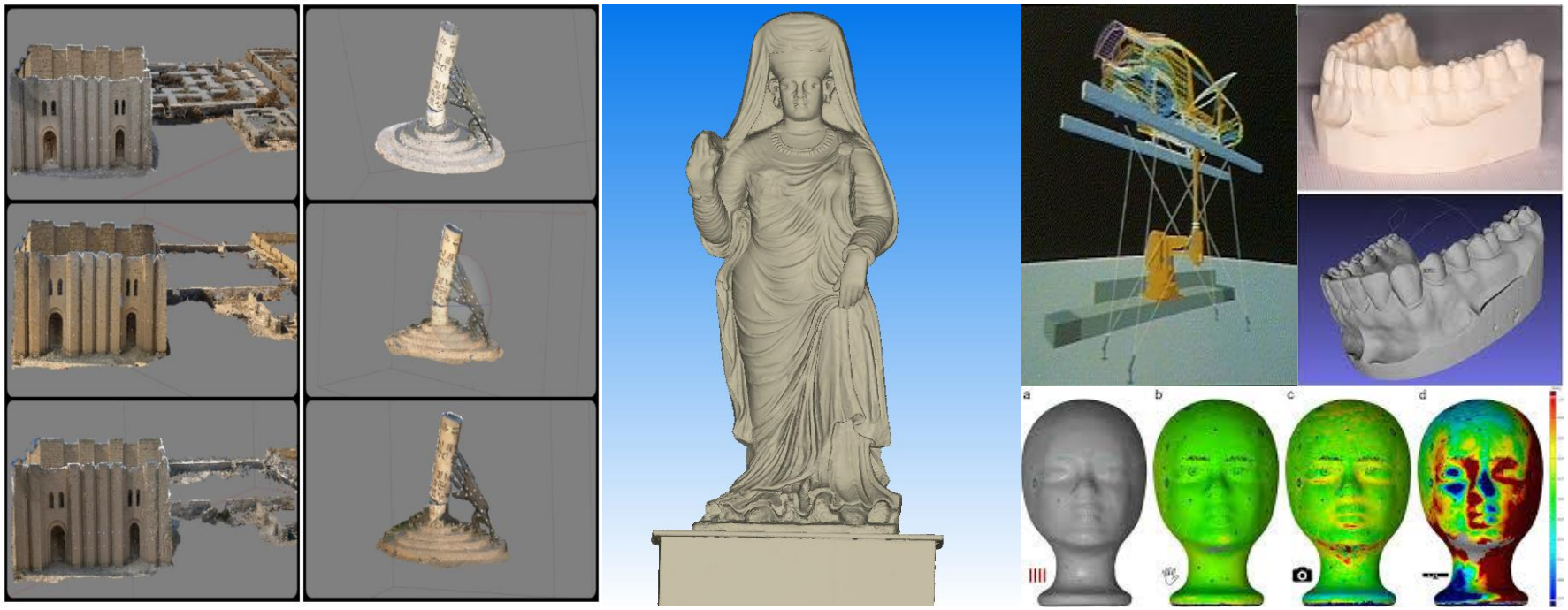
UNIVERSITY OF BAGHDAD

COLLEGE OF ENGINEERING

DEPARTMENT OF SURVEYING ENG.



Close-Range Photogrammetry- Applications

BSc - 4TH Stage

2020-2021

Lecture 9

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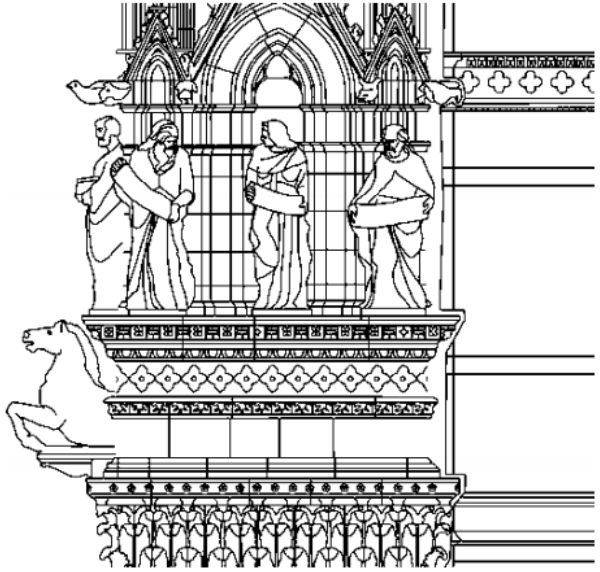
CRP Applications

Close-range photogrammetry techniques provide universal methods for the geometric measurement of almost any kind of object. As a result there are a wide range of potential application areas, such as:

- Architecture photogrammetry.
- Cultural and historical conservation photogrammetry.
- Industrial Machinery photogrammetry.
- Structuring and civil Engineering photogrammetry.
- Medical science photogrammetry.
- Forensic photogrammetry.
- Construction and BIM photogrammetry.
- Archeological photogrammetry.
- Aerospace photogrammetry.
- Multi-media photogrammetry.
- Scientific behavior and shape from stereo (CV) photogrammetry.

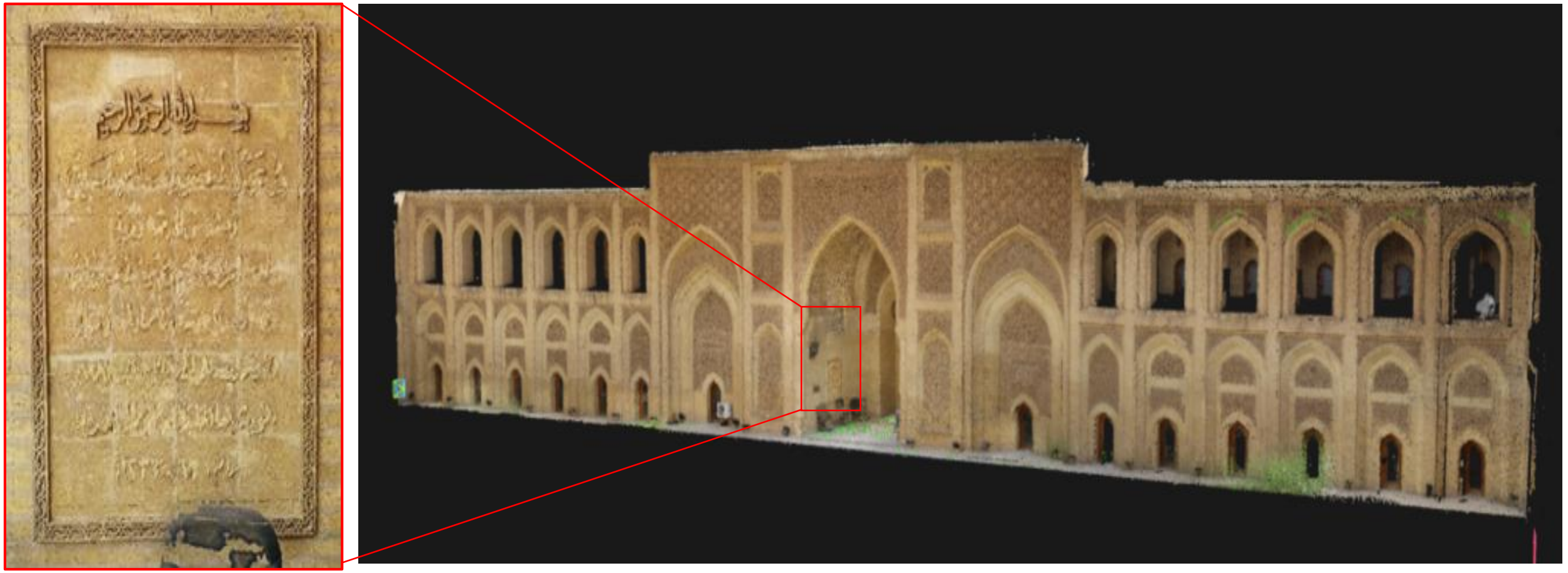
Architecture and cultural heritage

1. **Photogrammetric building records**: mostly aim to generate plan and elevation views for the following applications:
   - preservation and restoration of the building
   - art historical analysis
   - documentation



Photogrammetry offers a number of advantages compared with classical manual methods of measured building surveys:

- non-contact measurement avoiding scaffolding on the façade
- reduced risk of accidents
- fast on-site image acquisition
- high accuracy
- three-dimensional coordinate measurement
- measurement of free-form contours and surfaces (ornamental details)
- combination of graphical output with rectified original images (image maps)
- subsequent object measurement from archived metric images or historical photos



