

Image-Based 3D Modeling

Close-Range Photogrammetry for the extraction of 3D measurements



INTRODUCTION

CLOSE-RANGE PHOTOGRAMMETRIC SURVEY

SURFACE RECONSTRUCTION

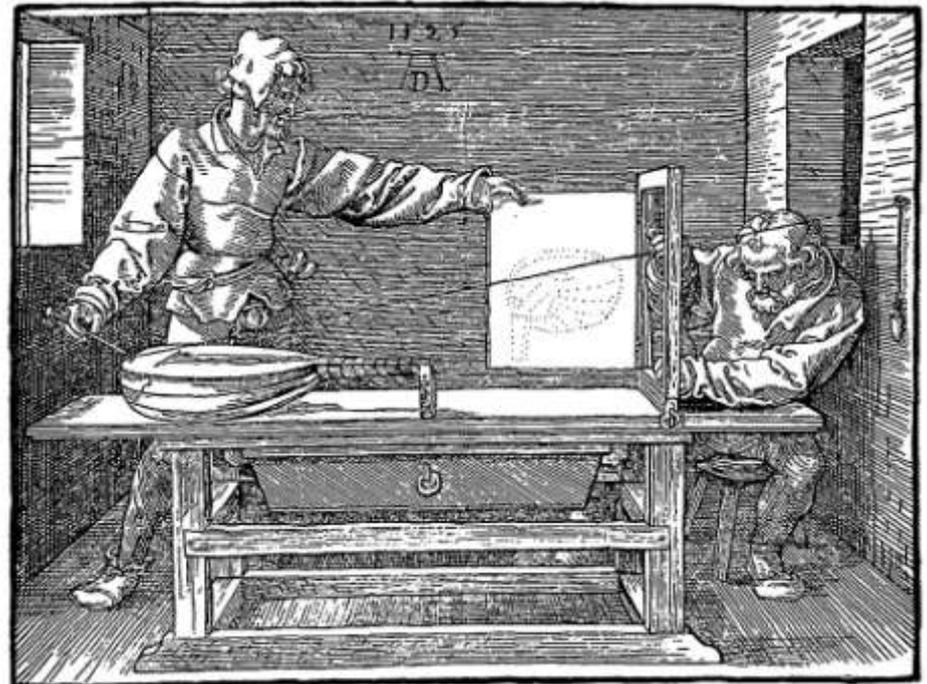
TEXTURE-MAPPING & VISUALIZATION

CONCLUSIONS

DEFINITION

“ **Photogrammetry** is the science, and art, of determining the size and shape of objects as a consequence of analysing images recorded on film or electronic media.”

(*Close Range Photogrammetry and Machine Vision* – K.B. Atkinson, 2003)



