Quick 3D record: a low-cost method for documentation and analysis of scattered architectures in the EMCHAHE project

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Early Medieval Churches: History, Archaeology and Heritage

This work makes part of the Marie Curie CIG EMCHAHE project "Early Medieval Churches: History, Archaeology and Heritage" (2013-2017), led by José Carlos Sánchez-Pardo at the University of Santiago de Compostela (Spain).

The research area of this project is the archaeology and history of the early medieval rural churches and their value for cultural management in Galicia (Northwest Spain). The project has two major goals:

- First, to generate new archaeological/historical knowledge on the social dynamics in such a peripheral area of Europe during the period of transformations that goes from the end of the Roman World until the peak of the feudal system (5th-11th centuries) by means of the study of the remaining evidences of the religious buildings of this period.
- Second, to learn how to re-direct all this knowledge towards a proper and effective management and communication of the important and rather unknown heritage value of the remains of these buildings: architectural, archaeological (unearth or visible), artistic, documentary or even toponymic.

At an archaeological level, the project characterises by a wide perspective, strongly linked to **Landscape Archaeology** approaches combined with **stratigraphical analysis** of both underearth or standing remains of **early medieval churches**.

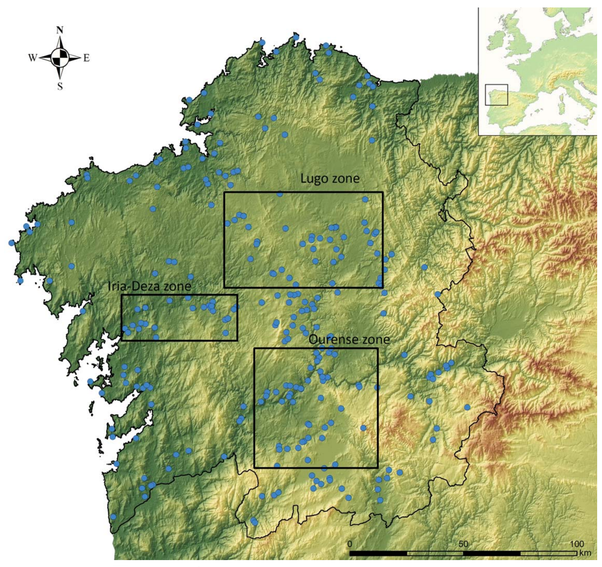
In this sense, the project, rather than focusing on a few examples, aims to **study a high number of churches** in order to get new evidence of the early medieval churches, comparing construction tecnhiques, chronologies and founders as well as distribution areas. As an estimation, the initial compillation of data for the project has recorded **265 churches** with possible early medieval evidences in Galicia.

Within this panorama, we have chosen 3 case-study areas:

- Area of Lugo: 2943 km^2 comprising 61 churches to survey
- Area of Iria-Deza: 1082 km^2 and 31 churches to survey
- Area of Ourense: 1820 km^2 and 36 churches to survey

So the project faces an important challenge:

How to document all these buildings in a feasible and practical way?

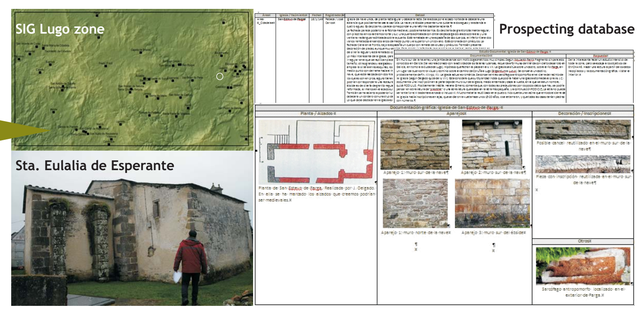


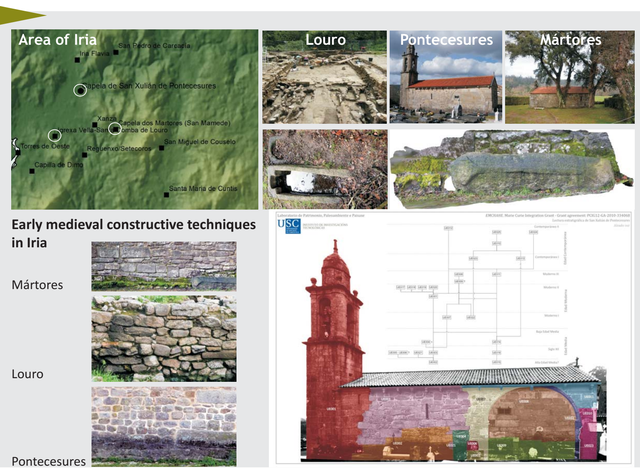
Approaches to the study and geometric survey of early medieval churches