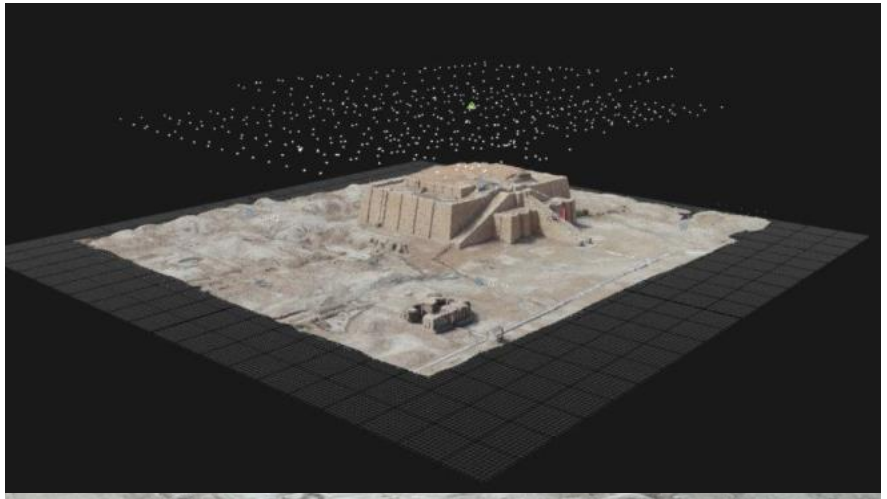
Al-Mustansiria School, Baghdad, Iraq

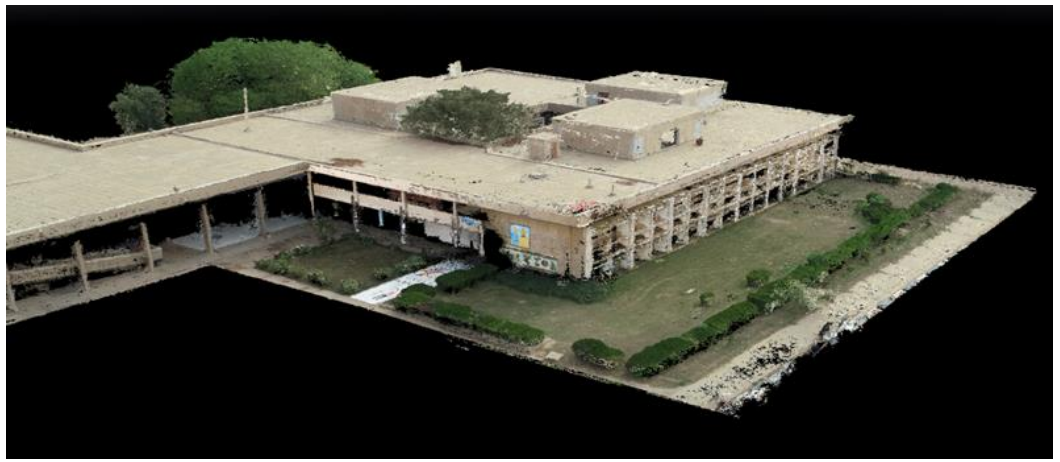
Al-Qushla, Baghdad, Iraq

Architecture and cultural heritage

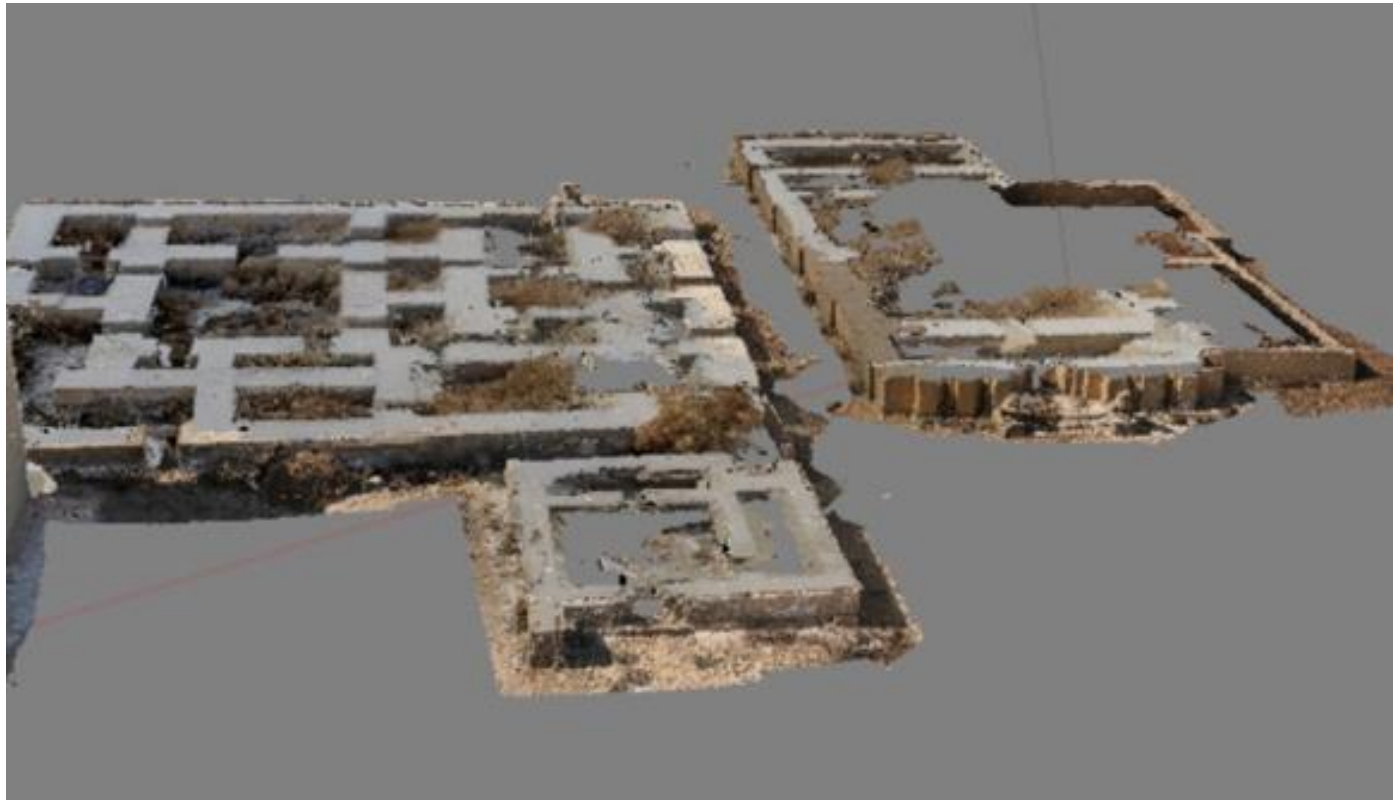
2. 3D models

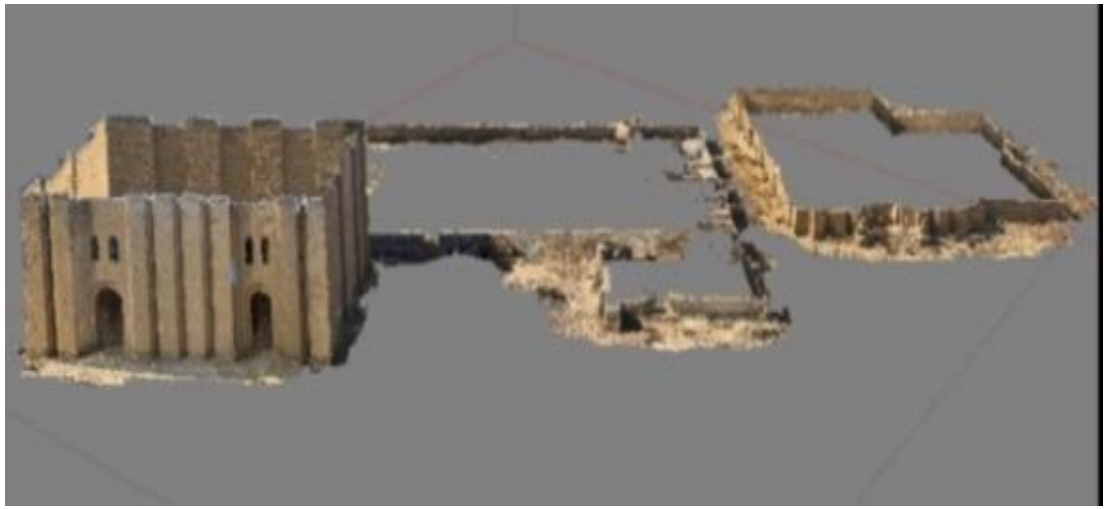
- **Building visualization:** If a building's 3D CAD data is available in a topologically structured form (e.g. by a photogrammetric process), 3D visualization methods (illumination models, texture mapping) can generate a photo-realistic representation. In addition to the purely aesthetic effect, these models also have practical application in building planning or facility management. Data can be stored in standard 3D CAD formats such as DXF and DGN.



