

# REPRESENTATION CHALLENGES

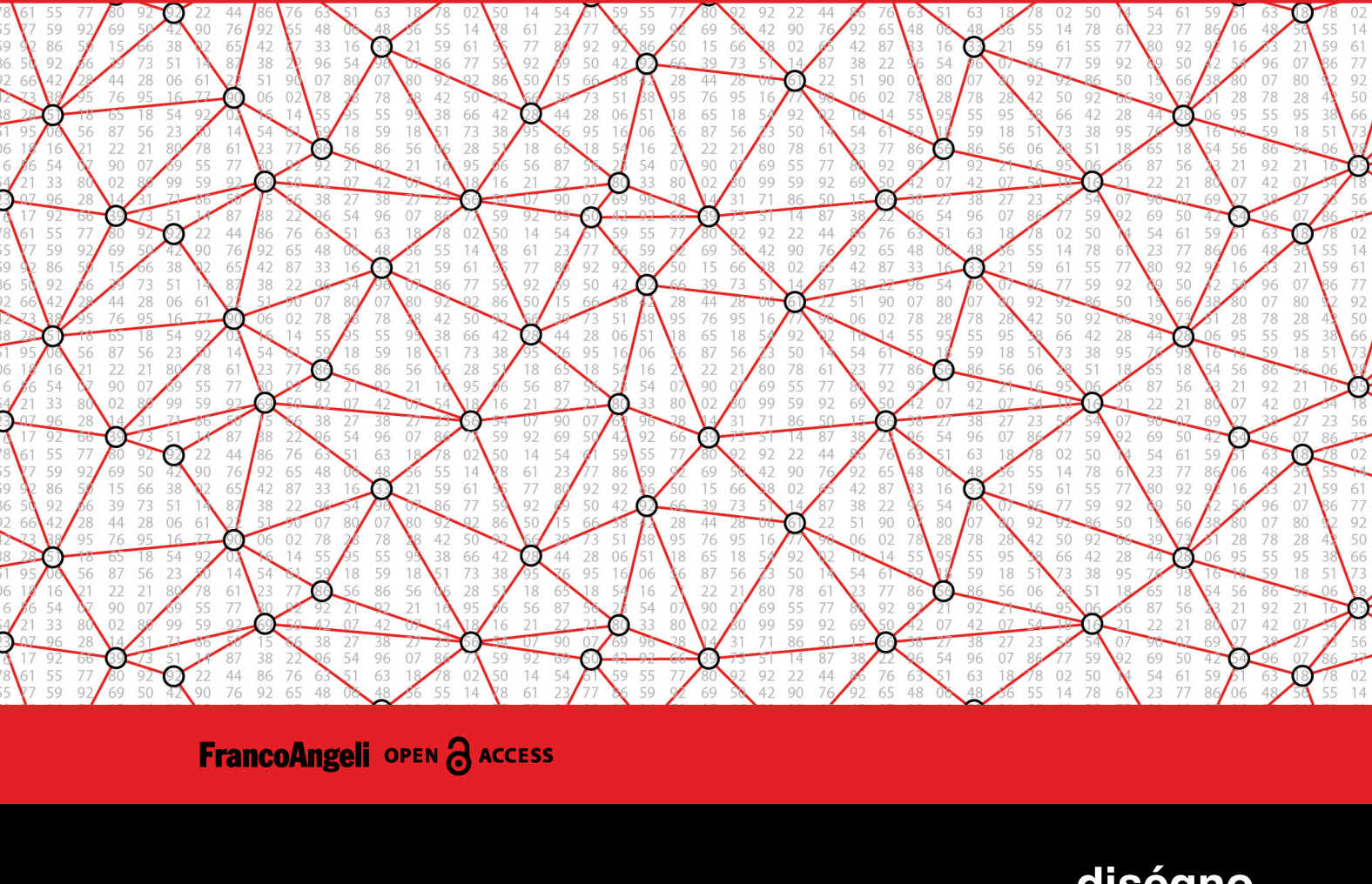
## Augmented Reality and Artificial Intelligence in Cultural Heritage and Innovative Design Domain