Albrecht Durer

APPLICATIONS

Architecture

Cultural Heritage

Engineering

3D City Modeling

Planning

Archeology

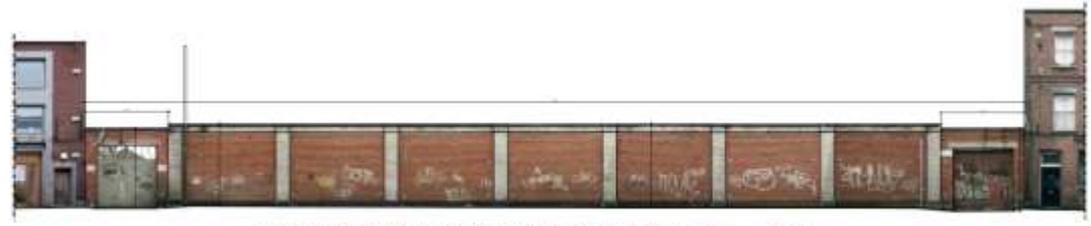
Geology

Film & Animation

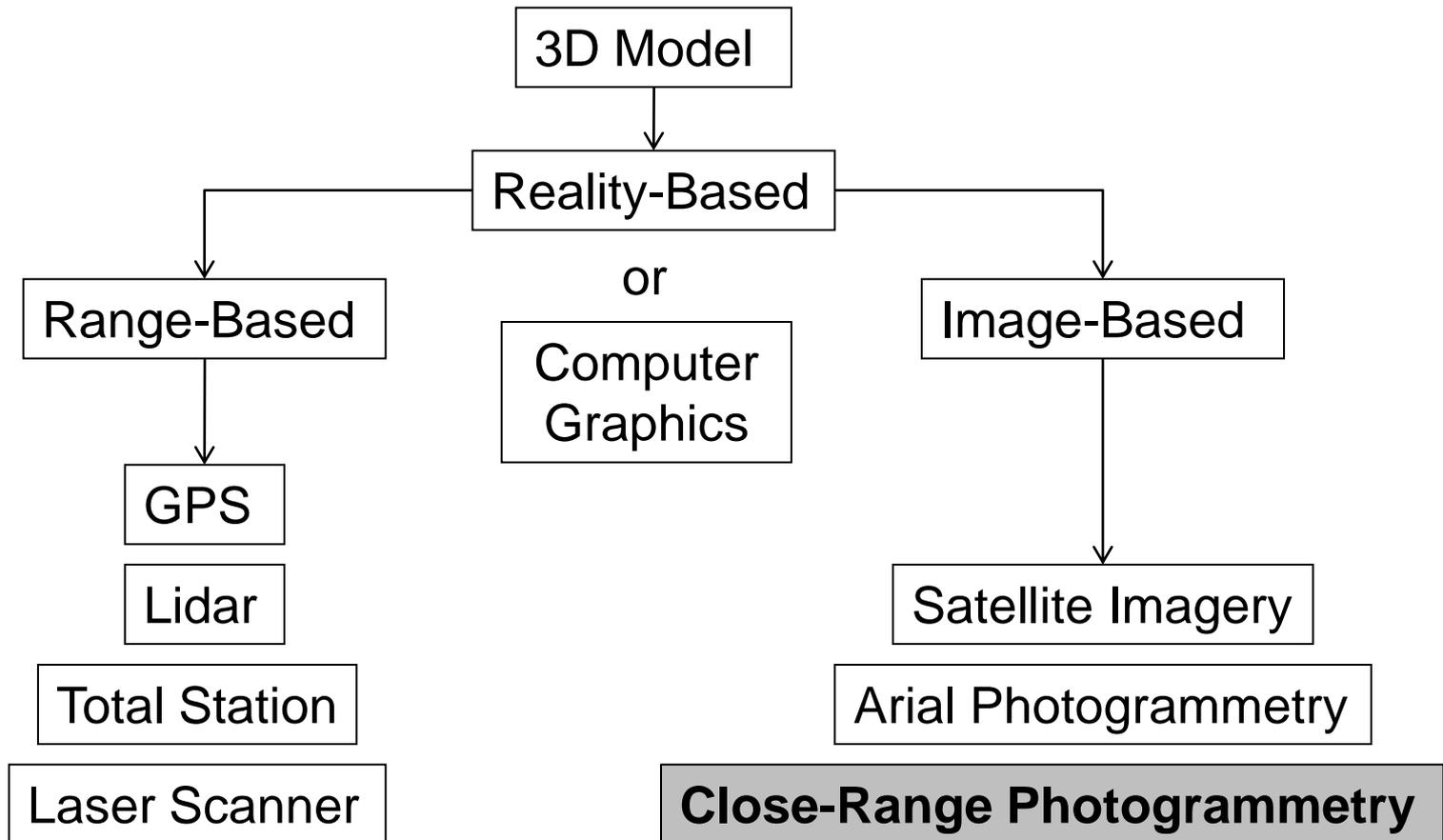
Accident Reconstruction

Forensic

Medical & Biological



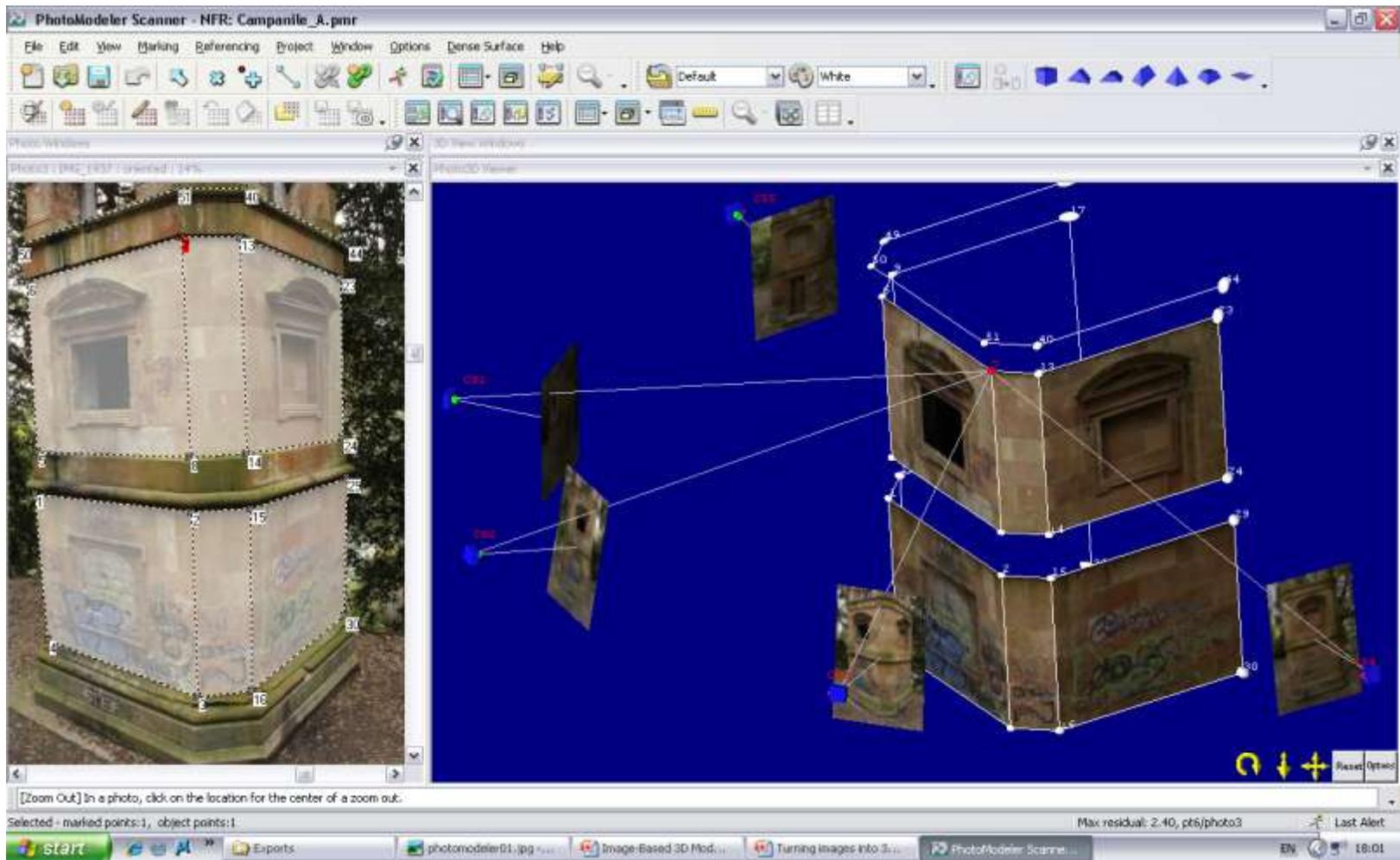
3D ACQUISITION SYSTEMS



HARDWARE



SOFTWARE



POSSIBLE OUTPUTS

- Textured 3D models of objects/buildings at high or low level of details
