measure the distance between 2 prominent points on the building with a tape to establish the scale of the building from the images.
- Choose points that are as far apart as possible. These points should be visible on all 3 images.
- Measure an additional distance for use as check.
- Take field notes with a sketch of the building showing approximate camera stations.
- Record details of your camera number and your image numbers.
- Sketch the locations of the scale points and record the distances between them.

Image Processing Software

A number of CRP software packages available:

- **Photomodeler (for this exercise)**
- Australis
- iWitness

- Download Photomodeler from www.photomodeler.com after you have completed the photography – the software is available for free for 10 days
- View the videos provided by Photomodeler
- Carry out calibration of your camera (Optional)
- Process images
- Provide a textured 3D display of the building