edited by

Andrea Giordano

Michele Russo

Roberta Spallone



director Francesca Fatta

The Series contains volumes of the proceedings of the annual conferences of the Scientific Society UID – Unione Italiana per il Disegno and the results of international meetings, research and symposia organised as part of the activities promoted or patronised by UID. The topics concern the Scientific Disciplinary Sector ICAR/17 Drawing with interdisciplinary research areas. The texts are in Italian or in the author's mother tongue (French, English, Portuguese, Spanish, German) and/or in English. The international Scientific Committee includes members of the UID Scientific Technical Committee and numerous other foreign scholars who are experts in the field of Representation.

The volumes of the series can be published either in print or in open access and all the authors' contributions are subject to double blind peer review according to the currently standard scientific evaluation criteria.

## Scientific Committee

Giuseppe Amoruso *Politecnico di Milano*  
Paolo Belardi *Università degli Studi di Perugia*  
Stefano Bertocci *Università degli Studi di Firenze*  
Mario Centofanti *Università degli Studi dell'Aquila*  
Enrico Cicalò *Università degli Studi di Sassari*  
Antonio Conte *Università degli Studi della Basilicata*  
Mario Docci *Sapienza Università di Roma*  
Edoardo Dotto *Università degli Studi di Catania*  
Maria Linda Falcidieno *Università degli Studi di Genova*  
Francesca Fatta *Università degli Studi Mediterranea di Reggio Calabria*  
Fabrizio Gay *Università IUAV di Venezia*  
Andrea Giordano *Università degli Studi di Padova*  
Elena Ippoliti *Sapienza Università di Roma*  
Francesco Maggio *Università degli Studi di Palermo*  
Anna Osello *Politecnico di Torino*  
Caterina Palestini *Università degli Studi "G. d'Annunzio" di Chieti-Pescara*  
Lia Maria Papa *Università degli Studi di Napoli "Federico II"*  
Rossella Salerno *Politecnico di Milano*  
Alberto Sdegno *Università degli Studi di Udine*  
Chiara Vernizzi *Università degli Studi di Parma*  
Ornella Zerlenga *Università degli Studi della Campania "Luigi Vanvitelli"*

## Members of foreign structures

Caroline Astrid Bruzelius *Duke University - USA*  
Pilar Chfás *Universidad de Alcalá - Spagna*  
Frank Ching *University of Washington - USA*  
Livio De Luca *UMR CNRS/MCC MAP Marseille - Francia*  
Roberto Ferraris *Universidad Nacional de Córdoba - Argentina*  
Glaucia Augusto Fonseca *Universidade Federal do Rio de Janeiro - Brasile*  
Pedro Antonio Janeiro *Universidade de Lisboa - Portogallo*  
Jacques Laubscher *Tshwane University of Technology - Sudafrica*  
Cornelie Leopold *Technische Universität Kaiserslautern - Germania*  
Juan José Fernández Martín *Universidad de Valladolid - Spagna*  
Carlos Montes Serrano *Universidad de Valladolid - Spagna*  
César Otero *Universidad de Cantabria - Spagna*  
Guillermo Peris Fajarnes *Universitat Politècnica de València - Spagna*  
José Antonio Franco Taboada *Universidade da Coruña - Spagna*  
Michael John Kirk Walsh *Nanyang Technological University - Singapore*



This volume is published in open access format, i.e. the file of the entire work can be freely downloaded from the FrancoAngeli Open Access platform (<http://bit.ly/francoangeli-oa>). On the FrancoAngeli Open Access platform, it is possible to publish articles and monographs, according to ethical and quality standards while ensuring open access to the content itself. It guarantees the preservation in the major international OA archives and repositories. Through the integration with its entire catalog of publications and series, FrancoAngeli also maximizes visibility, user accessibility and impact for the author.

Read more:

[http://www.francoangeli.it/come\\_publicare/pubblicare\\_19.asp](http://www.francoangeli.it/come_publicare/pubblicare_19.asp)

Readers who wish to find out about the books and periodicals published by us can visit our website [www.francoangeli.it](http://www.francoangeli.it) and subscribe to our "Informatemi" (notify me) service to receive e-mail notifications.

