



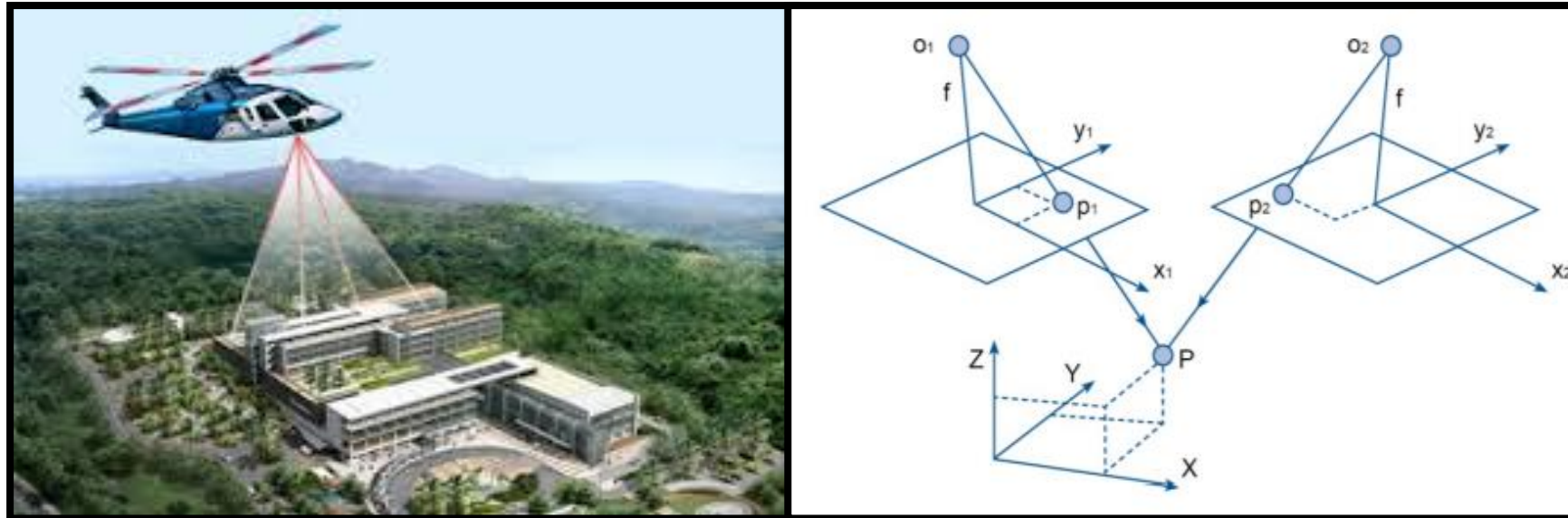
UNIVERSITY OF
BAGHDAD



COLLEGE OF
ENGINEERING



DEPARTMENT OF
SURVEYING ENG.



CLOSE-RANGE PHOTOGRAMMETRY- INTRODUCTION

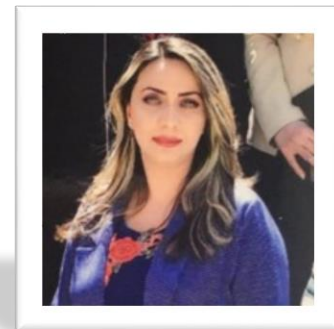
BSC - 4TH STAGE

2020-2021

LECTURE 2

DR. FANAR MANSOUR ABED

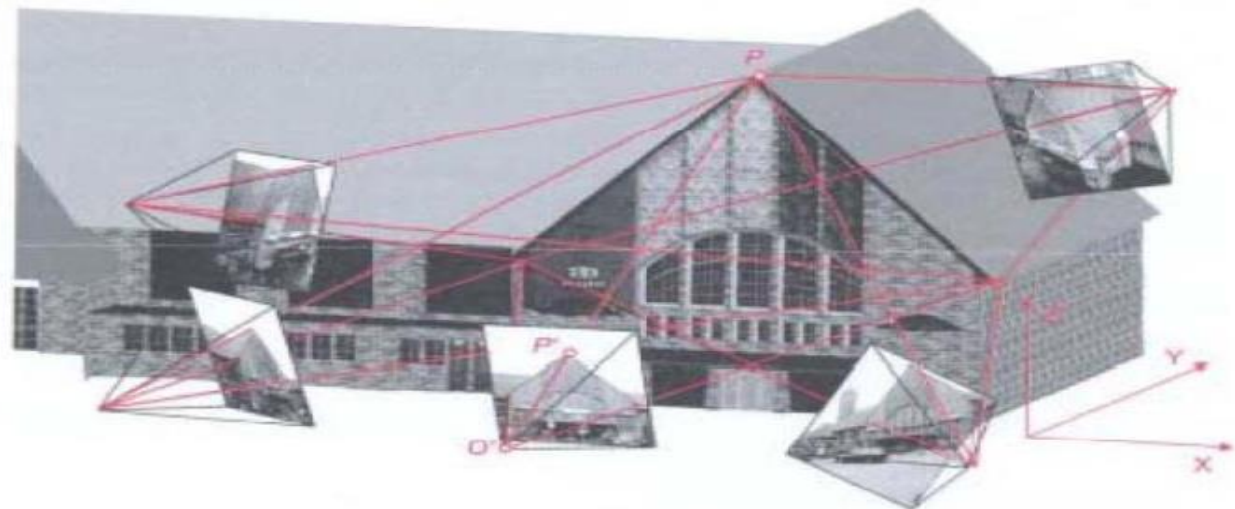
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Close Range Photogrammetry(CRP)

- **Terrestrial Photogrammetry (TP)** is a measurement technique where the coordinates of the points in 3D space of a terrestrial object are calculated by the measurements made in **two terrestrial photographic images (or more)** taken **from different positions**.
- **CRP** is a special term of terrestrial photogrammetry (**TP**) and its generally used in conjunction with object to camera distances of not more than **300-400 meters**.