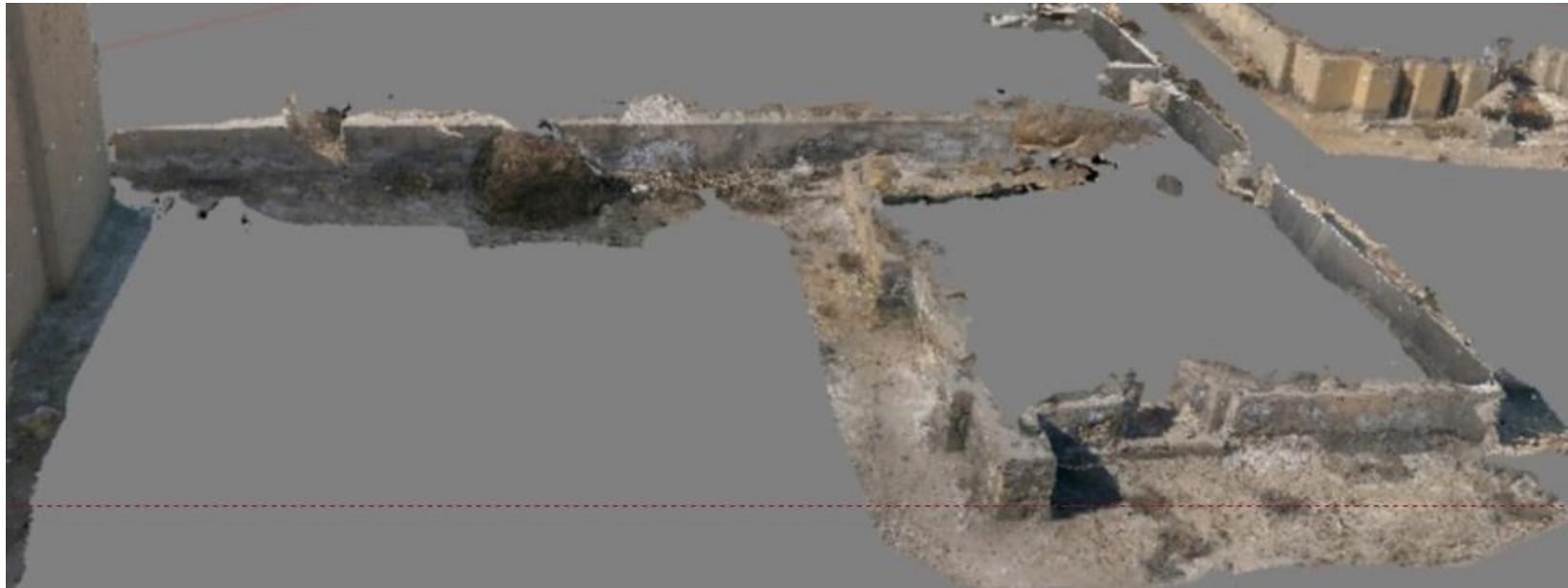


UR Ziggurat, Al-Nasiriya, Iraq





Tell Harmal, Baghdad, Iraq



Architecture and cultural heritage

• City models:

3D city models are increasingly of interest, for example in:
• urban planning
• emissions analysis (sound, exhaust gases)
• planning mobile telephone networks
• setting up information systems (operational planning for rescue services, transport management)
• tourism (internet presentation)
• three-dimensional city maps

These applications require the 3D model to be up-to-date and complete, rather than having high accuracy in the geometry and detail.

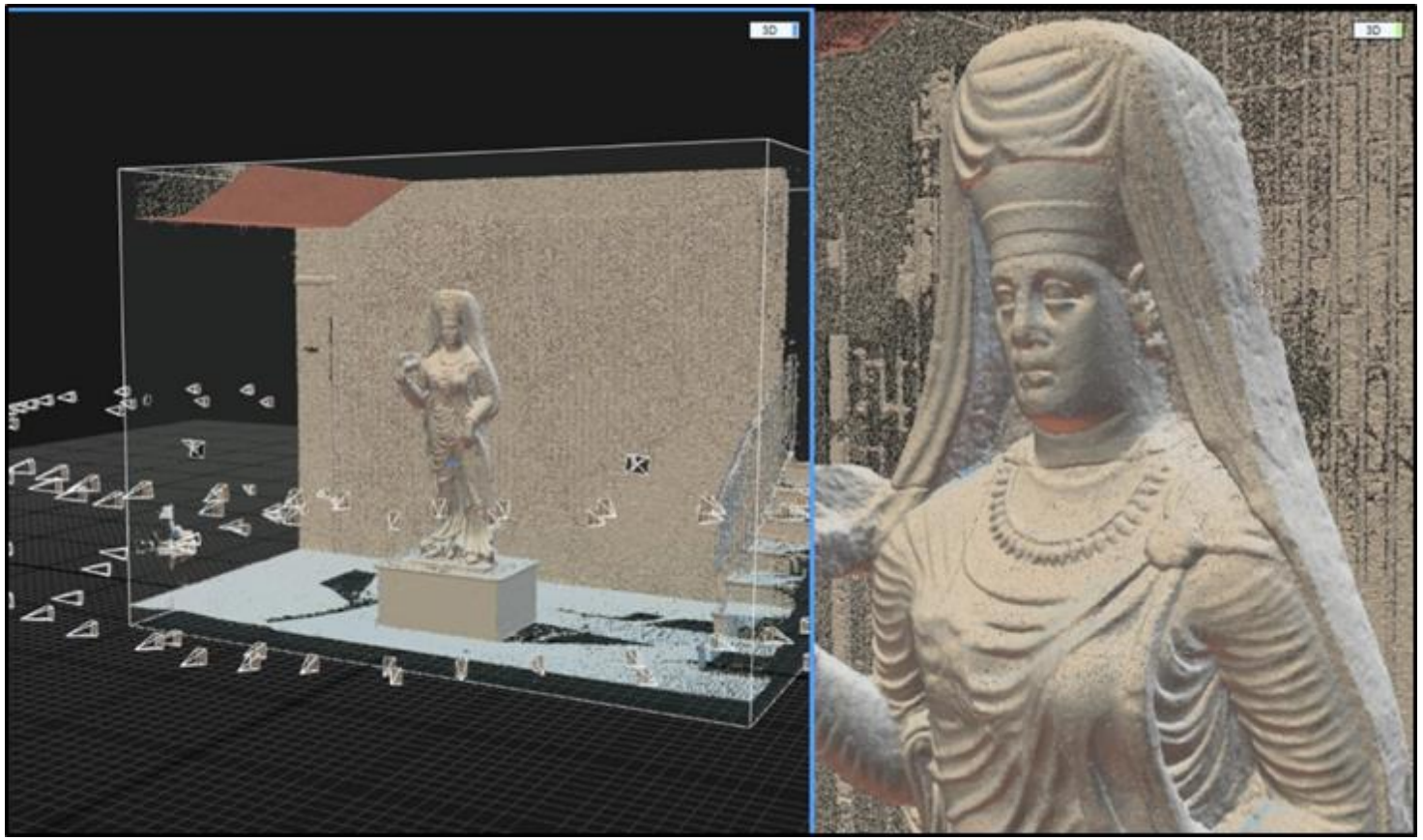
Fast generation of city models can be achieved through:
• aerial photogrammetry (automatic extraction of buildings)
• airborne laser scanning (to extract buildings from discontinuities in the height model)
• video acquisition from moving vehicles

Architecture and cultural heritage

3. Free-form surfaces

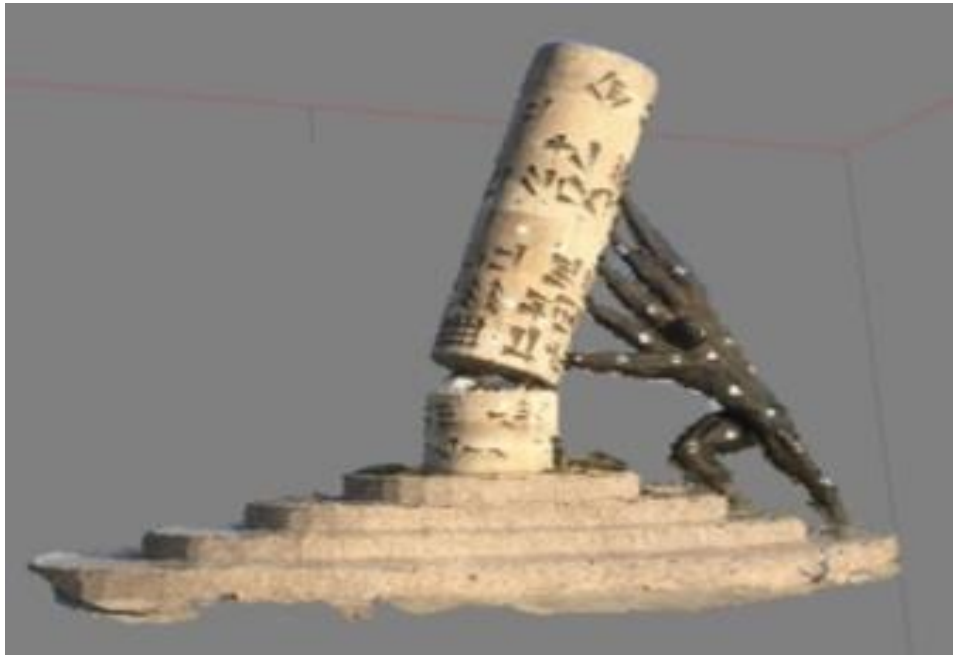
- **Historical objects and works of art**

The art historical analysis and restoration of sculptures and ornamental building features requires the measurement of free-form surfaces. Classical stereo measurement is suitable for line extraction if the object surface has distinct contours. The surfaces of smaller objects can be measured by active pattern projection methods.