- 3D models with semantic information (GIS)
- Extraction of Plans and Sections (2D)
- Orthophotos and Rectified Photos for Elevations (2D)

3D & 2D

POSSIBLE OUTPUTS



PHOTOGRAMMETRIC WORKFLOW



Project Requirements



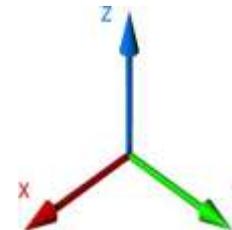
Network Design



Camera Calibration



Image Acquisition



Camera Orientation

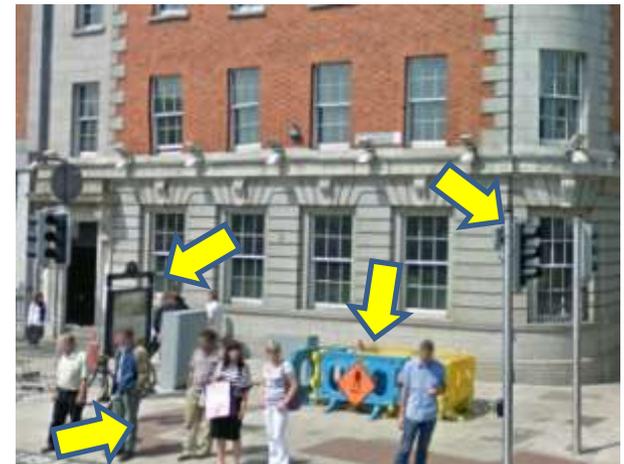
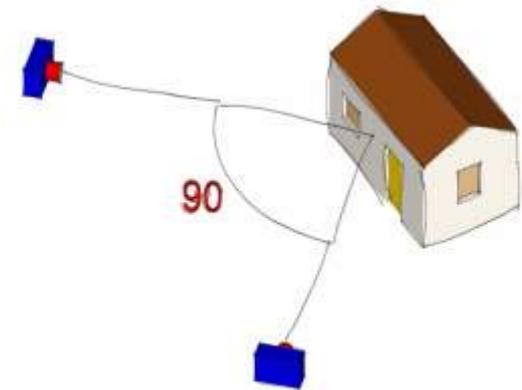
PROJECT REQUIREMENTS