# **REPRESENTATION CHALLENGES**

Augmented Reality and Artificial Intelligence in  
Cultural Heritage and Innovative Design Domain

edited by

Andrea Giordano

Michele Russo

Roberta Spallone

1222-2022  
80 ANNI



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

ICEA

DIPARTIMENTO DI STORIA  
DISEGNO E RESTAURO  
DELL'ARCHITETTURA



SAPIENZA  
UNIVERSITÀ DI ROMA



Politecnico  
di Torino

Dipartimento  
di Architettura e Design

#### Scientific Committee

Salvatore Barba  
*Università di Salerno*

Marco Giorgio Bevilacqua  
*Università di Pisa*

Stefano Brusaporci  
*Università dell'Aquila*

Francesca Fatta  
*Università Mediterranea di Reggio Calabria*

Andrea Giordano  
*Università di Padova*

Alessandro Luigini  
*Libera Università di Bolzano*

Michele Russo  
*Sapienza Università di Roma*

Cettina Santagati  
*Università di Catania*

Alberto Sdegno  
*Università di Udine*

Roberta Spallone  
*Politecnico di Torino*

#### Scientific Coordination

Andrea Giordano  
*Università di Padova*

Michele Russo  
*Sapienza Università di Roma*

Roberta Spallone  
*Politecnico di Torino*

#### Editorial Committee

Isabella Friso  
*Università IUAV di Venezia*

Fabrizio Natta  
*Politecnico di Torino*

Michele Russo  
*Sapienza Università di Roma*

*The texts as well as all published images have been provided by the authors for publication with copyright and scientific responsibility towards third parties. The revision and editing is by the editors of the book.*

ISBN printed edition: 9788835116875  
ISBN digital edition: 9788835125280

#### Peer Reviewers

Marinella Arena  
*Università Mediterranea di Reggio Calabria*

Salvatore Barba  
*Università di Salerno*

Marco Giorgio Bevilacqua  
*Università di Pisa*

Cecilia Bolognesi  
*Politecnico di Milano*

Stefano Brusaporci  
*Università dell'Aquila*

Francesca Fatta  
*Università Mediterranea di Reggio Calabria*

Andrea Giordano  
*Università di Padova*

Massimo Leserri  
*Università di Napoli "Federico II"*

Stefania Landi  
*Università di Pisa*

Massimiliano Lo Turco  
*Politecnico di Torino*

Alessandro Luigini  
*Libera Università di Bolzano*

Pamela Maiezza  
*Università dell'Aquila*

Domenico Mediatì  
*Università Mediterranea di Reggio Calabria*

Cosimo Monteleone  
*Università di Padova*

Michele Russo  
*Sapienza Università di Roma*

Cettina Santagati  
*Università di Catania*

Alberto Sdegno  
*Università di Udine*

Roberta Spallone  
*Politecnico di Torino*

Marco Vitali  
*Politecnico di Torino*

#### Patronage



Cover image: Michele Russo

Copyright © 2021 by FrancoAngeli s.r.l., Milano, Italy.

This work, and each part thereof, is protected by copyright law and is published in this digital version under the license *Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International* (CC BY-NC-ND 4.0)

*By downloading this work, the User accepts all the conditions of the license agreement for the work as stated and set out on the website*

<https://creativecommons.org/licenses/by-nc-nd/4.0>

7

Francesca Fatta  
Preface

9

Andrea Giordano, Michele Russo, Roberta Spallone  
Representation Challenges: The Reasons of the Research

## AR&AI theoretical concepts

23

Francesco Bergamo  
The Role of Drawing in Data Analysis and Data Representation

29

Giorgio Buratti, Sara Conte, Michela Rossi  
Artificial Intelligency, Big Data and Cultural Heritage

35

Marco Ferrari, Lodovica Valetti  
Virtual Tours and Representations of Cultural Heritage: Ethical Issues

41

Claudio Marchese, Antonino Nastasi  
The Magnificent AI & AR Combinations: Limits? Gorgeous Imperfections!