The close-range photogrammetry relies on the reconstruction of the object simultaneously from several images from different and best possible perspective to ensure a suitable geometry of intersecting rays. (A. Behrens, C. Lasseur, D. Mergelkuhl)



Close Range Photogrammetry(CRP)

- With Terrestrial photogrammetry (TP) the cameras are usually **accessible**, so that direct measurements can be made to obtain exposure stations (**similar to airborne with GPS**).
- Known exterior orientation parameters (**E.O.P.**) are a source of **control**, replacing the necessity for locating control in object space.
- TP may be **static** (photos of stationary objects), **or dynamic** (photos of moving objects).

Objectives

- Making accurate 3-D models
 - Can be used for Accurate Measurements
- Making Textured models
 - Can be used as a final product (Photo-Realistic)
- Making Dense Surface Models
 - Can be used for Meshing, Contour Maps

TERRESTRIAL PHOTOGRAPHS



Dr. Pramesh Hada, Assistant Professor, nec

- photographs are taken from elevated ground stations.
- Method is very similar that the camera is in stationary position.
- Camera used in this method is called photo-theodolite as it will require the same features as theodolite.
- It is much cheaper and can be carried out by individual surveying firms also.

THE PHOTO-THEODOLITE

CONSTRUCTION AND USE OF PHOTOTHEODOLITE (PU 2006)

- Is a combination of camera and theodolite mounted on the same tripod,
- Used in terrestrial photogrammetry for mapmaking and other purposes.
- Photographs obtained are used for the construction of topographic maps, classification of soil, interpretation of geology.
- While taking the photographs the camera axis is kept parallel to each other.

It consists of :

- A camera box of fixed focus type
- A hollow rectangular frame placed vertically to the rear side
- The sensitized photographic plate.

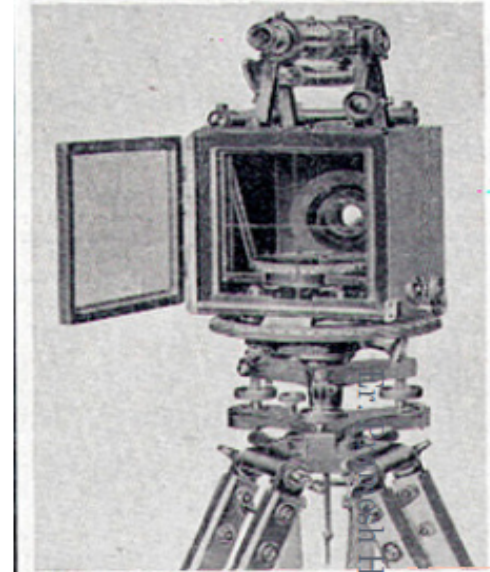


PHOTO-THEODOLITE. An instrument which gives true photographic perspectives in a vertical plane and has a mechanism for recording on the negative the information necessary for interpreting the photographs and plotting the ground plans.

Asst. Professor, nec



Past vs. present!

- Past ... Photo-theodolite & Stereo-metric cameras

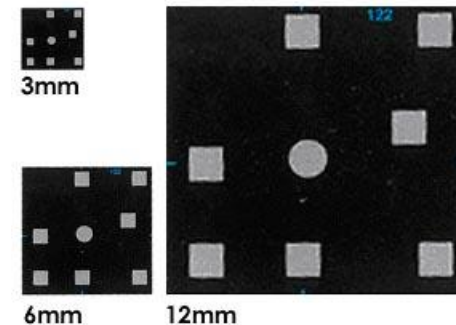
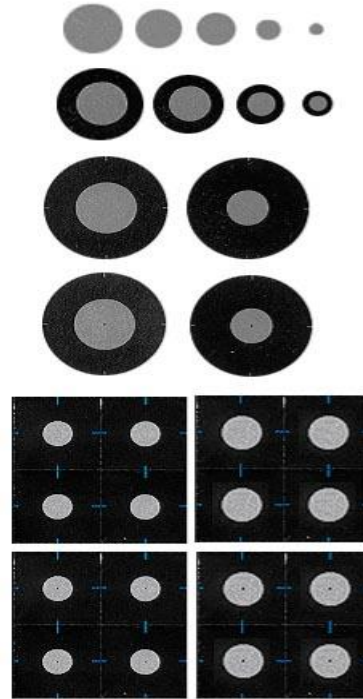


- Present ... multistation!
(check video)



Equipments!

- Digital Camera
 - High resolution camera (preferred > 7 MP)
 - Lens/Camera have been calibrated
- Targets
 - Retro-reflective targets
 - Coded targets preferred
 - Circular targets
 - Hard-body tooling targets
- Software
 - MetaShape/PhotoModeler, etc.
 - There are many other software packages which may include specific applications



Acquisition of Data: Camera

Cameras can be broadly classified into two types:

- Metric
 - Single Cameras
 - Stereo-metric Cameras
- Non-metric

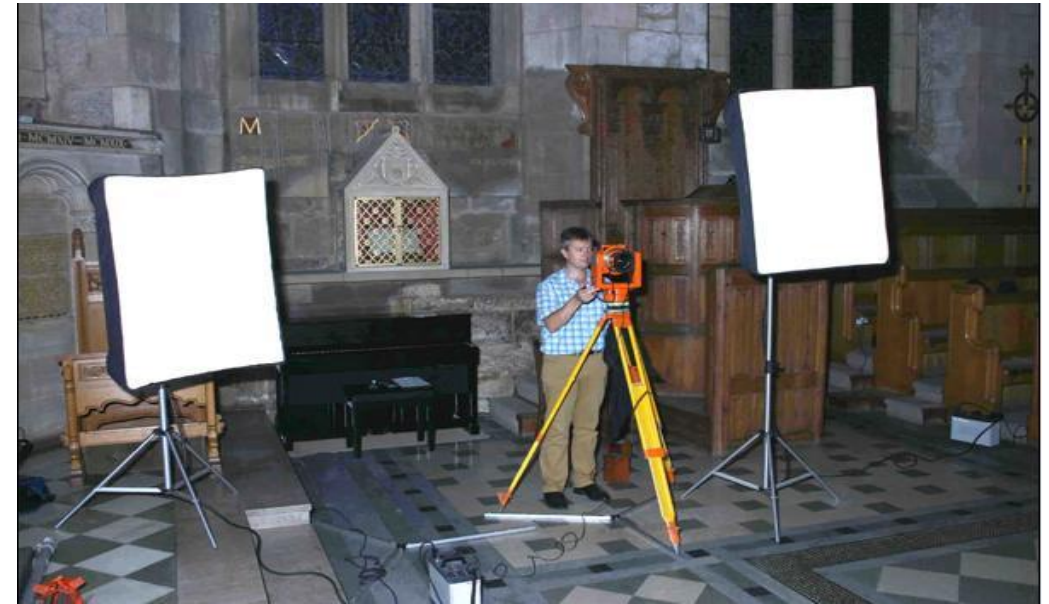


Metric Cameras

Photogrammetric Camera that enables geometrically accurate reconstruction of the optical model of the object scene from its stereo photographs

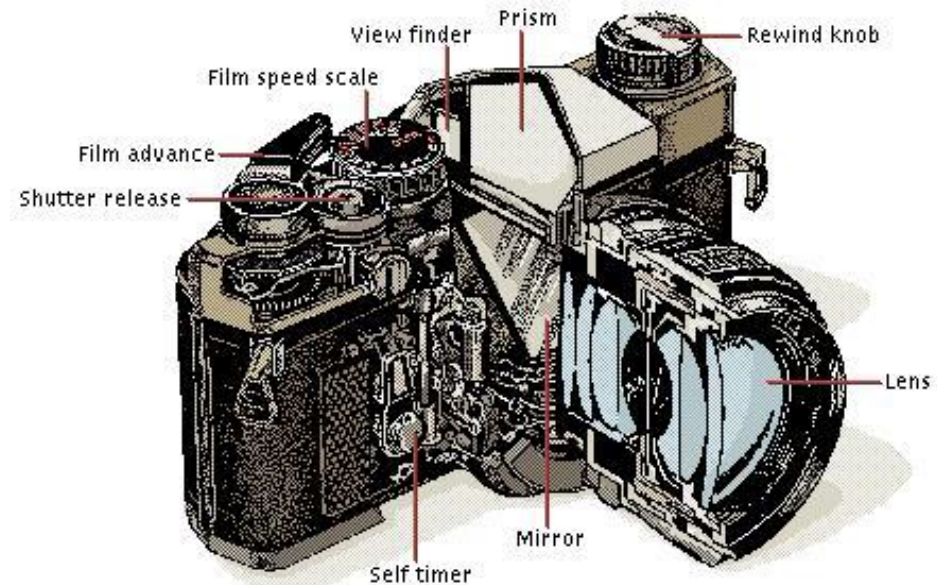
Single Cameras

- Total depth of field
- Nominal focal length
- Format of photographs
- Tilt range of camera axis and number of intermediate stops



Non-metric Cameras

- Cameras that have not been designed especially for photogrammetric purposes.
- A camera whose interior orientation is completely or partially unknown and frequently unstable.