Lady of Hatra, Iraqi National Museum, Baghdad, Iraq

Lamasso, Iraqi National Museum, Baghdad, Iraq



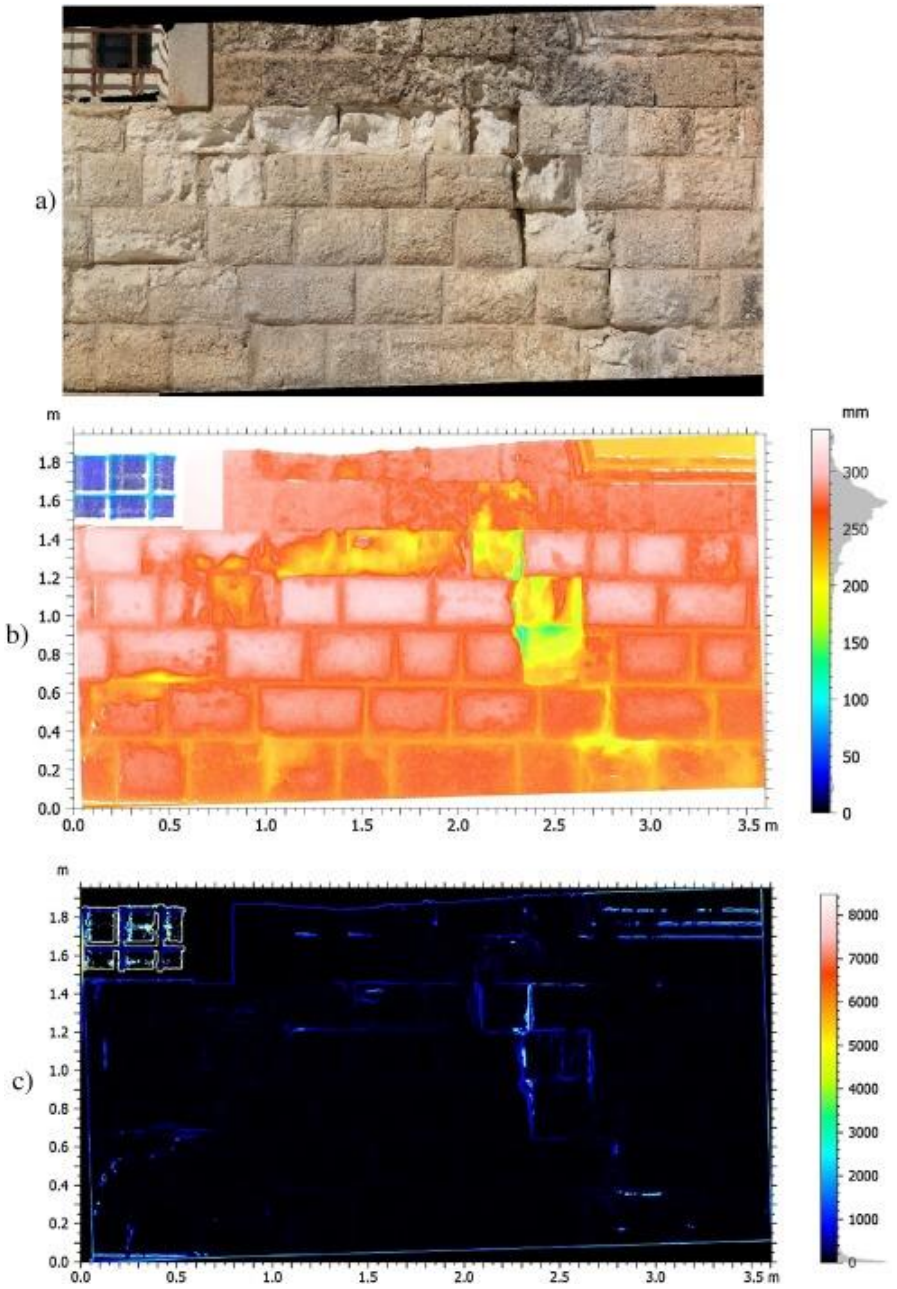
Iraqi Save Culture Monument, Baghdad, Iraq

Architecture and cultural heritage

- **Surface measurement:**

- Deformation analysis
- Building maintenance

The accuracy in this type of applications is specified to about 1/10 mm. A separate reference frame containing calibrated reference points can be re-attached to a test area in order to deal with repeated measurement.

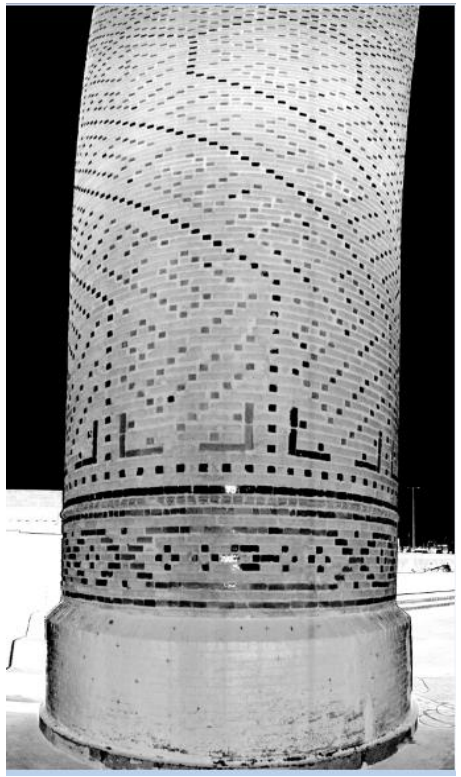


Engineering surveying and civil engineering

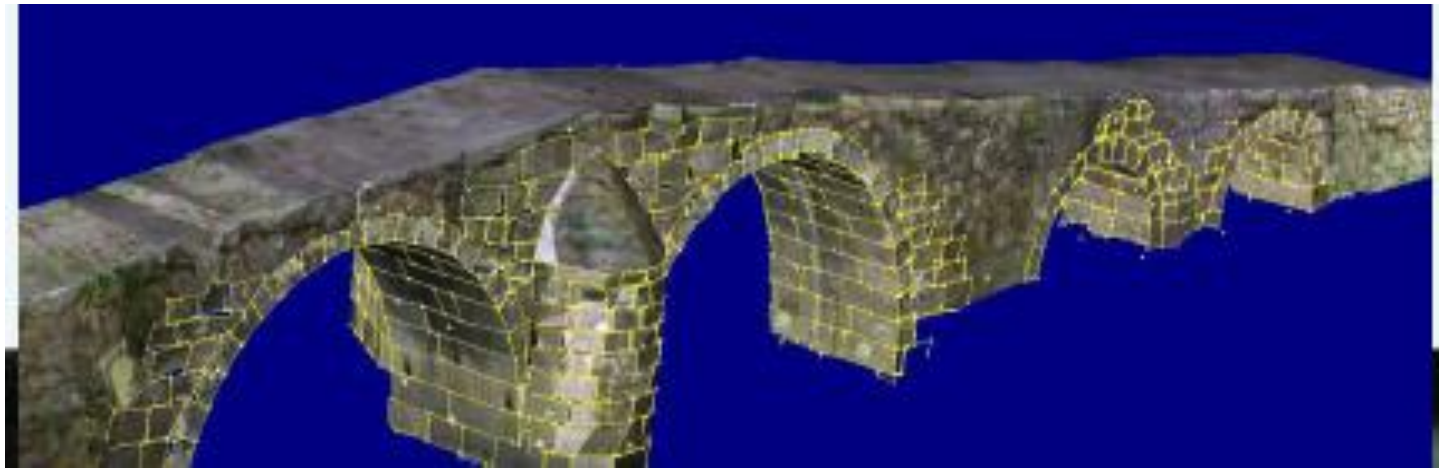
1. Measurement of deformations

A key task in geodetic engineering surveys is to monitor deformations on buildings exposed to some particular mechanical or thermal strain. For these applications, accuracy requirements are typically in the order of millimetres for object dimensions of more than 100 m (e.g. cooling towers, chimneys, dams, sluices, cranes, historical buildings etc.).