47

Valerio Palma  
Data, Models and Computer Vision: Three Hands—on Projects

53

Alberto Sdegno  
Drawing Automata

59

Marco Vitali, Giulia Bertola, Fabrizio Natta, Francesca Ronco  
AI+AR: Cultural Heritage, Museum Institutions, Plastic Models and Prototyping.  
A State of Art

## AR&AI virtual reconstruction

67

Alessio Bortot  
Physical and Digital Pop-Ups. An AR Application in the Treatises on  
Stereotomy

73

Maurizio Marco Bocconcino, Mariapaola Vozzola  
The Value of a Dynamic Memory: from Heritage Conservation in Turin

79

Antonio Calandriello  
Augmented Reality and the Enhancement of Cultural Heritage: the Case of  
Palazzo Mocenigo in Padua

85

Cristina Cándita, Andrea Quartara, Alessandro Meloni  
The Appearance of Keplerian Polyhedra in an Illusory Architecture

91

Maria Grazia Cianci, Daniele Calisi, Sara Colaceci, Francesca Paola Mondelli  
Digital Tools at the Service of Public Administrations

97

Riccardo Florio, Raffaele Catuogno, Teresa Della Corte, Veronica Marino  
Studies for the Virtual Reconstruction of the Terme del Foro of Cumae

103

Maurizio Peticarini, Chiara Callegaro  
Making the Invisible Visible: Virtual/Interactive Itineraries in Roman Padua

## AR&AI heritage routes

111

Marinella Arena, Gianluca Lax  
Saint Nicholas of Myra. Cataloguing, Identification, and Recognition Through AI

117

Stefano Brusaporci, Pamela Maiezza, Alessandra Tata, Fabio Graziosi, Fabio Franchi  
Prosthetic Visualizations for a Smart Heritage

123

Gerardo Maria Cennamo  
Advanced Practices of Augmented Reality: the Open Air Museum Systems for  
the Valorisation and Dissemination of Cultural Heritage

129

Serena Fumero, Benedetta Frezzotti  
The Use of AR Illustration in the Promotion of Heritage Sites

135

Alessandro Luigini, Stefano Brusaporci, Alessandro Basso, Pamela Maiezza  
The Sanctuary BVMA in Pescara: AR Fruition of the Pre-Conciliar Layout

141

Alessandra Pagliano, Greta Attadema, Anna Lisa Pecora  
Phyigitalarcheology for the Phlegraean Fields

147

Andrea Rolando, Domenico D'Uva, Alessandro Scandiffio  
A Technique to Measure the Spatial Quality of Slow Routes in Fragile  
Territories Using Image Segmentation

153

Giorgio Verdiani, Ylenia Ricci, Andrea Pasquali, Stéphane Giraudeau  
When the Real Really Means: VR and AR Experiences in Real Environments

159

Ornella Zerlenga, Vincenzo Cirillo, Massimiliano Masullo, Aniello Pascale, Luigi Maffei  
Drawing, Visualization and Augmented Reality of the 1791 Celebration in Naples

## AR&AI classification and 3D analysis

167

Marco Giorgio Bevilacqua, Anthony Fedeli, Federico Caprioli, Antonella Gioli, Cosimo  
Monteleone, Andrea Piemonte  
Immersive Technologies for the Museum of the Charterhouse of Calci

173

Massimiliano Campi, Valeria Cera, Francesco Cutugno, Antonella di Luggo, Domenico  
Iovane, Antonio Origlia  
CHROME Project: Representation and Survey for AI Development

179

Paolo Clini, Roberto Pierdicca, Ramona Quattrini, Emanuele Frontoni, Romina Nespeca  
Deep Learning for Point Clouds Classification in the Ducal Palace at Urbino

185

Pierpaolo D'Agostino, Federico Minelli  
Automated Modelling of Masonry Walls: a ML and AR Approach

191

Elisabetta Caterina Giovannini  
Data Modelling in Architecture: Digital Architectural Representations