- Close co-operation with client or contractor
- Defining object or area to be measured
- Type of output results required
- ***Resolution of fine details (smallest object feature to be measured)***
- Scale
- Coordinate System
- Accuracy to be achieved (it has to fit the purpose)
- Time schedule for on-site work, data processing and output delivery
- Staff and cost management



NETWORK DESIGN

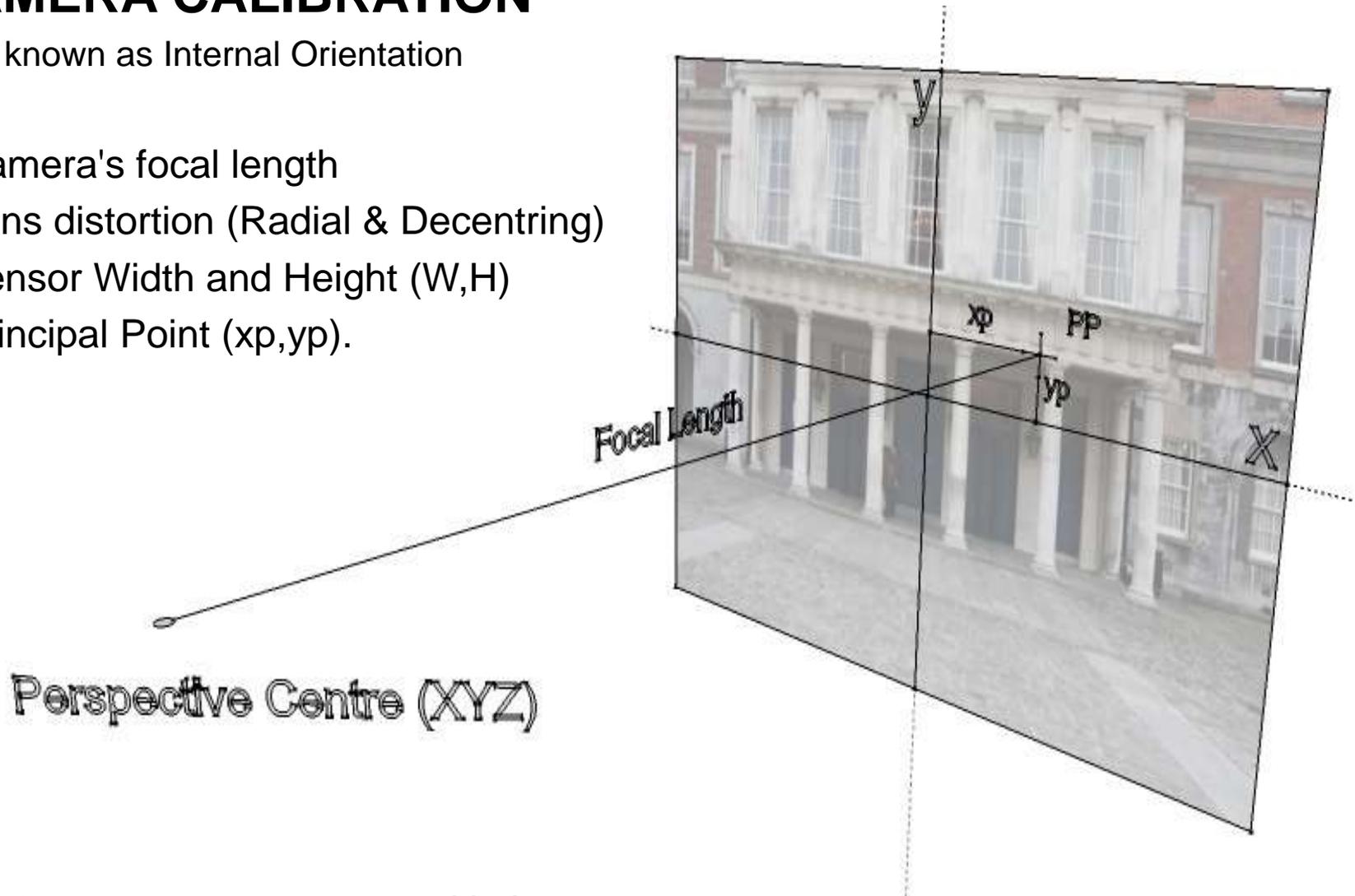
- Image Scale
- Resolution / Image quality
- Object environment / surroundings
- Depth of field
- Imaging angle
- Number and distribution of image points
- ***Intersection angles / Ray intersection***
- Field of view
- ***Visibility / Occlusion / Self-Occlusion***