Non-metric Cameras

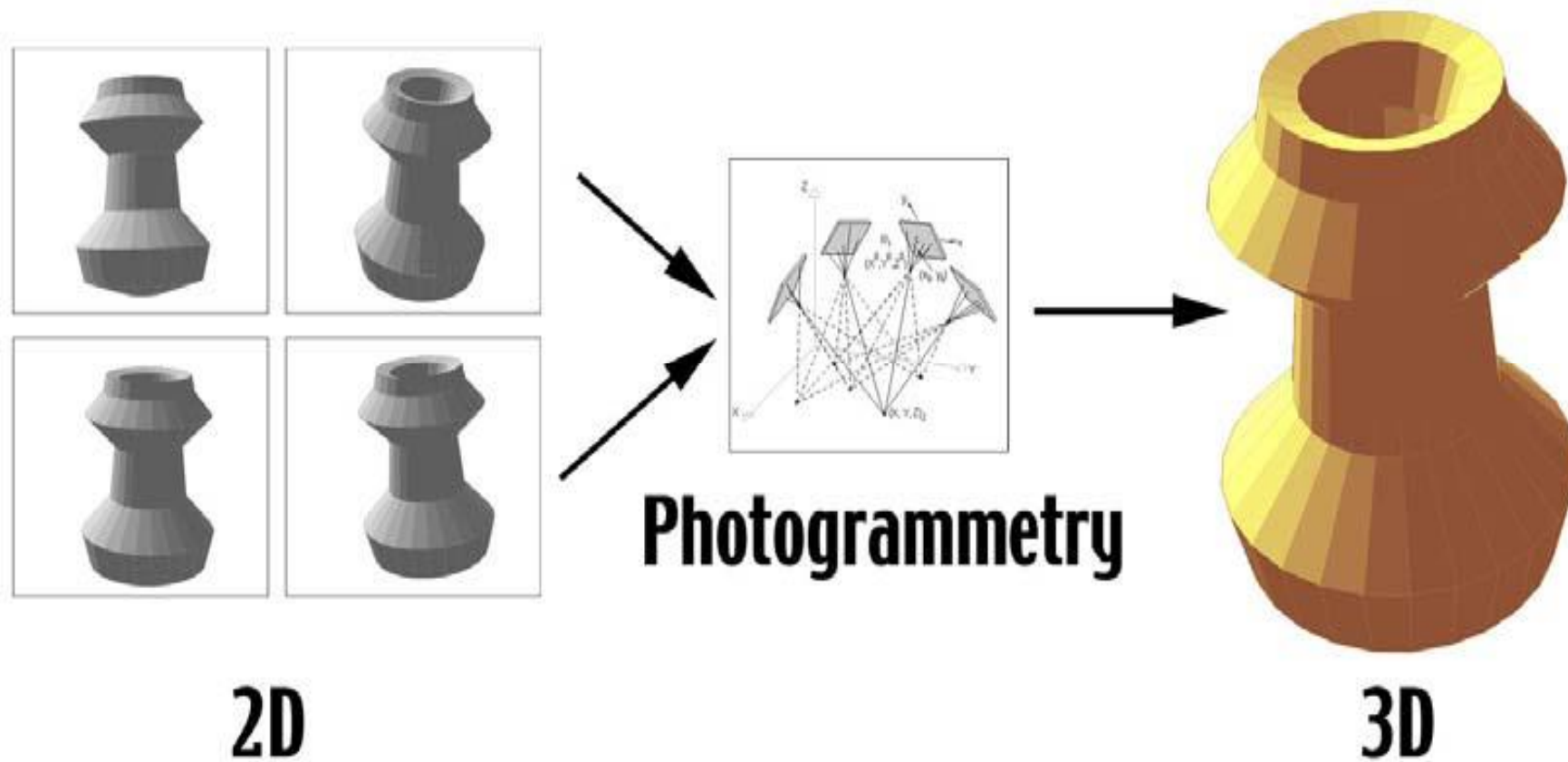
Advantages

- General availability
- Flexibility in focusing range
- Price is considerably less than for metric cameras
- Can be hand-held and thereby oriented in any direction

Disadvantages

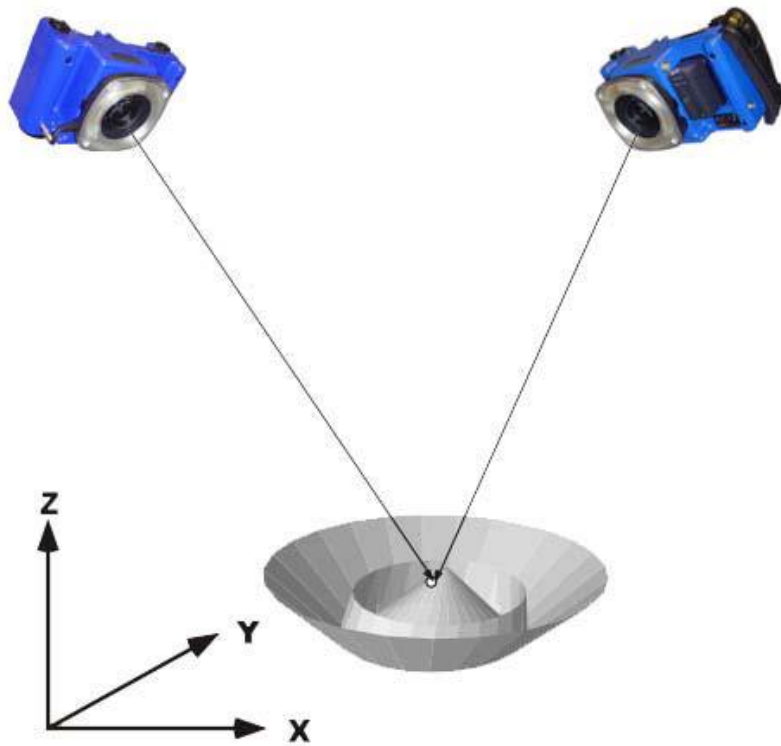
- Lenses are designed for high resolution at the expense of high distortion
- Instability of interior orientation (changes after every exposure)
- Lack of fiducial marks
- Absence of level bubbles and orientation provisions precludes the determination of exterior orientation before exposure

Concept Of CR Photogrammetry

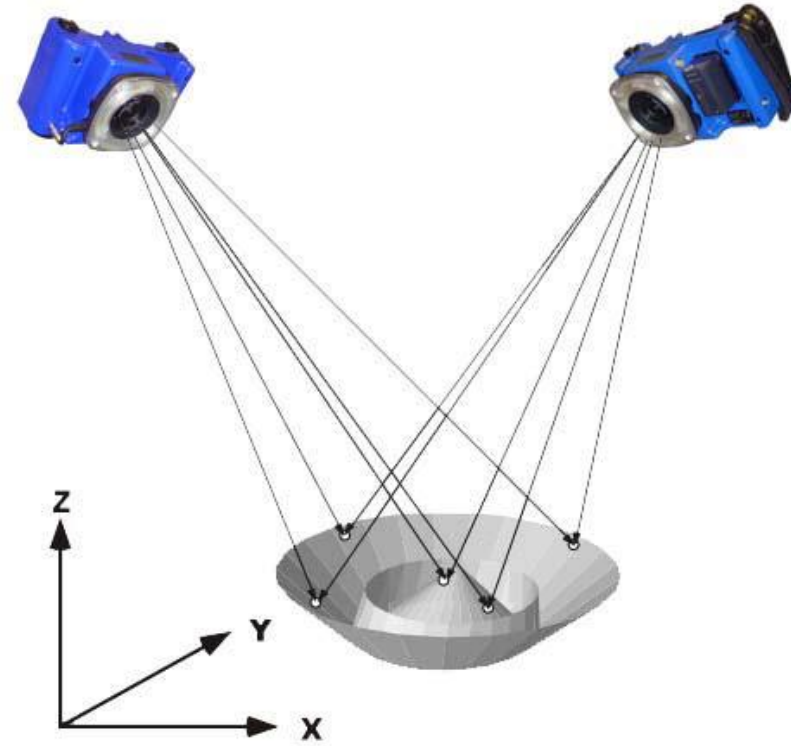


How it is done?

