THE ETRUSCANS IN 3D:
FROM SPACE TO UNDERGROUND

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ETRUSCAN 3D Project

- 3D surveying and modeling of different Etruscan heritage sites and objects for:
  - Documentation and digital conservation
  - Restoration purposes
  - Digital contents for multimedia exhibitions
  - Archaeological studies

- From space to underground: 3D data collection and visualization from landscape scale (territory, heritage site, archaeological area) to object scale (tomb, relief, artifact)
The Etruscan: a bit of history…

- Civilization of ancient Italy in the area corresponding roughly to the actual Tuscany
- 800 B.C. to ca 200 B.C.
- Earliest urban civilization in the northern Mediterranean area
- Architectures influenced by the Greek style
- Figurative art with sculptures, cast bronze, wall paintings, etc.
- Large necropolises with thousands of underground tombs
- Tumuli (burial mounds) featuring carvings on the walls, outstanding quality paintings

### A bit of history…

- Banditaccia’s Necropoli
- Typical dromos
- Capitel tomb
- Hanting and Fishing tomb
- Auguri tomb
- Fustigazione tomb
3D surveying and modeling = complex system of decisions, processes and representations

Specifications / Requirements

Project design / Planning

Data acquisition

Data processing

Data representation

ETRUSCAN 3D Project

Complex system of decisions, processes and representation

Specifications / Requirements

Geometric resolution

3D model use

3D model representation

Budget

Schedule / Deadline

Scene location / constraints
Complex system of decisions, processes and representation

Specifications / Requirements

- Project design / Planning
- Data acquisition
- Data processing
- Data representation

Project design / Planning

- Technique selection
- Sensor parameters
- Sensor setup
- View planning
- Lighting

Specifications / Requirements

- Project design / Planning
- Data acquisition
- Data processing
- Data representation

Data acquisition

- Active / Passive
- Multi-stations
- Geo-referencing
- Targets
- Maps / Drawings
Complex system of decisions, processes and representation

Specifications / Requirements

Project design / Planning

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Data representation

Data processing

Image triangulation

Point clouds editing

Procedural

Dense matching

Co-registration

Mesh generation

Editing

Texturing

Data representation

Static / Animation

Interactive

Immersive

Web

Sections / Plans
3 field campaigns (2009, 2010, 2011) in the main necropolises and museums

TOF laser scanning for the geometric modeling

- Tomb of the Monkey: 6 scans, avg 5 mm sampling step, 41 M points, 3 M polygons
- Tomb of the Augurs: 2 scans, avg 1 cm sampling step, 6 M points, 400K polygons

High resolution images (Vis, UV and IR) for texturing, image-based rendering and restoration

- Ca 50 panoramic images (ca 45 images per pano)
- Hunting and Fishing Tomb: more than 100 HDR images

Range data (point clouds):

- registration, merging, overlap reduction, meshing, editing, filling holes, texture mapping
- rendering & visualization
  - Tomb of the Monkey: 3 M polygons
  - Tomb of the Augurs: 400K polygons

Image data:

- Radiometric adjustment, 2D-3D registration, editing, texture mapping

Visualization:

- Offline rendering based on pre-defined paths
- Mono- and stereoscopic (anaglyph) visualization
Data processing & Virtual Tour realization

- Radiometric correction of the acquired images
- Panorama generation (stitching + editing)
- Panorama linking
- Extra contents insertion
- Web visualization
- 2D / 3D visualization
- Material for exhibition and educational purposes

Data processing & Geo-browser realization

- Geographic information System to contextualize the Etruscan population and its territory
- Geo-Browser application based on open-source remote sensing data and visualization tools
- App linked to an external database containing archaeological and cultural information
- Hot spots to visualize information
- Tool for communication and educational purposes
Data processing & Geo-browser realization

Archaeological & Architectural Analyses

- Sections, plans, maps, exploded visualization, etc.

[Steingraeber, 1985]
- From the books we learn that the Etruscan tombs were a reflection of the Etruscan houses (in terms of shapes / geometry)

- Geometric analyses of the inner wall

- Results underline that each inner wall has practically the same inclination value and that the inclination is oriented toward the inside of the room

- Thanks to reality-based 3D models it is moreover possible to derive precise metric measures, not only in linear terms as distances from point to point, but also areas and volumes (excavation volumes, amount of collapsed areas, etc.)

  Actual roof situation

  Virtually reconstructed roof

  → Collapsed part: 0.8 m³
Multi-spectral imaging (IR & fluorescence UV) integrated with 3D reliefs to derive quantitative information and study mural paintings

(in collaboration with Art-Test, Firenze, Italy)

Preservation & Conservation issues

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![IR image]

![color UV image]

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Preservation & Conservation issues

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Identification of pre-existing figures now disappeared

visible
- Multi-spectral imaging (IR & fluorescence UV) integrated with 3D reliefs to derive quantitative information and study mural paintings

Color infrared

Ultraviolet
Preservation & Conservation issues

- Multi-spectral imaging (IR & fluorescence UV) integrated with 3D reliefs to derive quantitative information and study mural paintings

- Application to import the registered images (tensor) and derive the spectral reflectance curves ("spectral firma") or segment areas with similar material or localize restoration interventions

Spectral firma to distinguish materials or identify restoration interventions
- Application for augmented reality visualization of 3D modeled museums objects (in collaboration with No-Real, Torino, Italy)

- User selects an object and manipulate a target in front of a webcam
- Virtual appearance of the digital artifact in your hand

Multimedia museum exhibition

in collaboration with Historia, Italy
Conclusions and Outlook

- 3D surveying and modeling project not only for documentation and conservation issues
- Reality-based 3D models used for multimedia exhibition, archaeological and architectural analyses, geo-visualization, conservation and restoration policies, communication and educational purposes, etc.
- 3D models are unfortunately not yet the state-of-the-art in the heritage field

Open issues:
- Automation….where do we stand?
- How do we store / preserve 3D surveying data for the future?
- Which is the right (technical) solution to share 3D data?
- How do we critically compare optical 3D measurement techniques without a common terminology for the sensors specifications?

...Thank you...

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