Zoller+Fröhlich

TLS Documentation of Tangible Cultural Heritage - Challenges and Solutions

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History

- 1963 - Foundation of the company by Hans Zoller and Hans Fröhlich in a coal cellar

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Subsidiaries and partners

- Z+F is an internationally operating company with its headquarters in Germany
- Subsidiaries in the UK and USA
- Global distribution network:

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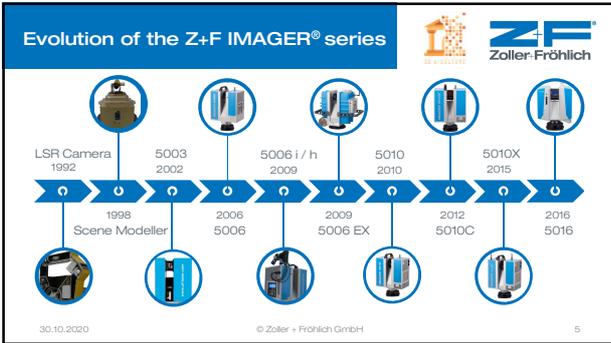## Evolution of the Z+F IMAGER® series

LSR Camera 1992 — 5003 2002 — 5006 i / h 2009 — 5010 2010 — 5010X 2015

1998 Scene Modeller — 2006 5006 — 2009 5006 EX — 2012 5010C — 2016 5016

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3D Laser Scanners – Z+F IMAGER®

IMAGER® 5016   IMAGER® 5010X   IMAGER® 5006EX

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Complexity of Documentation

Today, acquiring 3D data is easier than ever, however, it remains a complex task. As part of the EU project VIGIE 2020/654, the following categories have been identified, which influence the complexity of a project and the data quality, seen from the perspective of a manufacturer:

- Data Capture Technology
- Object Properties
- Environmental Factors

STUDY ON QUALITY IN 3D
DIGITISATION OF TANGIBLE
CULTURAL HERITAGE

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Data Capture

Level of Detail

It is important to define the required level of detail prior to data capture.

It has a direct influence on the choice of technology, necessary setups, data size, and thus project time and cost.

Technology Object Environment

inception Kourion, Cyprus

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Data Capture

Active Measurements
These instruments send out an active signal to measure the distance to an object directly, e.g. lidar, sonar, radar

Passive Measurements
Passive systems establish 3D coordinates by using photos of an object and photogrammetry

Hybrids
Hybrid systems project a pattern onto a surface and establish 3D measurements by analysing its deformation on photos

Source: J. Raychev et al, ITHET, 2017

Technology Object Environment
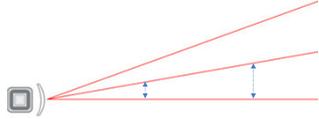
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Data Capture

Depending on the requirements, the appropriate technology has to be chosen, as each instrument is optimized for a certain purpose.

Focusing on optical methods, data quality and project complexity depend on multiple parameters, e.g.:

- **Resolution**

Sensor   Optics

Object

Technology Object Environment
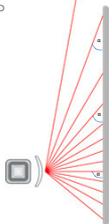
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Data Capture

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Focusing on optical methods, data quality and project complexity depend on many parameters, e.g.:
- Resolution
- **Distance to the object**

Technology — Object — Environment

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Data Capture

Depending on the requirements, the appropriate technology has to be chosen, as each instrument is optimized for a certain purpose.

Focusing on optical methods, data quality and project complexity depend on many parameters, e.g.:
- Resolution
- Distance to the object
- **Angle of incidence**

Technology — Object — Environment

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Data Capture

Depending on the requirements, the appropriate technology has to be chosen, as each instrument is optimized for a certain purpose.

Focusing on optical methods, data quality and project complexity depend on many parameters, e.g.:
- Resolution
- Distance to the object
- Angle of incidence
- **Focal point**

Technology — Object — Environment

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Data Capture

Depending on the requirements, the appropriate technology has to be chosen, as each instrument is optimized for a certain purpose.

Focusing on optical methods, data quality and project complexity depend on many parameters, e.g.:
- Resolution
- Distance to the object
- Angle of incidence
- Focal point
- **Field of view**

Technology | Object | Environment

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Data Capture

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Technology | Object | Environment
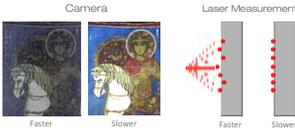
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Data Capture

Depending on the requirements, the appropriate technology has to be chosen, as each instrument is optimized for a certain purpose.

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- Focal point
- Field of view
- **Range**

Technology | Object | Environment

Min Range 30cm

Min Range 60cm

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Data Capture

Zoller·Fröhlich

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Focusing on optical methods, data quality and project complexity depend on many parameters, e.g.:

- Resolution
- Distance to the object
- Angle of incidence
- Focal point
- Field of view
- Range
- **Measuring time**

Camera   Laser Measurement

Faster   Slower   Faster   Slower

➡ The more time is allowed for the measurement, the less noise will be present in the data

Technology   Object   Environment

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Data Capture

Zoller·Fröhlich

Depending on the requirements, the appropriate technology has to be chosen, as each instrument is optimized for a certain purpose.