- Mathematically intersecting converging lines in space.
- The precise location of the point can be determined.



Single point triangulation



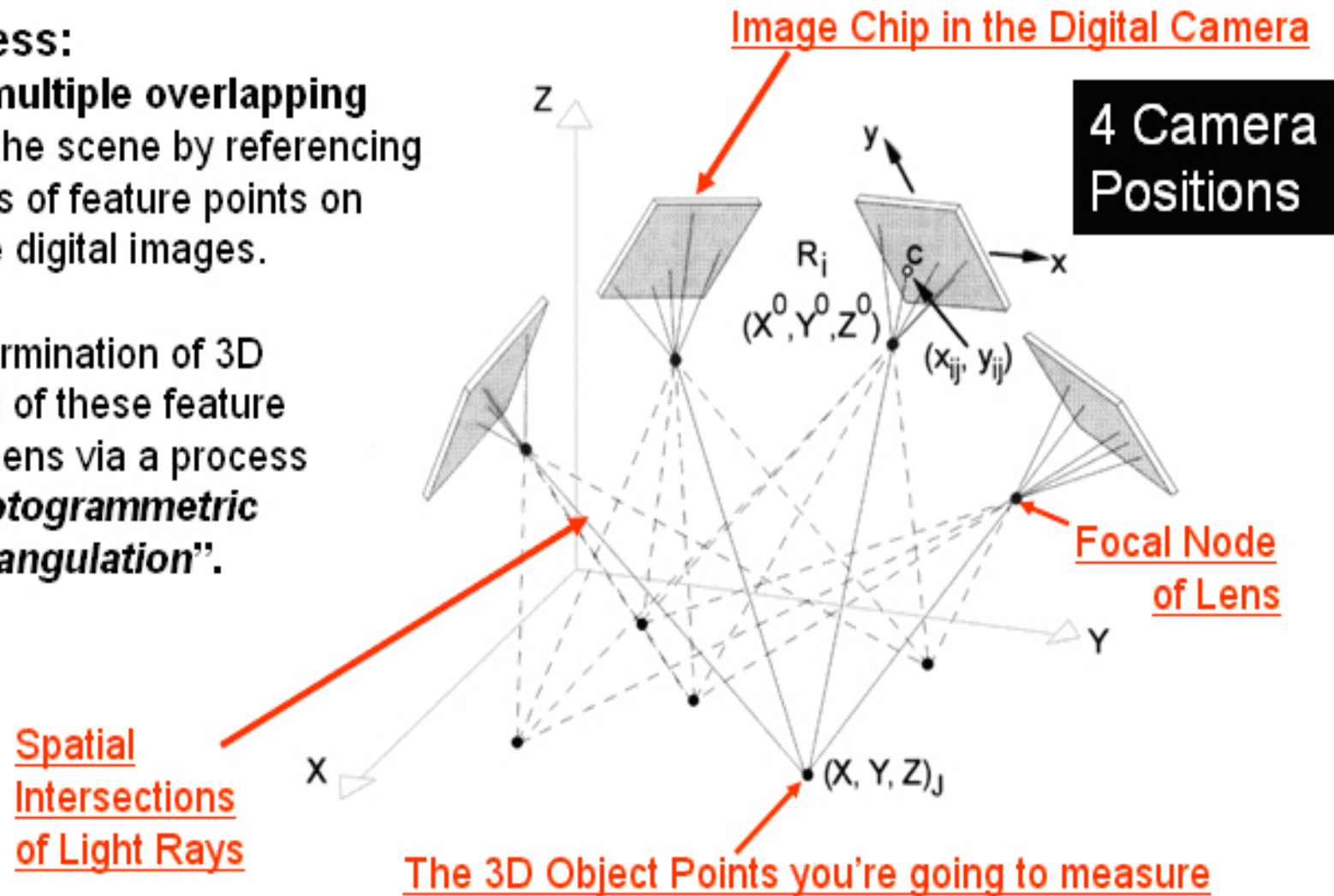
Multiple point triangulation

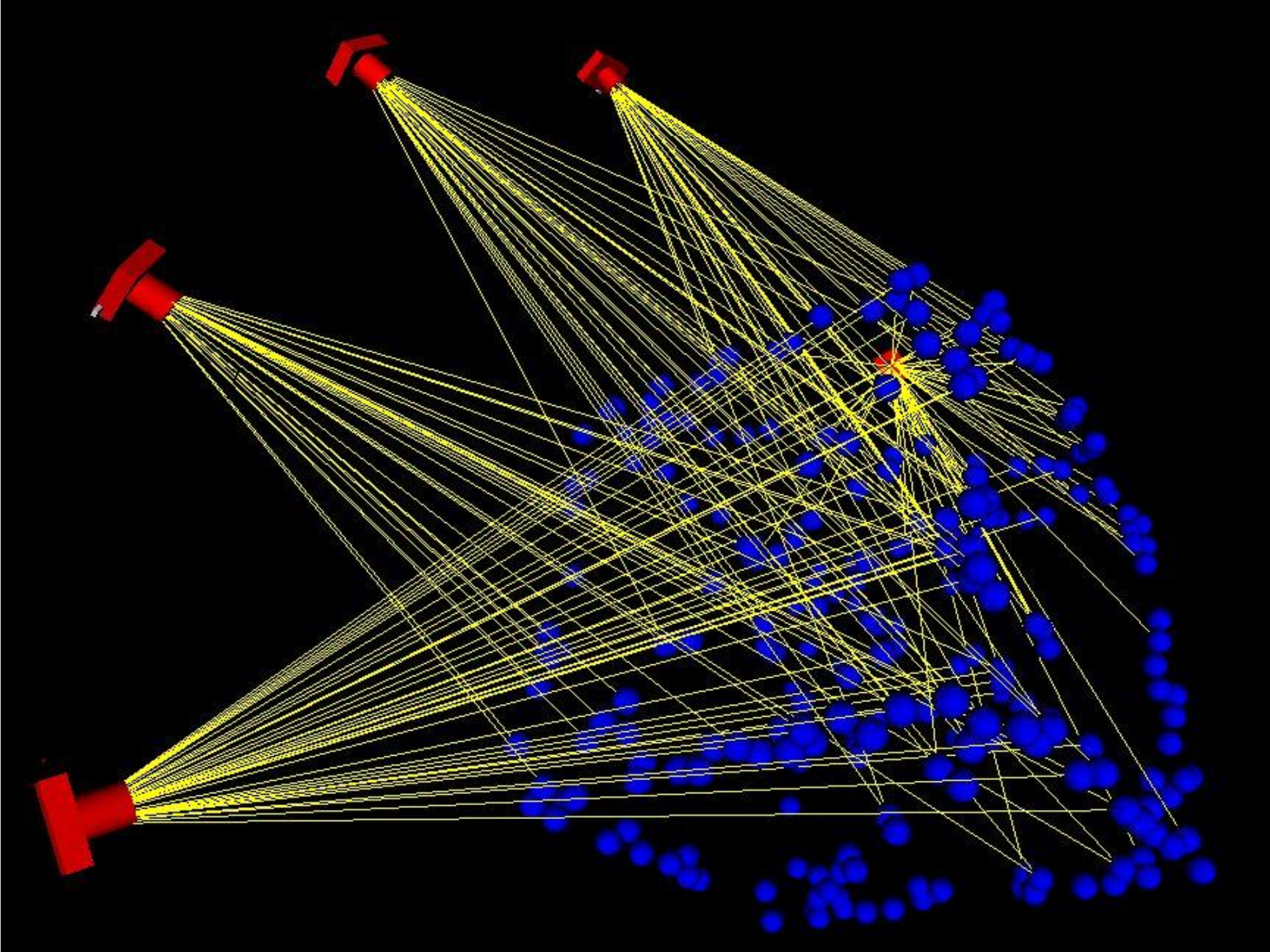
Close Range Photogrammetry (*inside and outside the camera*)

The Process:

1. Record **multiple overlapping images** of the scene by referencing 2D positions of feature points on two or more digital images.

2. The determination of 3D coordinates of these feature points happens via a process called "**Photogrammetric Bundle Triangulation**".





WHY Close Range PHOTOGRAMMETRY???

- Very precise
- Time effective
- Cost effective
- Based on **well established and tested Algorithms**
- Corrects all sorts of distortions
- Wider Scope of Applications

Advantages

- Object not touched during measurement such as measurement of water waves and currents
- Data capture or acquisition is rapid