197  
Marco Limongiello, Lucas Matias Gujski  
Image-Based Modelling Restitution: Pipeline for Accuracy Optimisation

203  
Federica Maietti, Marco Medici, Ernesto Iadanza  
From AI to H-BIM: New Interpretative Scenarios in Data Processing

209  
Michele Russo, Eleonora Grilli, Fabio Remondino, Simone Teruggi, Francesco Fassi  
Machine Learning for Cultural Heritage Classification

215  
Andrea Tomalini, Edoardo Pristeri, Letizia Bergamasco  
Photogrammetric Survey for a Fast Construction of Synthetic Dataset

## AR&AI urban enhancement

223  
Giuseppe Amoruso, Polina Mironenko, Valentina Demarchi  
Rebuilding Amatrice. Representation, Experience and Digital Artifice

229  
Paolo Belardi, Valeria Menchetelli, Giovanna Ramaccini, Margherita Maria Ristori, Camilla Sorignani  
AR+AI = Augmented (Retail + Identity) for Historical Retail Heritage

235  
Fabio Bianconi, Marco Filippucci, Marco Seccaroni  
New Interpretative Models for the Study of Urban Space

241  
Marco Canciani, Giovanna Spadafora, Mauro Saccone, Antonio Camassa  
Augmented Reality as a Research Tool, for the Knowledge and Enhancement of Cultural Heritage

247  
Alessandra Pagliano  
Augmenting Anghi: Murals in AR for Urban Regeneration and Historical Memory

253  
Caterina Palestini, Alessandra Basso  
Evolutionary Time Lines, Hypothesis of an AI+AR-Based Virtual Museum

259  
Daniele Rossi, Federico O. Oppedisano  
Marche in Tavola. Augmented Board Game for Enogastronomic Promotion

## AR&AI museum heritage

267  
Massimo Barilla, Daniele Colistra  
An Immersive Room Between Scylla and Charybdis

273  
Francesco Borella, Isabella Friso, Ludovica Galeazza, Cosimo Monteleone, Elena Svaldruz  
New Cultural Interfaces on the Gallerie dell'Accademia in Venice

279  
Laura Carlevaris, Marco Fasolo, Flavia Camagni  
Wood Inlays and AR: Considerations Regarding Perspective

285  
Giuseppe D'Acunto  
Augmented Reality and Museum Exhibition. The Case of the Tribuna of Palazzo Grimani in Venice

291  
Giuseppe Di Gregorio  
The Rock Church of San Micidario of the Pantalica Site and 3DLAB VR/AR-Project

297  
Elena Ippoliti  
Understanding to Enhance. Between the Technical and Humanist Approaches

303  
Gabiella Liva, Massimiliano Ciammaichella  
Illusory Scene and Immersive Space in Tintoretto's Theatre

309  
Franco Prampolini, Dina Porpiglia, Antonio Gambino  
Medma Touch, Feel, Think: Survey, Catalog and Sensory Limitations

315  
Paola Puma, Giuseppe Nicastro  
The Emotion Detection Tools in the Museum Education EmoDeM Project

321  
Leopoldo Repola, Nicola Scotta di Carlo, Andrea Maioli, Matteo Martignoni  
MareXperience. AI/AR for the Recognition and Enhancement of Reality

## AR&AI building information modeling and monitoring

329  
Vincenzo Bagnolo, Raffaele Argiolas, Nicola Paba  
Communicating Architecture. An AR Application in Scan-to-BIM Processes

335  
Marcello Balzani, Fabiana Raco, Manlio Montuori  
Integrated Technologies for Smart Buildings and PREdictive Maintenance

341  
Fabrizio Banfi  
Extended Reality (XR) and Cloud-Based BIM Platform Development

347  
Carlo Biagini, Ylenia Ricci, Irene Villoresi  
H-Bim to Virtual Reality: a New Tool for Historical Heritage

353  
Fabio Bianconi, Marco Filippucci, Giulia Pelliccia  
Experimental Value of Representative Models in Wooden Constructions

359  
David Campagnolo, Paolo Borin  
Automatic Recognition Through Deep Learning of Standard Forms in Executive Projects