Photogrammetric deformation analysis is usually applied in cases where object or environmental conditions do not allow sufficient time on-site for extensive geodetic measurements. Image acquisition additionally provides an objective documentation of the object's state at the time of exposure.



Al-Khademia Old Minarite, Baghdad, Iraq



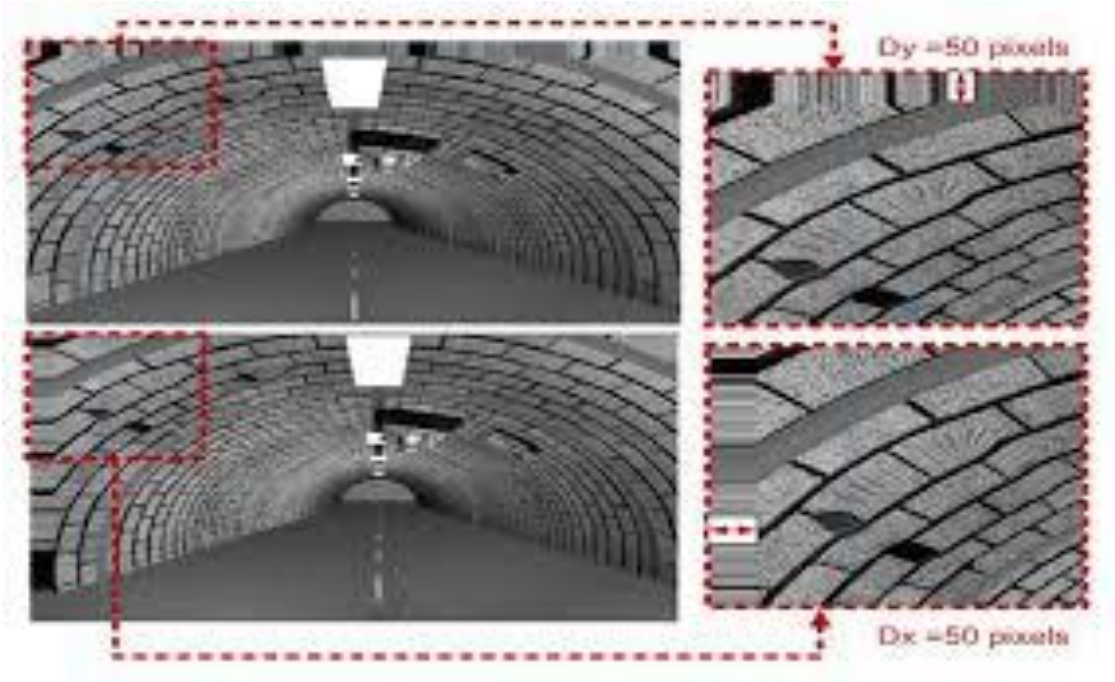
Engineering surveying and civil engineering

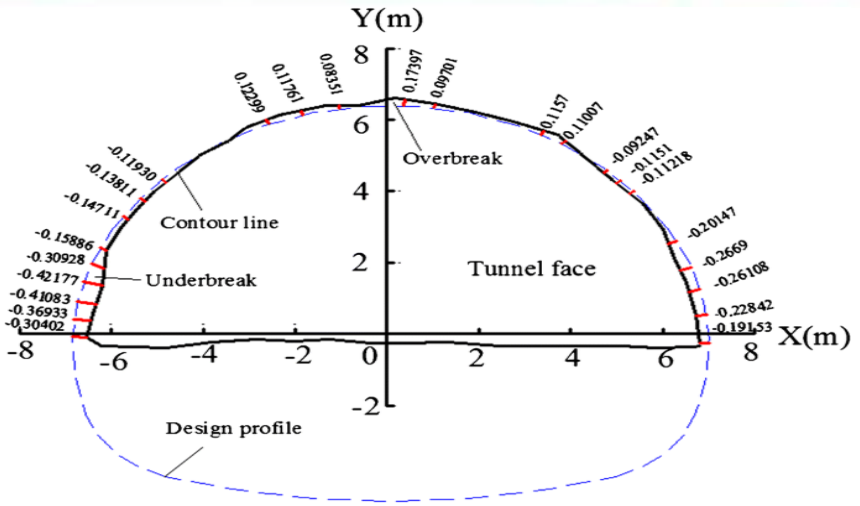
2. Tunnel profile measurement

A particular task in engineering surveying is the measurement of tunnel interiors for shape and deformation analysis. Tunnel cross-sections are normally determined. There are severe limitations on the choice of suitable camera stations which are usually located along the longitudinal axis of the tunnel.

There are two main methods of targeting the tunnel wall:

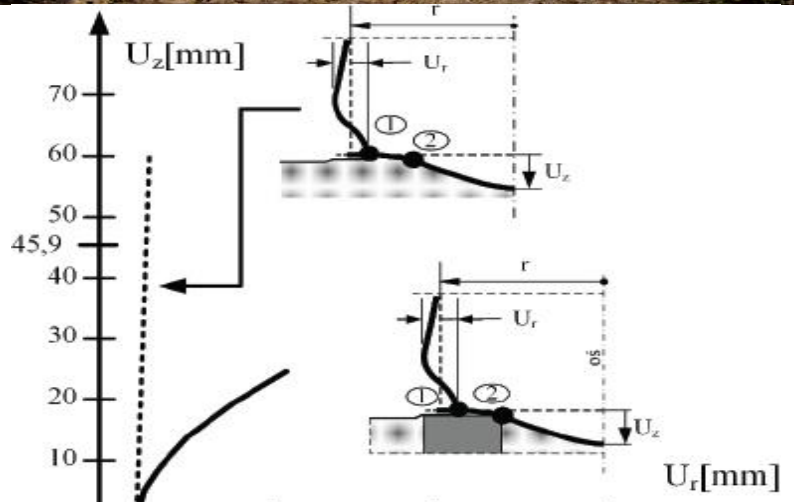
- point-by-point marking with discrete targets
- linear marking using rotating lasers or light sections