Study approach in EMCHAHE

The methodological strategy in EMCHAHE is based on the application of two successive work phases:

- **Prospective phase** (extensive strategy)
  - Revision of documentary sources
  - Creation of a SIG
  - Selection of study areas
  - Architectural survey
- **Analytical Phase** (intesive strategy)
  - Comprehensive study of the early medieval churches :
    - Documentation of the early medieval remains
    - Geometric documentation of singular elements and churches
    - Stratigraphic analysis of paraments
    - Cluster analysis
    - Analysis of mortars and bricks
    - Analysis of lapidary inscriptions and markings
    - Territorial analysis





Geometric Survey for a 3D Record

Challenges and Requirements:

- Detailed analysis of a large number of churches: to represent elevations and plants, identifying demarcation of materials, specific elements, contours of stratigraphic units, etc.
- Great agility is required due to the dispersion of the sites and the time and economic constraints.
- We need a technique that does not involve additional resources and that can be easily integrated into the fieldwork by the archaeologist
- A technique that allows to correctly represent the elevations and volumes of the studied churches. Moreover, it has to enable centrimetric measurements.

Solved with CLOSE-RANGE PHOTOGRAMMETRY SfM

Fieldwork
- Planning
- Measurement (scalebar, measuring tape/disto)
- Capture images

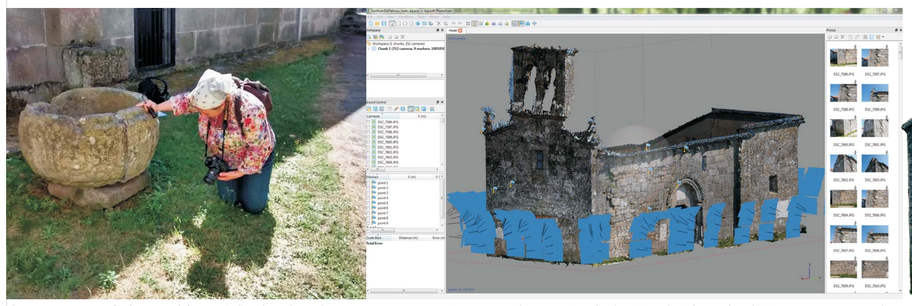
1-4 hours each church
(working time of 1 person)

Processing
- Agisoft Photoscan Pro
- Automation
- You need to enter parameters and control

1-3 hours each

Results
- 3D digital metric copy
- Ortoimages
- Images
- 3D models, 3D pdf

0,5-2 h each church



Capturing images of a baptismal font in Baños de Molgas (Ourense area)

Procesing in Photoscan Pro the San Xoan de Palmou church (Deza area)

Ortoimage of San Mamede dos Mártores chapel (Iria area)

From the data adquisition to the results

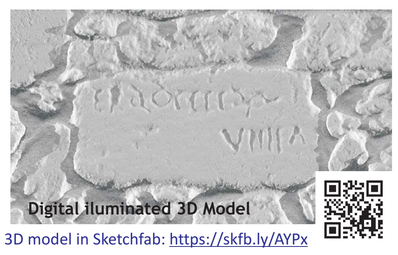
High level of detail can be achieved (singular element)

Photographs of details can achieve high quality.

Advantages
- **It does not involve a large investment of time**, ie. the case of S. Mamede sarcophagus: 20 min. for taking photos + 1 h for editing results.
- **It improves the analysis**: details that can not be observed in reality, can be appreciated in the 3D model: inscriptions, reliefs, prints, erosion, etc.
- **It facilitates the disclosure**: the 3Dpdf, sketchfab, etc. enables to visualize and interact with the model.

Problems
- It is necessary a good field data record (quality images, enough overlapping, correct lighting, etc.).
- It implies more effort in the postprocessing phase.

Inscription in San Martiño de Armental church



You can view this 3D model in Sketchfab: https://skfb.ly/AYPx

Sarcophagus cover in San Mamede dos Mártores chapel

You can view and download this 3D model in pdf here: http://hdl.handle.net/10347/11401

Ortoimage - Paraments

Essential result for Analytical phase:

Advantages
- **It improves representation**: the whole of the elevation can be represented unobstructed and without distortion; it involves less work than image rectification or creating mosaics of photographs.
- **It speeds up analysis:** it allows to review in the office the analyzes performed in the field and to take new measurements without having to return to the site.
- **It facilitates disclosure**: the representation of the results is more uniform and complete.