- Photographs store semantic and metric data with very high density
- Photographs are documents related to time and it can be used as legal evidence
- Not only rigid and fixed objects but also deformation and movement can be measured
- Time dependant parameters such as velocity, acceleration and frequency can be determined

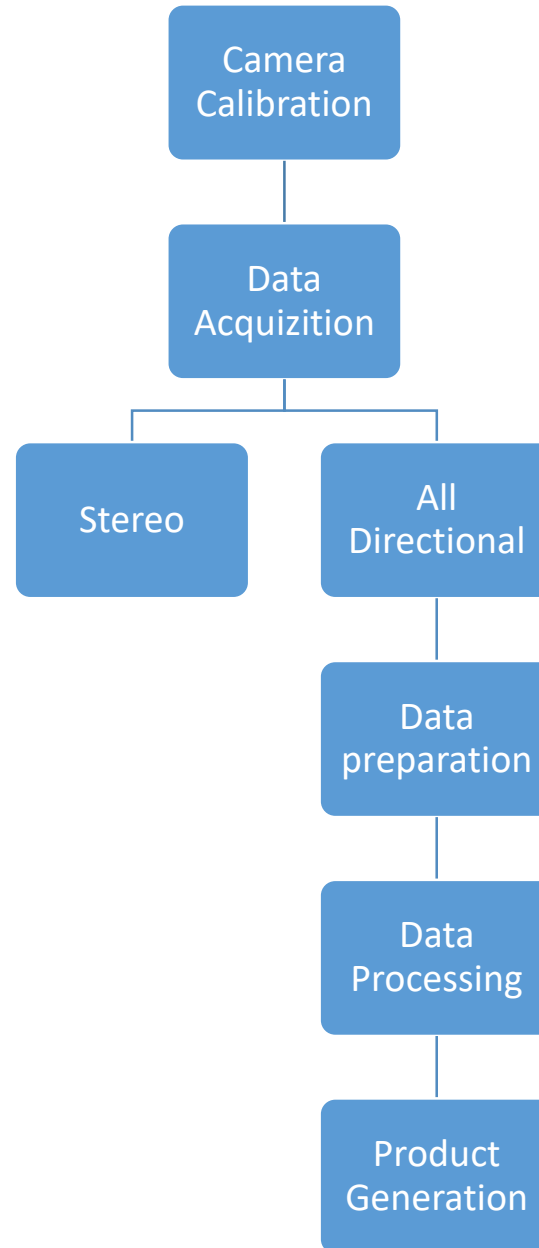
Advantages

- Evaluation, repetition and amendment are always possible
- Photography and evaluation are flexible and can easily be optimised to the project requirement such as Accuracy
- Invisible part of spectrum can be used for creating images
- Complicated shapes and movements are easily measured
- Cameras which freeze the action at a particular instant of time make possible measurement of dynamic occurrences such as deflection of beams under impact loads
- Surveying of Glaciers (determining changes in size and velocity of Glacier) thus 4th dimension of time was included in the analysis of measurement.