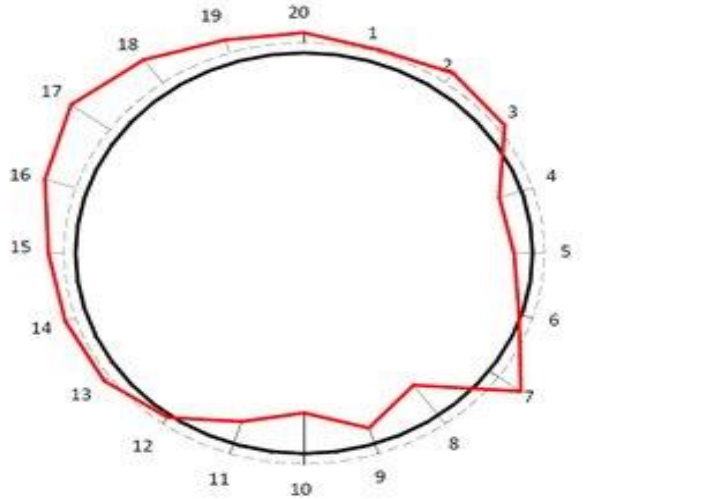




Engineering surveying and civil engineering

3. Deformation of concrete tanks



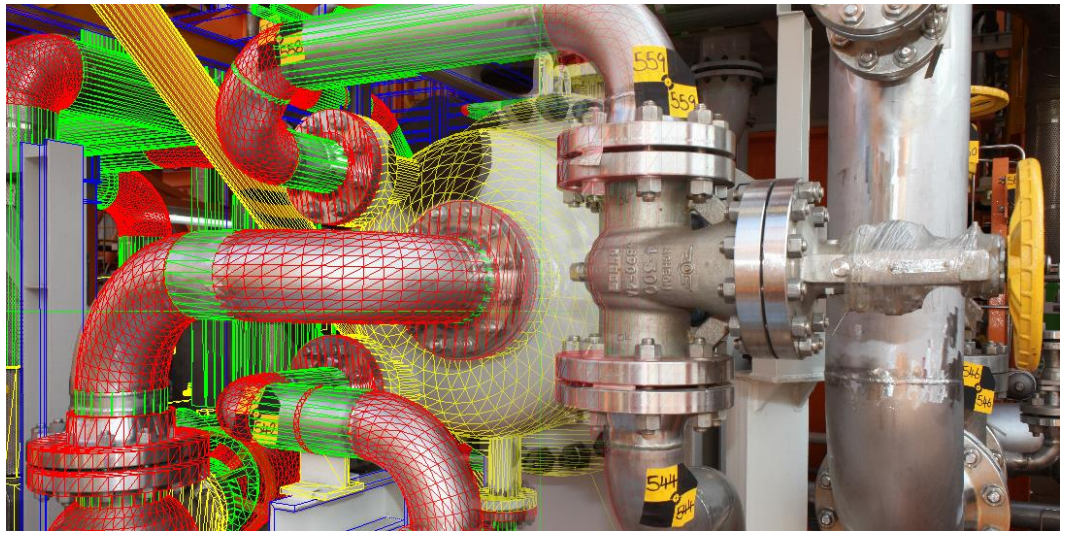


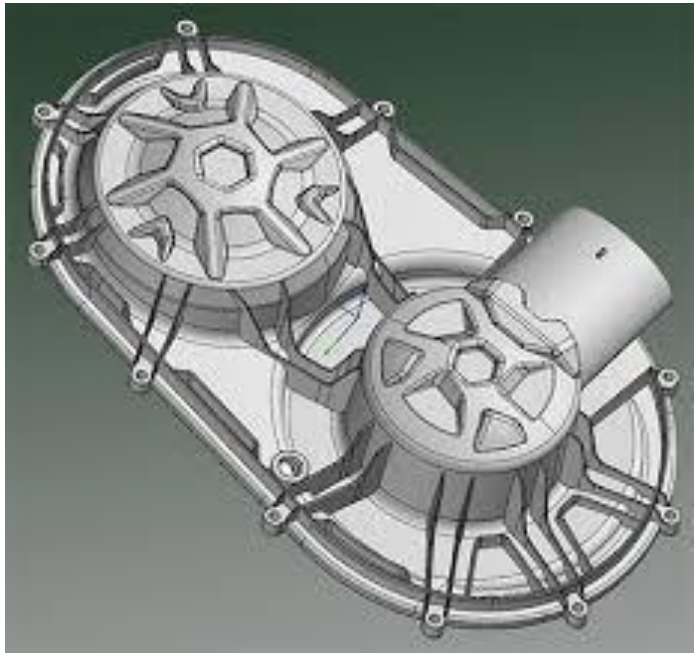
Industrial applications

1. Power stations and industrial plant

As-built documentation encompasses the measurement and inventory recording of an existing production facility. Most commonly, the complex structures and arrangements of pipes and machinery must be measured three-dimensionally for the following purposes:

- generation of up-to-date construction plans and CAD models, to centimetre accuracy, for production planning and control, and plant information systems (facility management).
- provision of precise geometric data (millimetre accuracy or better) to enable the replacement of large components which are manufactured off-site to fit existing mechanical interfaces.





Industrial applications

2. Aircraft and space industries

Photogrammetric applications in the aerospace industry are distinguished by extremely high accuracy specifications for very large objects.

Examples of application areas include:

- Measurement of parabolic antennas.
- Measurement of large tooling jigs and mechanical gauges.
- Production control of large components and assembly interfaces.
- Space simulations.

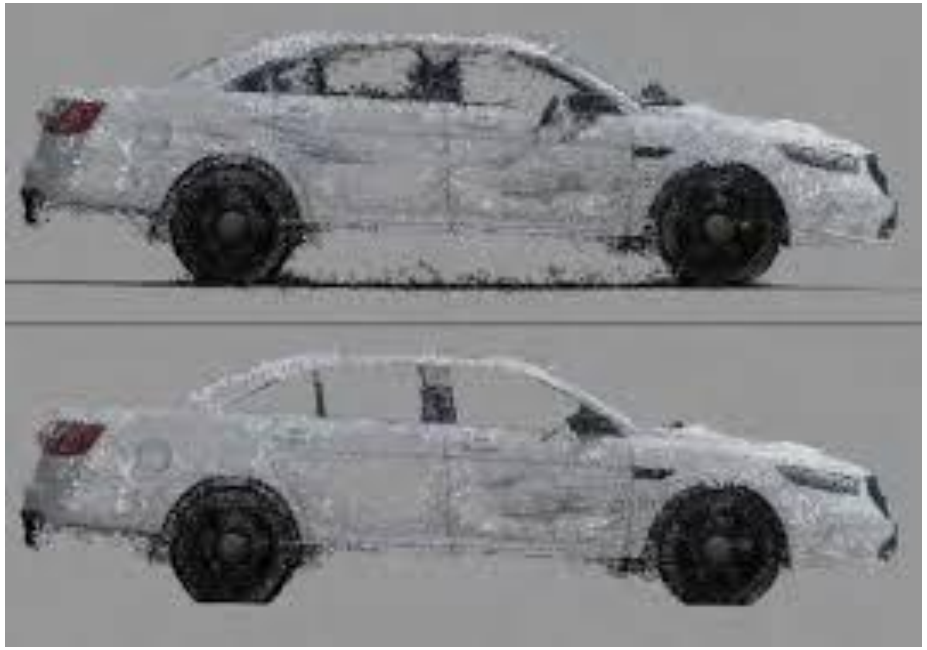
Industrial applications

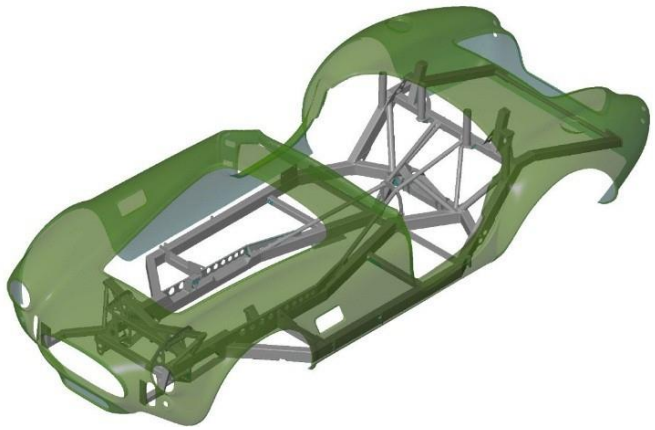
3. **Car industry**

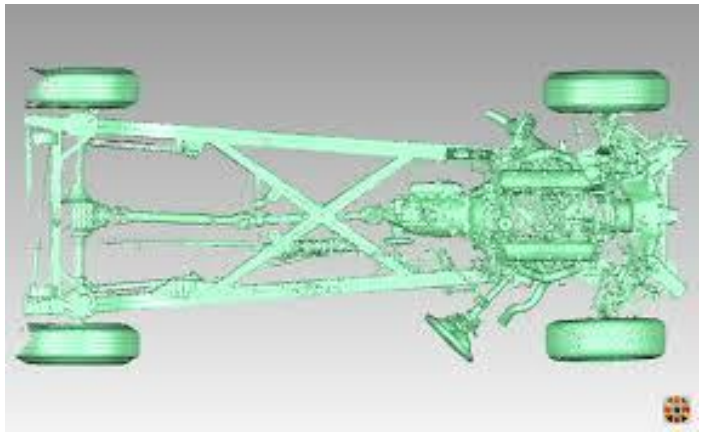
Three-dimensional measurement technology has, for some time, been one of the most important tools for quality control in the car industry. Mechanically probing coordinate measuring machines (CMMs) are mainly used for the high-precision measurement (1–10 µm) of small components.

The following shows a selection of areas where photogrammetry can be applied:

- Alignment of production cells and assembly facilities.
- Surface measurement of design models (reverse engineering).
- Car body measurement in a wind tunnel.
- Deformation measurement in torsion and car safety tests.
- Inspection of parts from third party suppliers.
- Control of production machines (e.g. brake pipes).