365  
Matteo Del Giudice, Daniela De Luca, Anna Osello  
Interactive Information Models and Augmented Reality in the Digital Age

371  
Marco Filippucci, Fabio Bianconi, Michela Meschini  
Survey and BIM for Energy Upgrading. Two Case Study

377  
Raissa Garozzo  
A Proposal for Masonry Bridge Health Assessment Using AI and Semantics

383  
Federico Mario La Russa  
AI for AEC: Open Data and VPL Approach for Urban Seismic Vulnerability

389  
Assunta Pelliccio, Marco Saccucci  
V.A.I. Reality. A Holistic Approach for Industrial Heritage Enhancement

## AR&AI education and shape representation

397  
Maria Linda Falcidieno, Maria Elisabetta Ruggiero, Ruggero Torti  
Visual Languages: On-Board Communication as a Perception of Customer Care

403  
Emanuela Lanzara, Mara Capone  
Genetic Algorithms for Polycentric Curves Interpretation

409  
Anna Lisa Pecora  
The Drawn Space for Inclusion and Communicating Space

415  
Marta Salvatore, Leonardo Baglioni, Graziano Mario Valenti, Alessandro Martinelli  
Forms in Space. AR Experiences for Geometries of Architectural Form

421  
Roberta Spallone, Valerio Palma  
AR&AI in the Didactics of the Representation Disciplines

427  
Alberto Tono, Meher Shashwat Nigam, Stasya Fedorova, Amirhossein Ahmadian, Cecilia Bolognesi  
Limitations and Review of Geometric Deep Learning Algorithms for Monocular 3D Reconstruction in Architecture

# Medma Touch, Feel, Think: Survey, Catalog and Sensory Limitations

Franco Prampolini  
Dina Porpiglia  
Antonio Gambino

## *Abstract*

The project is named 'Medma Touch, Feel, Think – Technological retrofit of the Archaeological Museum of Medma–Rosarno for the 3D catalog of the exhibits works on display and the possible use by subjects with sensory limits'. We have carried out the 3D survey of all the main finds with analytical photo-modeling techniques, their scientific cataloging on ICCD's specifications, the creation of a website with a high interactivity content and an Application that allows the sharing of extended informations for blind people, through the combined use of analog 3D models and AR authoring software. A sustainable initiative, a driver for the technology transfer of innovation (often invoked, but rarely implemented), capable of generating 'social empowerment'. The methodology can also be shared by small entities, but characterized by contents of high historical and cultural values, especially if they are able to build-up a territorial network of high identitarian values.

## *Keywords*

photo-modeling, scientific cataloging, inclusion, sustainability.





The Project arose from a proposal of the Rotary International District 2100 (which also funded it extensively) and collects a broad institutional and social partnership: The ABAP Superintendence of Reggio C. and Vibo Valentia (a special thanks goes to Fabrizio Sudano, pro tempore manager of the Museum), the Italian Union of the Blind and Visually Impaired (UICI), The City of Rosarno, The Metropolitan City of Reggio Calabria, Terna SPA (which has effectively contributed to the financing) and many other Bodies and Associations that have contributed in different ways over time [1][2].

The Archaeological Museum of Medma–Rosarno is located in the archaeological park, in the town of Rosarno, full of olive trees that define its historical image in close connection with the actual perception of the territories, much like as they have been described directly by Paolo Orsi [Orsi 1913, passim] at the beginning of the last century on the occasion of the first major excavation campaigns. The exhibition is divided into three main sections.

It starts with the reconstruction of the necropolis: the different types of tombs are reconstructed, while 10 small showcases – intentionally shaped in such a way as to recall the cemetery “niches” – contain a small but significant sampling of the sepulchral equipment. It then continues with splendid specimens of medmean coroplastic findings –statuettes of different sizes and shapes–, busts, large masks, cryophores, vases, and iron weapons found in the sacred area of Calderazzo, presented on the sides of a virtual ‘Via Sacra’. The last room contains the materials from the town, including a ritual fountain in terracotta and objects from the Giovanni Gangemi private collection, donated to the State, which consists of valuable vases with both black and red figures, including an amphora with scenes from the struggle for Achilles’ arms.