Drawbacks

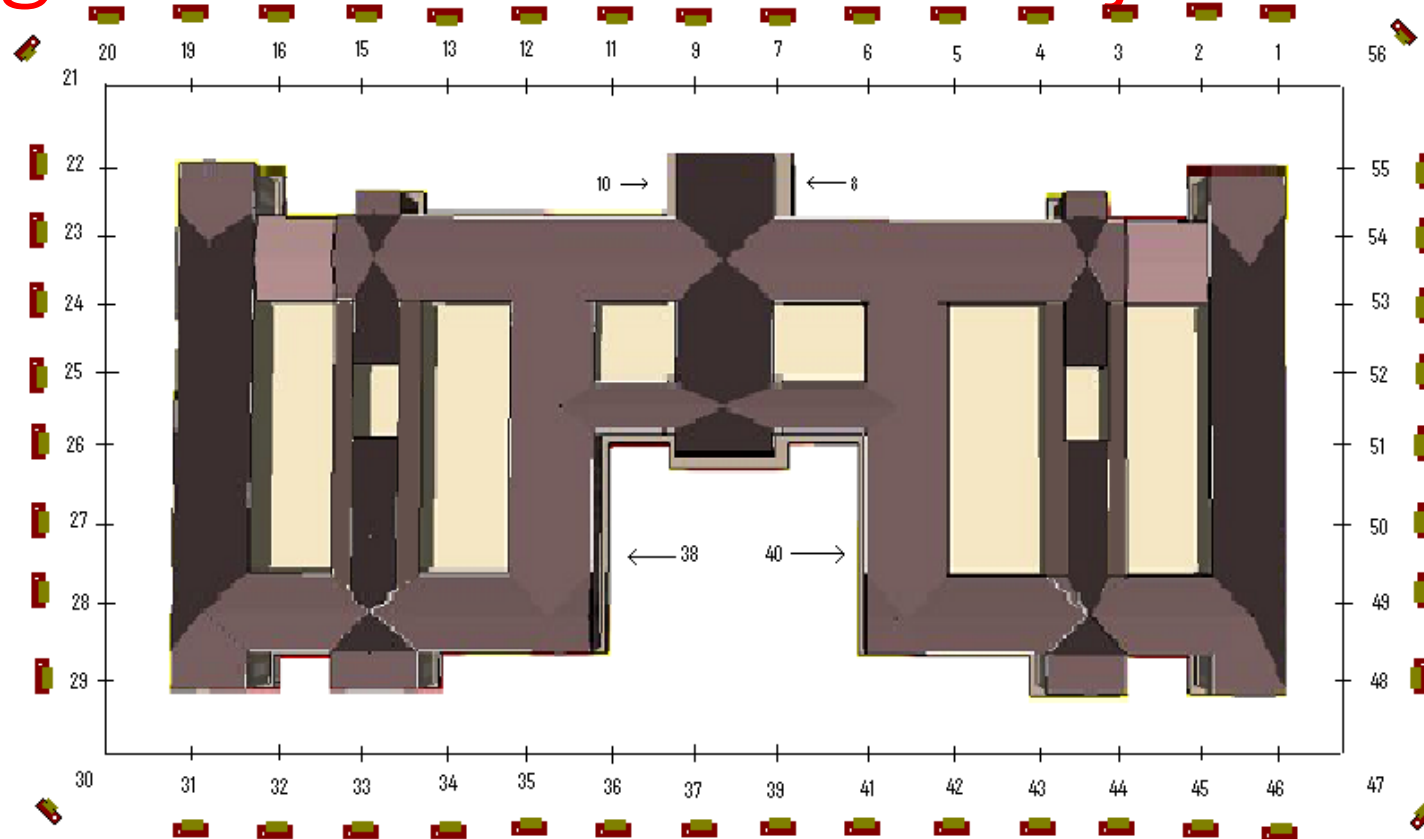
- The result of measurement is not immediately at hand, because time is needed for photographic processing and for evaluation.
- Except for the simplest problems, the need for specialised and expensive equipment makes the method expensive.
- Errors during photography and development of film can ruin the whole measuring project.
- It must be possible to photograph the object.
- Specialised instrumentation and personnel are not always available.

Methodology



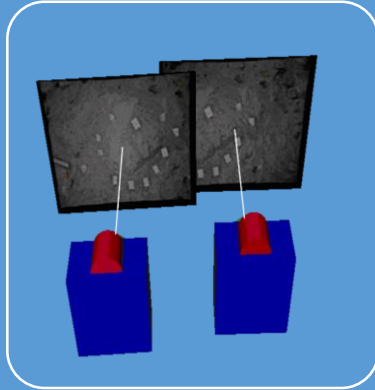
Data Acquisition

Planning the measurement Project



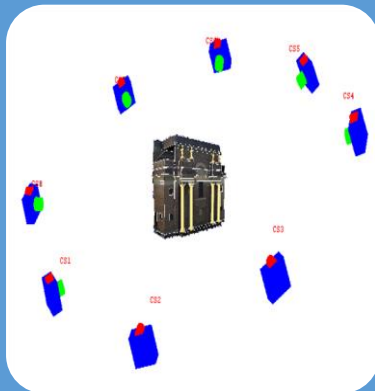
Involves selecting the number and locations of camera positions for taking the photographs.