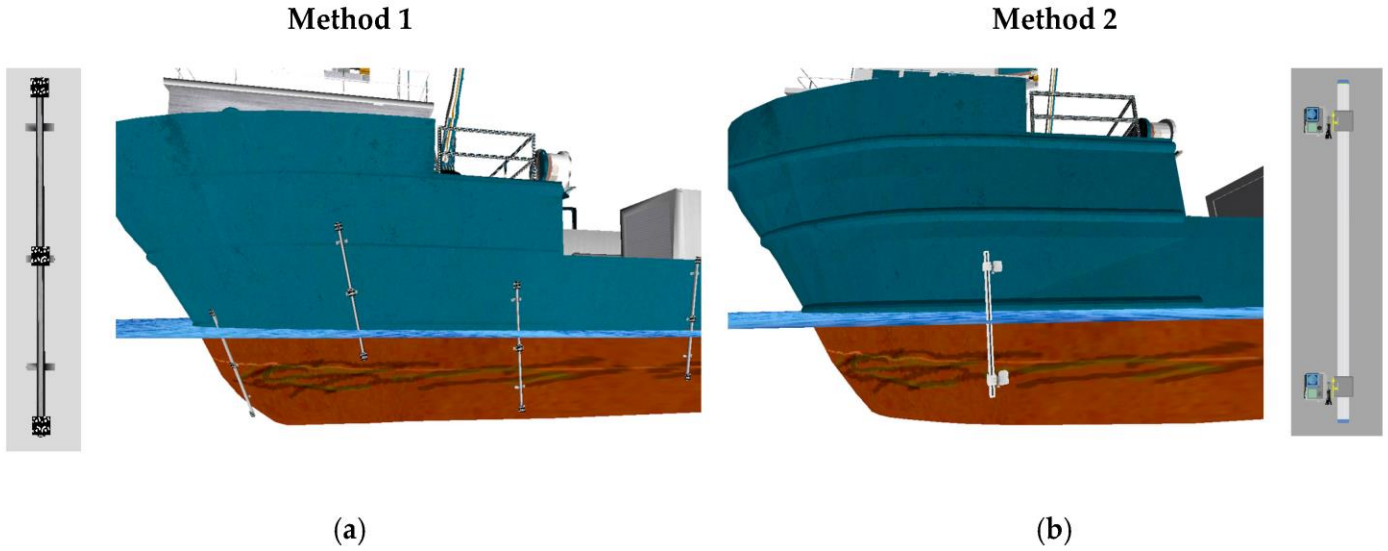


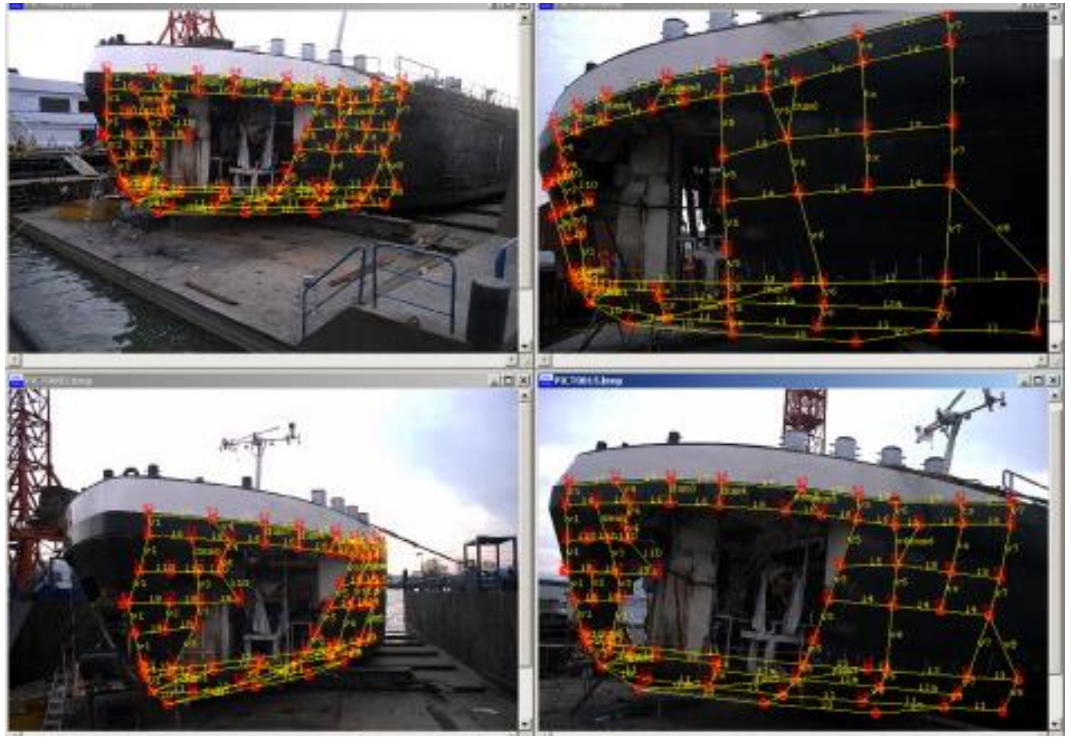
Industrial applications

4. Ship building industry

Metrology applications in the ship building industry are characterized by:

- Measurement of large objects (> 30m)
- Restricted access.
- Vibrations and disadvantageous environmental conditions.

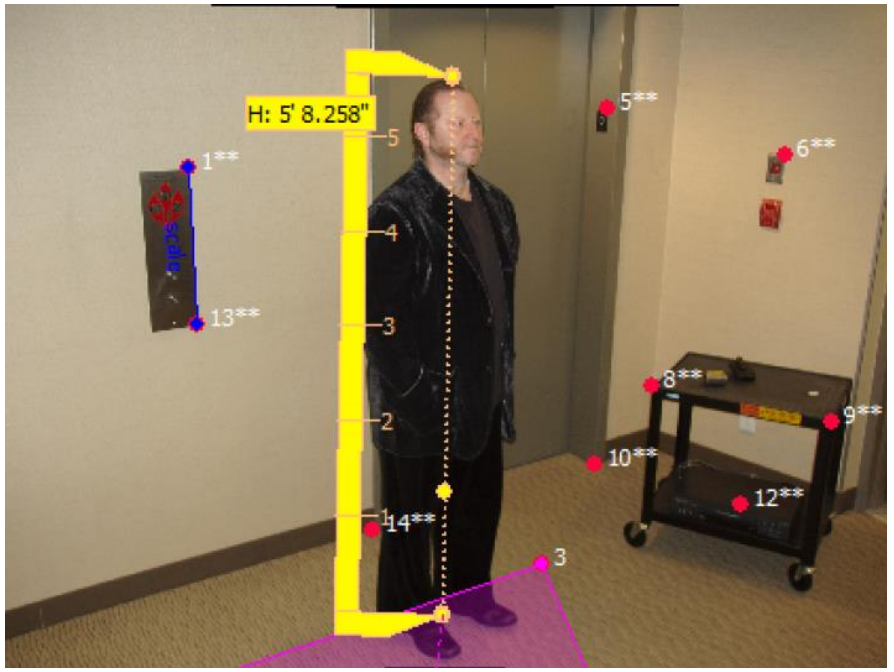


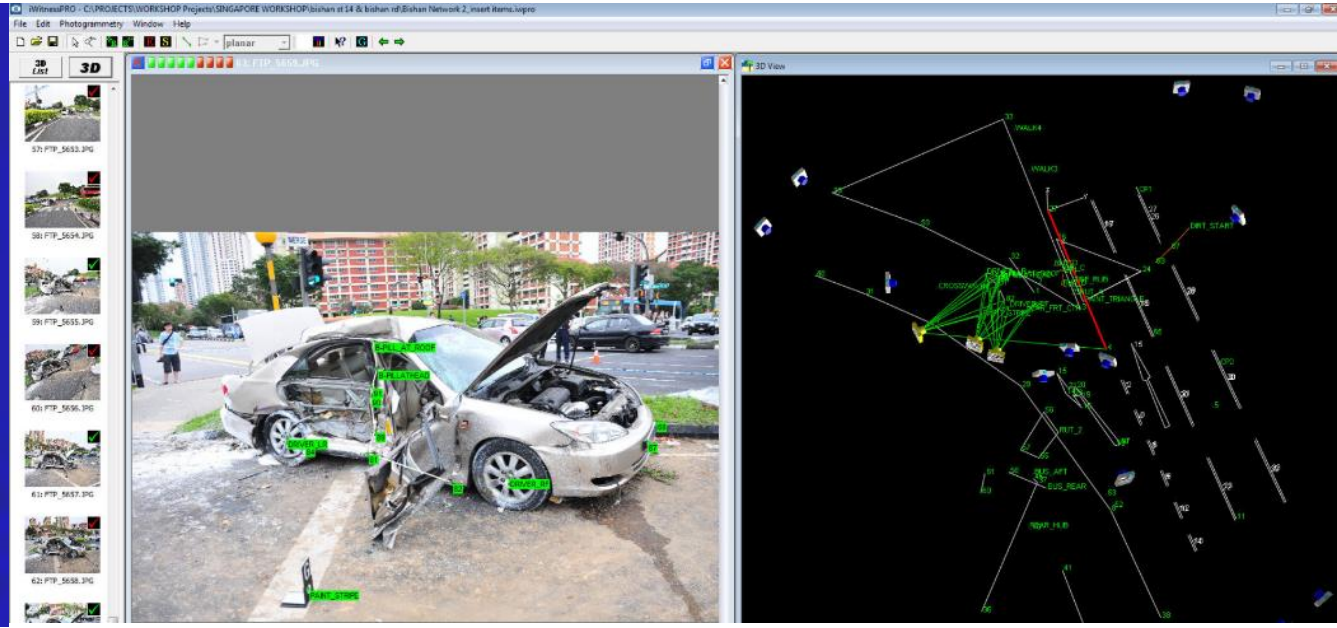


Forensic applications

Photogrammetry is often used in accident and crime applications, including:

- Traffic accident recording.
- Recording and reconstruction of aircraft crashes.
- Scene-of-crime measurement.
- Estimating the height of criminals.
- Reconstructing bullet trajectories.
- Object reconstruction from amateur images.
- Detecting environmental pollution from aerial images.