The project can be summarized in five fundamental keywords.



Fig. 1. The Medma–Rosarno Archaeological Museum in Rosarno (RC).

a. The large hall shaped like an ideal “Via Sacra” and, in the background, the s.c. “Arula Tyrò”.

b. The large feminine terracotta busts showcase, from the sacred area of Calderazzo.

c. The “Necropolis” hall: “pano view” from the Virtual Tour materials. (Ph. Gianluca Milasi). Note the “LOGES” tactile paving path set up by the project in the museum.



## Surveying and Cataloging

Over one hundred and fifty exhibits were surveyed with analytical photo–modeling techniques, reconstructed, and scientifically cataloged in a digital environment. The results, in terms of geometric precision and chromatic accuracy, are very satisfactory. The scaling and geometric verification of the models are carried out through the use of a calibrated tablet which contains 30 markers of known coordinates singularly distinguishable by 12–bit encoding (fig. 2). The

markers have different sizes, to be significant regardless of the shooting distance and to ensure rigorous verification of final residual errors. The precision obtained is firmly attested in a sub-millimeter range which makes the models themselves coherent with the 1:1 scale survey. From the chromatic point of view – a critical factor in consideration of the particular nature of the relieved objects – excellent results were obtained thanks to a controlled shooting environment and post-production of the photos, that included the ‘masking’ of non-essential elements for the restitution.

The use of high-resolution cameras leads to very accurate modeling, which permits to push the analysis of single the objects to a very high level of detail, significantly expanding the possible critical data collection in fractions of time, if compared with any direct analysis, and at a very higher level of security (fig. 6).

In many occasions it has been possible to extend the survey to the entire object surface (internal/external), making it the complete 3D analysis of the object immediately available, including the direct measurement of significant points of interest straight from the model, the automatic extraction of profiles, etc. (fig. 4).

After a pre-cataloging phase based on the use of QR-Code and historical inventory numbers, an actual catalog form has been compiled, compliant with the ICCD specifications (RA-3.00) which permit direct compatibility with national databases on cultural heritage (fig. 3).



Fig. 2. Votive altar, (aka "Ara della Fenice") upon the calibrated grid.



Fig. 3. Catalogue form on ICCD specification.



Fig. 4. Ortoprojection and perspective section of a red figure vase. (invent. 141437).

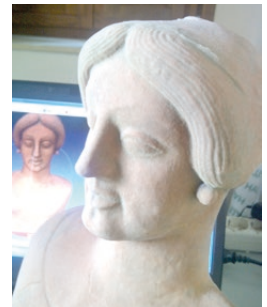


Fig. 5. Full color 3D print reproduction of a medean feminine bust.

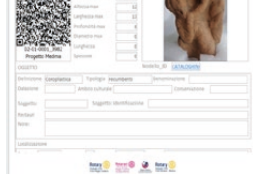


Fig. 6. 3D model (front) and a study of the actual deviations between the original point and the final mesh. "Overall surveillance" by a 5th century b.C. small Satyr bronze.



### 3D reproduction

Three-dimensional reproductions were made on one side to, somehow, replace certain important finds transferred to other museums and, partly, to be used in an interactive application for people with sensory disabilities, both through direct full-color 3D printing in real scale and through a more ‘traditional’ procedure of sculpting reproduction controlled by the digital model, used for larger objects that were “oversize” for the 3D printing available technology (fig. 6). The final results, in terms of geometric precision and color accuracy, are very satisfying.

### Sharing and WEB

A website has been created in a standard environment (WordPress) and permits to retrieve information about the museum, consult the multimedia catalog, and explore (or download, subject to proper authentication) the three-dimensional models at different resolution. Full-res. models in 3D/.OBJ format are available (millions of vertices point clouds, 100 Mb or more), but we are working on smaller size models (around 1 Mb) in the GLB format by resampling the textures to grant sharability over smartphone even at a very low band connection. We are also

Fig. 7. Medma touch, feel, think App. From RAI TG-R reportage. Special thanks to RAI journalist Giulia Bondi and to Marika Meduri, president of unsighted association of Reggio Calabria (app. tester).



formalizing a partnership with the IIf consortium to reach complete control over the distribution of patented 3D models. The site also provides a high level of multidisciplinary interactivity allowing specialists and scholars, through Wiki-type pages, to collaborate with the implementation of the descriptive part of the forms. Finally, it contains a complete virtual tour of the museum, which is currently being programmed to allow a direct visual consultation of the catalog.