Problemática
- The elements that are too high (tower bells, roofs) are not well represented with photographs taken from the ground.

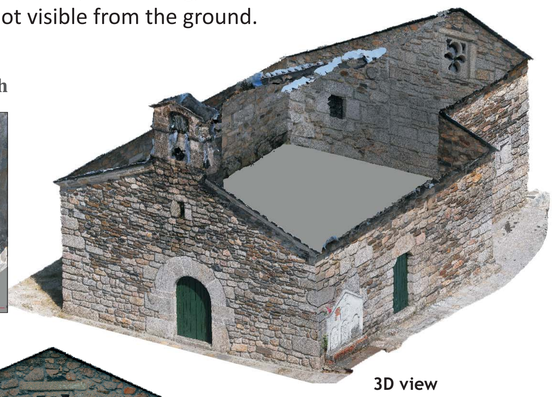
San Mamede dos Mártores chapel

3D Models from terrestrial photogrametry

Advantages
- **3D metric copy**: it allows to record the geometry, analyze volume, texture, relationship with the environment, etc., in the office.
- **It increases the possibility of representation**: elevations, plans, sections, perspectives, interactive 3D models can be obtained.
- It allows to **represent three-dimensionally the constructive phases** of the building, propose 3D reconstruction hypotheses, etc.
- **It facilitates research and dissemination of results.**

Problems
- It is necessary to supplement this process with photographs taken from lifted elements (drone, scaffolding, etc.) to best record some elements that are not visible from the ground.

Santo Tomé de Tordea church

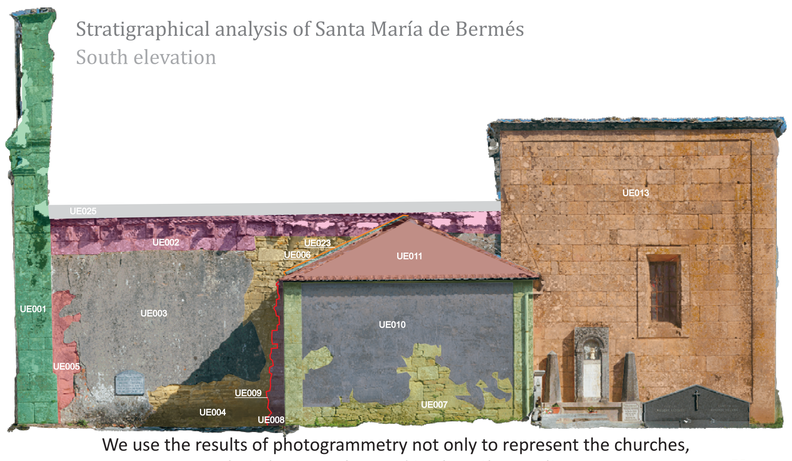


Conclusions

Initially EMCHAHE did not envisaged the use of any heritage geometric documentation method except conventional photography, because the wide-scale focus of the project was directed to the understanding of churches within a larger context rather than to the detailed study of each one.

However, the complexity of the stratigraphy documented in many of the buildings and the need to individually understand the characteristics of the construction phases, bondings, decorative items or typologies employed in these first galician churches, required a more detailed study of the buildings. This implied representation by means of some quick, cheap and easy to use system.

Profites of this workflow
- The photogrammetric methodology developed has proved to be very **effective and practical** for the needs of a large-scale study like this one.
- It offers **flexibility** to adapt to the characteristics of each church that needs to be documented.
- **Lowcost** in comparison with other geometric documentation methodologies.
- Create a **digital copy enough agile and accurate**. It can be used later to make decisions or recover information without returning to the place.
- It improves the **heritage outreach**, the presentation of the results and reconstruction hypothesis that include not only the 2D stratigraphy but the volumes of the ancient buildings that have survived in the interior of the current churches.



We use the results of photogrammetry not only to represent the churches, but also to analyze and to show the results

Technical Sheet

EMCHAHE: "Early Medieval Churches: History, Archaeology and Heritage" (2013-2017), Marie Curie Career Integration Grant (Grant agreement - PCIG12-GA-2012-334068)

- **Director of EMCHAHE Project**: José Carlos Sánchez-Pardo (USC)
- **IP of EMCHAHE Project**: Marco V. García Quintela (USC)
- **Director or archaeological works**: Rebeca Blanco-Rotea (USC)
- **3D Documentation support**: Patricia Mañana-Borrazás (Incipit, CSIC)

You can download this poster in MINERVA Institutional Repository of the USC