CAMERA CALIBRATION

Also known as Internal Orientation

- Camera's focal length
- Lens distortion (Radial & Decentring)
- Sensor Width and Height (W,H)
- Principal Point (x_p, y_p).



CAMERA CALIBRATION

- *Test-field calibration*
- Self-Calibration

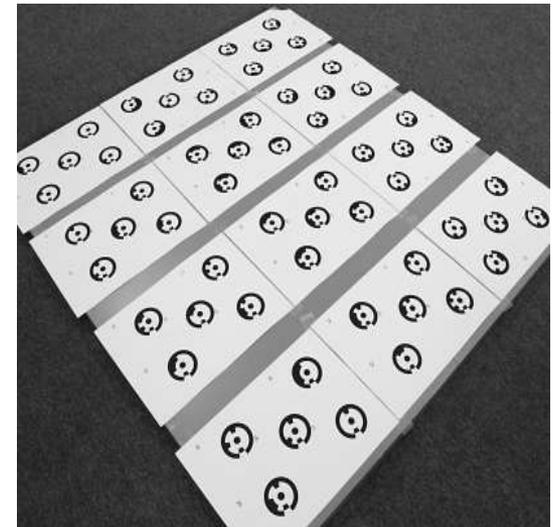
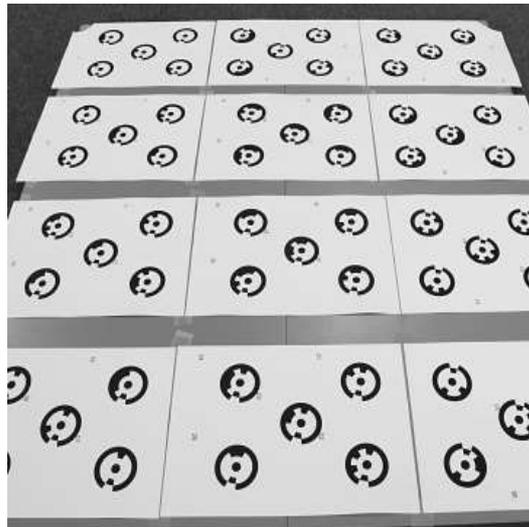
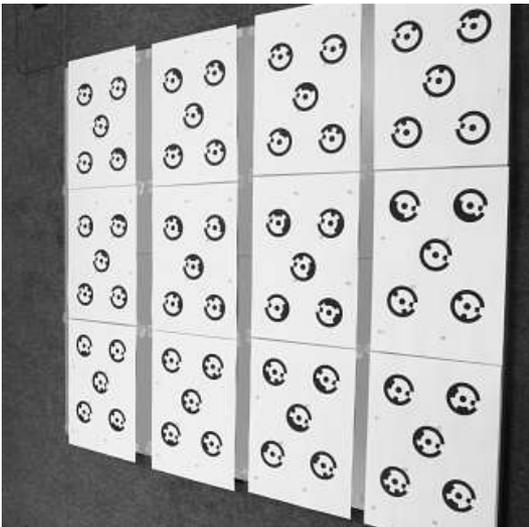
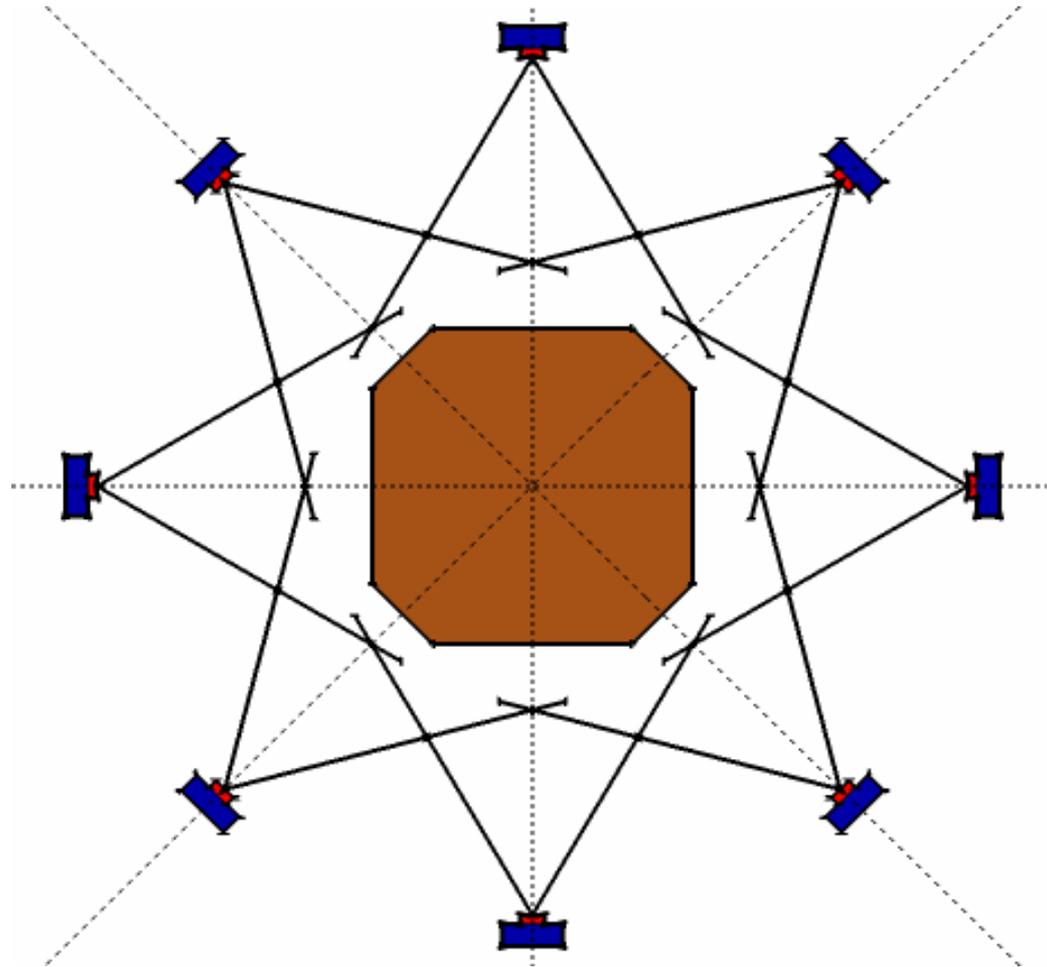