Data Acquisition



Stereo Photography

Camera Axis Unchanged while capturing Photographs
30-60% overlap between two side by side Photographs



All Directional Photography

Photography from all directions
45% change gives good overlap

Data Preparation

1. Feature Marking :

- Involves marking Target Features on Photographs
- Target Features can be formed using Points, curves, Edges, Cylinders or Shapes.
- Higher level features such as lines and surfaces are then built on these marked features.

Orientation

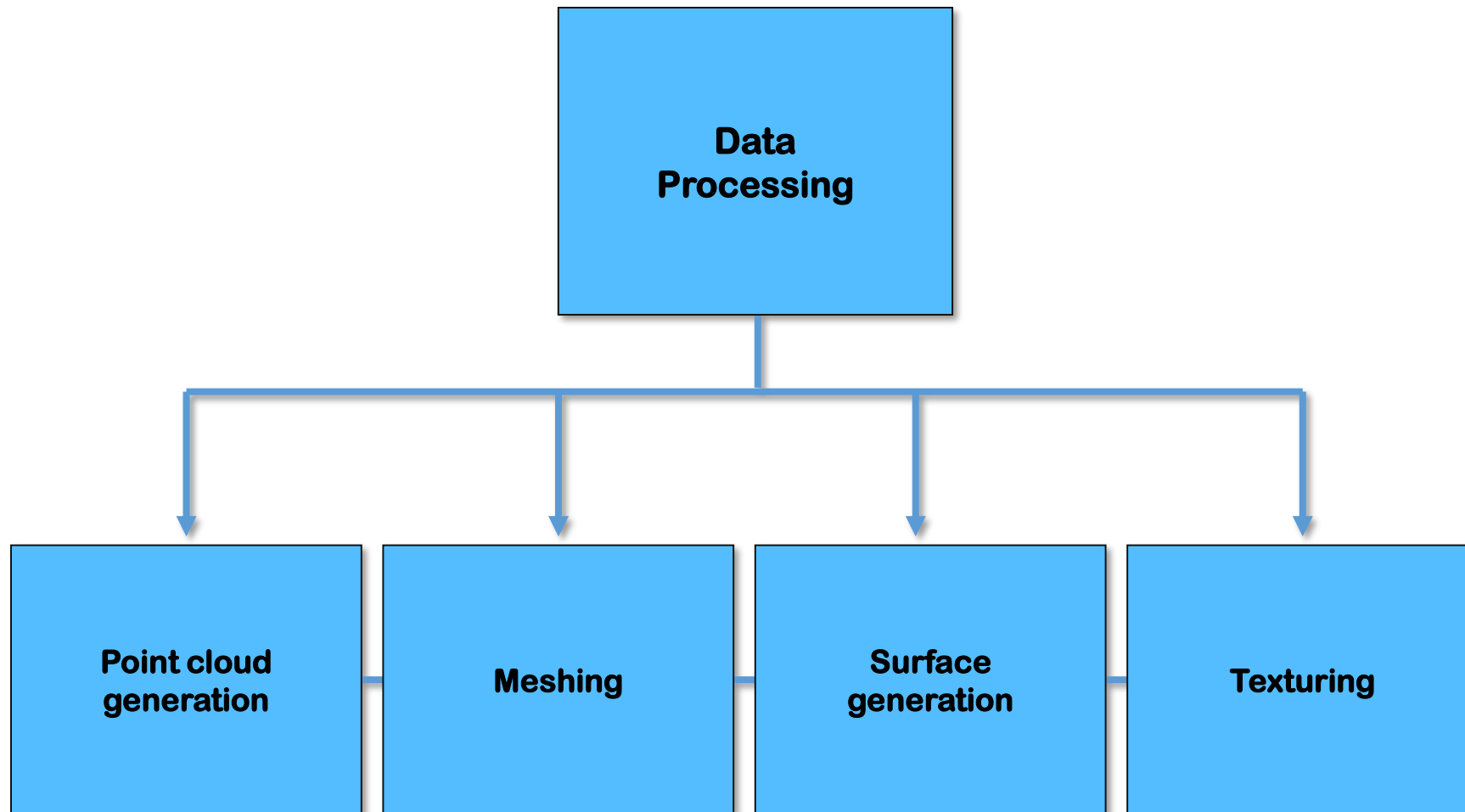
- Done by Referencing the Photographs
 - The points occurring in two or more photographs are referenced
 - Similarly Edges or Curves are also referenced

The Process is same as that of “**geo-Referencing**” the satellite image.

Idealisation!

- An ideal camera has
 - no lens distortion,
 - square pixels, and
 - a centered principal point.
- The images in the project are Resampled and
- The photographic marks are shifted to match the new idealized images.

Data Processing



- Point Cloud Generation

1. For each pair of photographs, overlap is checked,
 - a) align the image rows along the epi-polar lines
 - b) to reduce the image to the region of interest
2. The algorithm searches along a row of the destination image using an $N \times N$ patch of imagery from the source image.
3. Where it finds a good match it records it.
4. All the matches are then optimized for the best overall fit, throwing out bad and weak matches
5. A sub pixel refinement is carried out for the matches.
6. The matched positions are used to create 3D points using camera station information.

Meshing

- Equivalent to Triangulated Irregular Network

Surface Generation

- An algorithm is applied for the computer generation of realistic photos, from any direction, of a solid object in 3D space.

Texturing

- Block Adjustment is the process of defining the mathematical relationship between the images contained within a block, the camera or sensor model, and the ground. Once the relationship has been defined, accurate imagery can be created.

Exporting the Data

- The Resulting 3D Data can be exported to CAD or any other Graphics Program for further application specific processing. Various file formats are available like DXF, 3DS, OBJ, VRML, IGES, 3DM, STL or RAW files.

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