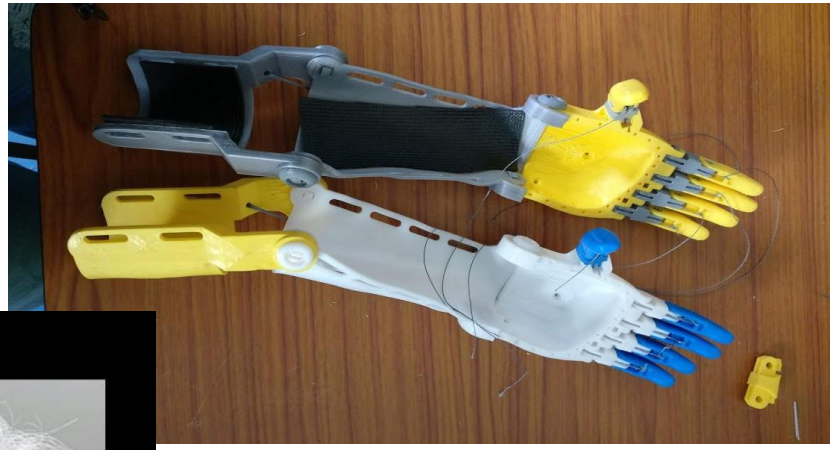


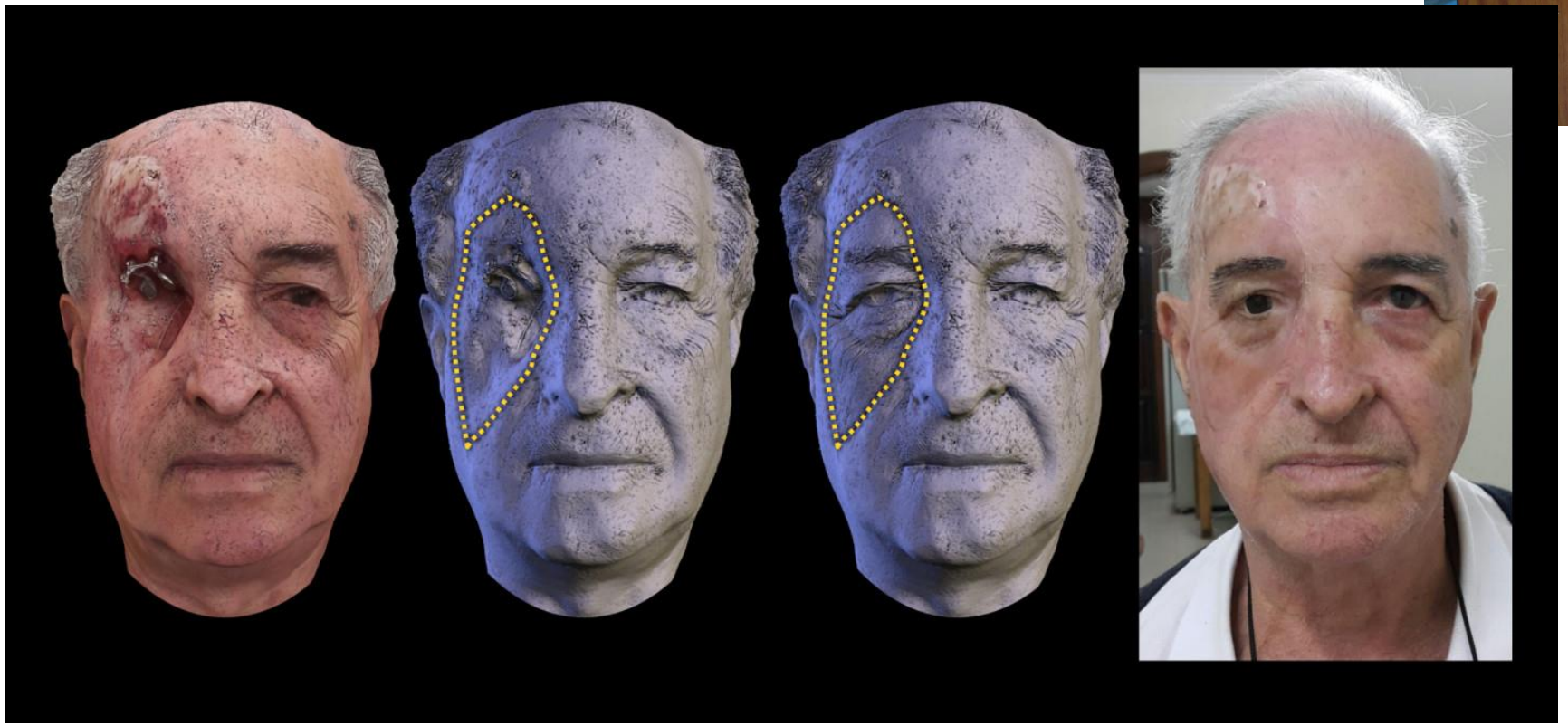


Medicine

In medicine, photogrammetry is mainly used to measure parts of the body, for example:

- To prepare and carry out operations.
- To adapt prostheses or substitutional operations.
- In motion studies.
- In the therapy for bone and spinal deformations
- To monitor growth.





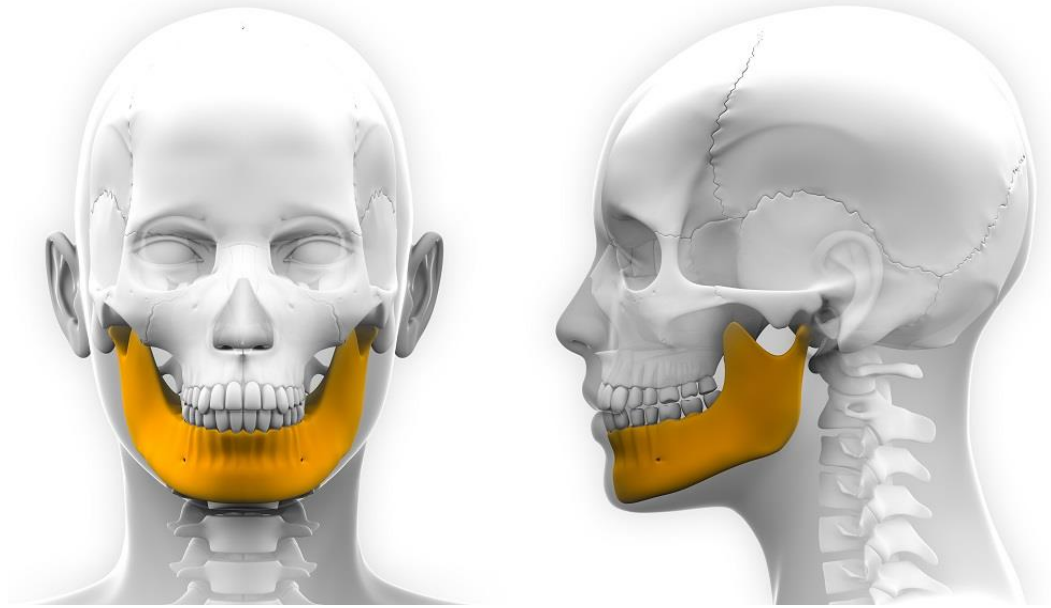
Medicine

1. Surface measurement

Medical surface measurements are mostly characterized by:

- The measurement of unstructured, soft, free-form surfaces.
- The recording of objects showing small or limited movement.
- The absence of permanent reference points on the object surface.

- Features of the photogrammetric process are:
  - Non-contact measurement without causing stress to the patient.
  - Short measurement time (tenths of a second).
  - No radiation exposure.
    - Suitable also for infants and children.
    - Subsequent measurement and diagnostic comparison over time.

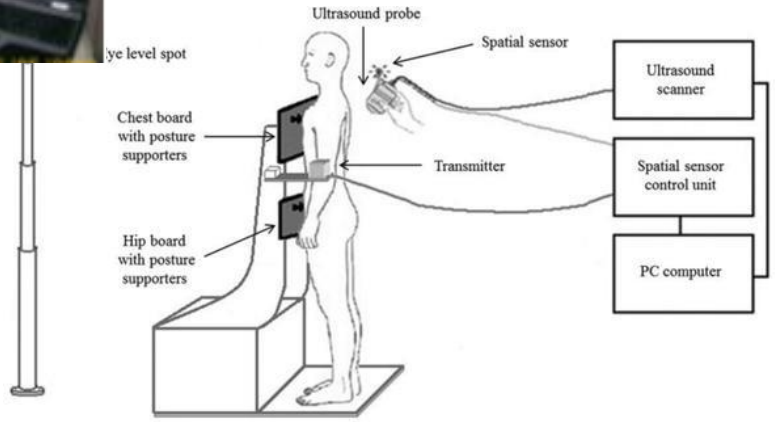


Medicine

2. On-line measuring systems

Medicine increasingly uses digital, photogrammetric, on-line measuring systems with tactile body probing. They usually consist of two cameras fixed into a mobile housing.

New photogrammetric 3D acquisition system



Resources:

- **Close range photogrammetry- Principals, Techniques, and applications**; By: **Thomas Luhmann, Stuart Robson, Stephen Kyle**, and **Stephen Kyle**; **Whittles Publishing 2011, UK.**

- **Acknowledgments goes to all figure sources.**