IMAGE ACQUISITION

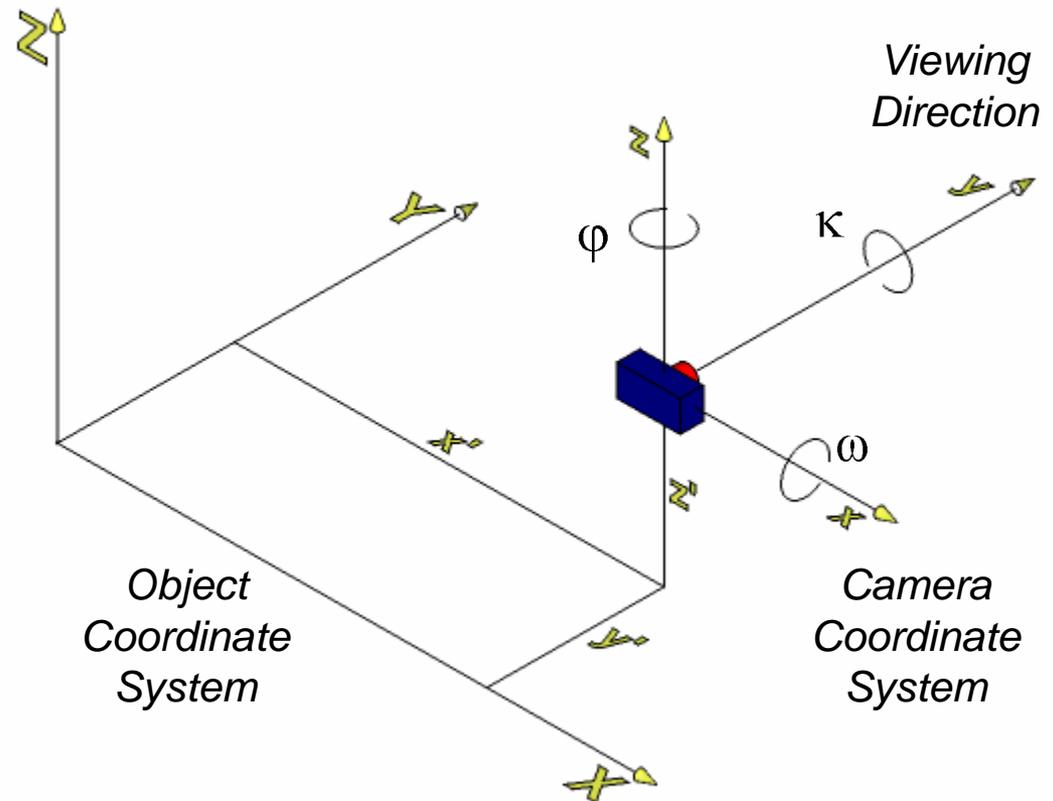
- Single image
- Stereo image
- ***Multi image***