Focusing on optical methods, data quality and project complexity depend on many parameters, e.g.:

- Resolution
- Distance to the object
- Angle of incidence
- Focal point
- Field of view
- Range
- Measuring time
- **Accuracies**

➡ Each instrument has certain accuracies, which manufacturers of professional equipment should specify

Technology   Object   Environment

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Object Properties

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Shape

More complex shapes require more data from various vantage points. Depending on the accessibility, and also movability, some cavities might not be possible to be documented or require the usage of different technology

Technology   Object   Environment   Cathedral of Cologne, Germany

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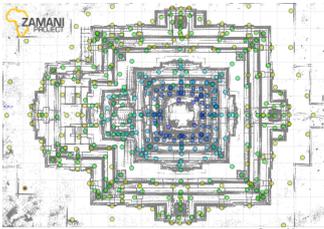**Object Properties**

Dimensions

The larger the object, the more data is needed, and the more complex it becomes to keep track in the field of the covered areas and to process the data in the office

Technology Object Environment

Bagan, Myanmar

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Object Properties

Symmetry

Symmetrical objects or parts of an object can easily confuse operator and algorithms

Technology Object Environment

Bagan, Myanmar

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Object Properties

Material

- Reflectivity
  Noise increases especially with darker objects and longer distances
- Surface Finishing
  Depending on the surface finish, the light can be fully absorbed or reflected so intensively that the sensor is blinded (highlights)
- Light transmittance
  Light can penetrate some materials and be reflected at different depths (e.g. marble)
- State of aggregation
  Water, rain or fog can cause issues
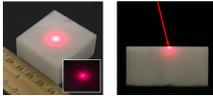
Laser-light diffusion on marble
Source: Godin et al 2001, "An assessment of laser range measurement on marble surfaces"

Technology Object Environment

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Object Properties

Object Condition

The state of the object can have an effect on the data quality, e.g. moss, dust, texture

Technology | Object | Environment

Cathedral of Cologne, Germany

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Circumstances/Environment

Technology | Object | Environment

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Circumstances / Environment

Accessibility

Technology | Object | Environment

Bagan, Myanmar

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Circumstances / Environment

Accessibility

Cathedral of Cologne, Germany

Technology   Object   Environment

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Circumstances / Environment

Accessibility

Technology   Object   Environment

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Circumstances / Environment

Accessibility

Technology   Object   Environment

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Circumstances / Environment

Circumstances / Environment

Accessibility

Mntoni, Zanzibar
Tanzania

Technology Object Environment

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Circumstances / Environment

Ambient Conditions
• Moving objects

Petra, Jordan

Technology Object Environment

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Circumstances / Environment

Ambient Conditions
- Moving objects
- Temperature, wind
- Illumination, shadows, changing conditions, color temperature

Technology → Object → Environment

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HDR

High Dynamic Range (HDR) technology combines multiple overexposed and underexposed images to prevent detail loss in scenes with high contrast

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HDR

HDR

Integrated light sources allow coloured scans, independent of external lighting conditions around

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Field Processing

A field software helps managing the project complexity by providing tools to:

- automatically align all data and detecting issues during field phase
- ensuring the completeness of data
- confirming the level of detail
- checking the quality of data

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Field Processing
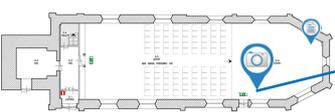
Annotations & Metadata

On site, the operator can augment scan data with additional information, such as photos, documents, audio recordings and annotate important features and provide customized metadata for each scan

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Sensor Fusion

- Fusion of data sources
- Data from other devices and technologies can be combined and integrated easily

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Sensor Fusion

Infrared Camera
Thermal Imagery can be used to identify

- Cracks
- Thermal bridges
- Problems with insulations
- Damp areas
- Electrical faults
- Locate voids behind walls

-> calibrated thermal camera system to be mounted on top of the scanner

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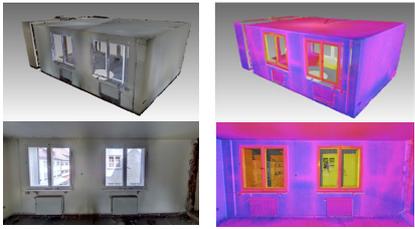## Sensor Fusion

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Conclusion & Outlook

Conclusion
There are many factors influencing complexity and data quality.
Therefore the EU-project VIGIE is of high importance to obtain a
framework and standards for high quality 3D documentation.

The future:
- Provide more intuitive and intelligent tools, further minimizing
  the complexity of projects
- Faster and more efficient data capturing technologies
- Provide augmented point clouds and intelligent processing
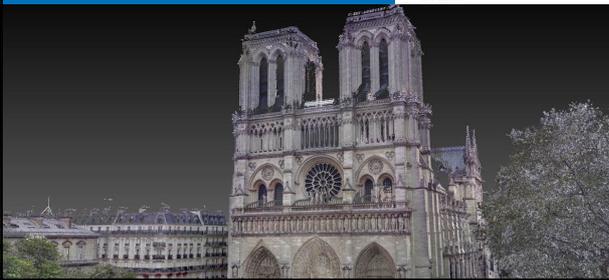 algorithms

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3D point cloud – Notre Dame

Thank you for your attention

Zoller + Fröhlich GmbH   Phone: +49 (0) 7522 9308-0
Simoniusstraße 22   Fax: +49 (0) 7522 9308-252
88239 Wangen im Allgäu   www.zofre.de ∣ www.zf-laser.com
Germany   info@zofre.de ∣ info@zf-laser.com

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