CAMERA ORIENTATION

Also known as External Orientation

The **exterior orientation** consist of six parameters which describe the spatial position (x,y,z) and the orientation (ω,κ,φ) of the camera coordinate system with respect to the global object coordinate system (X,Y,Z) .



SURFACE RECONSTRUCTION

Regular geometric shapes

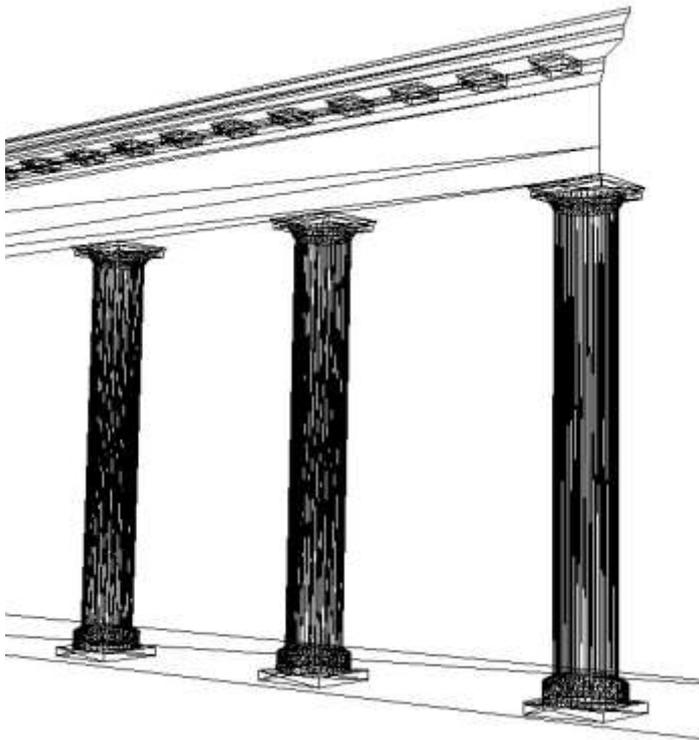


Free-form shapes

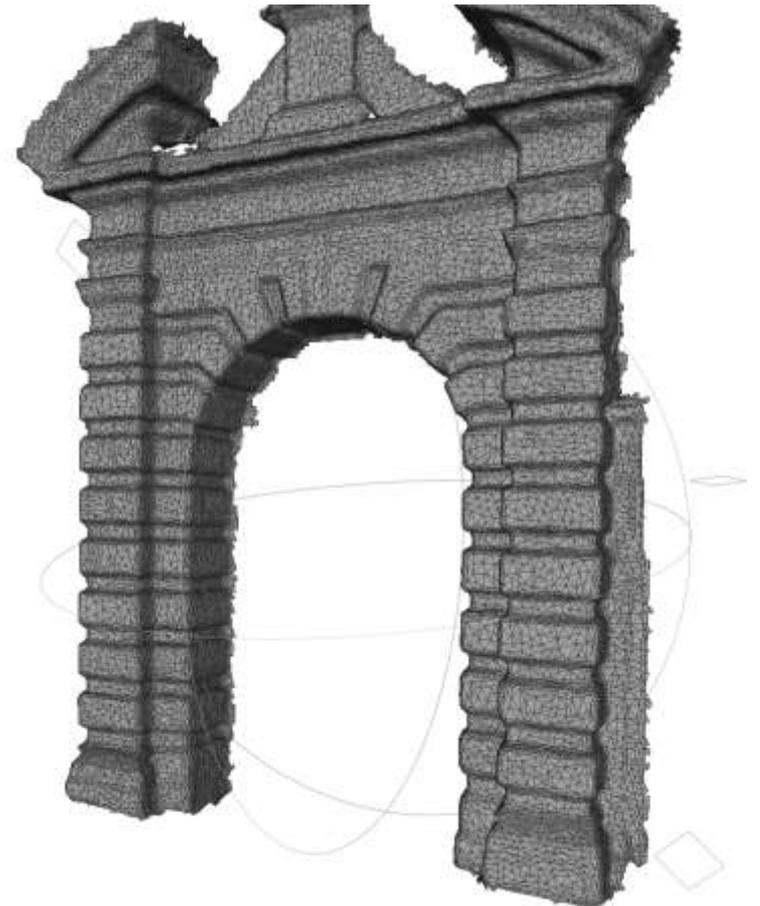


SURFACE RECONSTRUCTION

Regular geometric shapes



Free-form shapes



FREE-FORM SHAPES –Point Clouds

Stereo Images



FREE-FORM SHAPES –Point Clouds

MeshLab Software

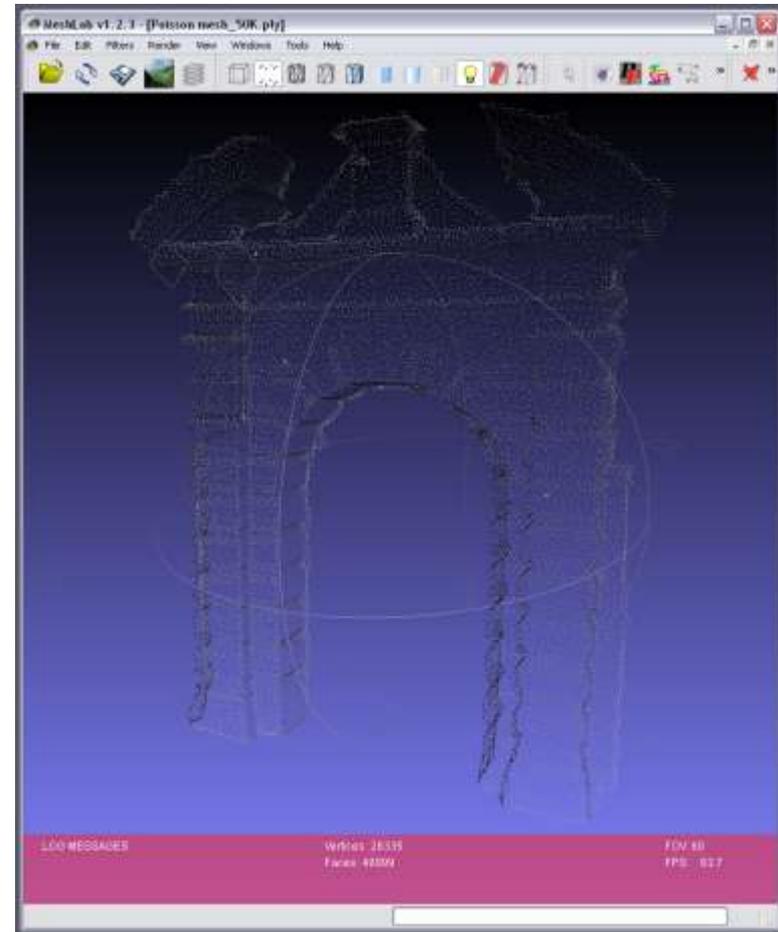
Pre-processing operations

- Data sampling
- Noise reduction
- Hole filling
- Data registration

Mesh generation

Post-processing operations

- Data smoothing
- Data decimation
- Hole filling



TEXTURE MAPPING & VISUALIZATION

Regular geometric shapes



Free-form shapes



TEXTURE MAPPING & VISUALIZATION

Export to different file formats

.dxf

.ply

.obj

.dae (Collada)

.skp (SketchUp)

.kml .kmz (Google Earth)

3D .pdf

.3ds

Other video formats

CONCLUSIONS

Benefits:

- Mobility of the system
- Multiple distance range
- Low cost
- No restriction for type of surface (as far as they are textured)
- Accuracy and resolution of a Laser Scanner

Problems:

- *Not suitable for very large and complex sites (best used to integrate with other techniques)*
- *Lighting conditions*

RESOURCES

- <http://www.photodeler.com/>
- <http://meshlab.sourceforge.net/>
- <http://cipa.icomos.org/>
- <http://www.isprs.org/publications/archives.aspx>
- [http://www.isprs.org/technical_commissions/wg5_5.aspx](http://www.isprs.org/technical_commissions/wg5/wg5_5.aspx)
- <http://3dom.fbk.eu/en/home>