### The Touch, Feel Think App

The core commitment of the project was addressed through the implementation of an application for unsighted persons, based on the use of high-resolution webcam and motion detection techniques that allow a completely hands-free approach. It starts with the 3D models (fig. 1, 7a, 7b, 7c). People approach the replicated object and touch it without any restrictions: the system recognizes the touch and plays a first general soundtrack which introduces the historical framing of the object, and afterward, if the exploration continues, gradually recognizes the parts that are progressively touched: the description can then continue in detail, giving an account of many details that can create curiosity and encourage a scientific deepening of the knowledge of the assets, as well as their contextual conditions. The whole process is developed in an authoring environment, by which the signals coming from the cameras through the definition of any number of sensitive areas (hot-spots) can be hierarchized and can lead to a really effective storytelling program. The system also implements directional ultrasonic loudspeakers, capable of containing noise pollution in the museum by limiting the sound flow to the single users. Feedback in application testing reported a very comfortable perceptual experience. The novelty of this approach lies in the alchemical engineering of standard technologies, widely available, but not yet applied in cultural heritage environments, to achieve shareable, but very effective, results at low cost. In this case, it is of great interest the integration between motion recognition technologies with the programmability of the software capable to create a single environment for authoring multimedia contents of high semantic value, dependent on the tactile interaction between the object and the blind perceiver; thus creating a real virtual/analog bridge independent of the technological mediator on the end-user side.

### Conclusions

The project is currently concluded in its prototype state and has already produced many positive feedbacks, even in this early stage, developing a profitable process that has brought together public institutions and private initiatives in a very effective synergy, characterized by a remarkable transversality.

One of the main results of this synergy was the positioning of the idea itself at the base of a further project included in the so-called 'Living-Lab Program', bottom-up initiatives financed by the European Community, directly arising from the territories as long as certain issues are perceived as strong, positive instances by the communities. A consortium has been therefore established between University and private companies for the industrialization of the prototype, within a more general enhancement action of the Museum and the Archaeological Park, that is taking shape in these very days.

The project, in this new phase, has led to the creation of an Association (ATS) between the PAU Department [3], which participates as a Research Body, and private companies active in the sector of protection, promotion, and safeguarding of cultural heritage.

In the future, we plan to integrate into the system motion sensors with capacitive proximity devices (NFC, etc.), also through the field testing of new sensors based on the very high transduction capacity derived from the use of Graphene materials in the surface treatment of analog 3D printed models, aimed at maintaining the hands-free approach that was greatly appreciated in the testing phase in a non-immersive environment.

Beyond the specific contents of this projects, and of the new ones, we strive to combine innovation, scientific rigorous approach, and enhancement of cultural heritage through an 'inclusive attitude', where the word 'inclusion' is purified of any declination linked to the idea of the 'due by law', or, even worse, to the one of 'charitable intervention'. Cultural inclusion, and generalized fruition capabilities, on the contrary, must be intended, as they are indeed, directly connected to the economic strengthening of initiatives and territories and a powerful drive for development. This approach presents itself immediately as highly sustainable, not just being self-financed, but, thanks to the strong idea of transparent (and inclusive) commonality of all the project revenues, it can directly function as a medium for the transfer of technological innovation (often invoked, but rarely actually implemented) and generates a condition that we like to call 'social empowerment'. The entire procedure becomes immediately shareable and the methodology can also be at disposal of "limited size" cultural institutions, such as small museums, or even private collection, which are, on the other side, often bearers of the highest historical and cultural values, particularly if, together with their hosting communities, they would reach to build some territorial networks of high local identity values.

#### Notes

[1] Rotary International – District IT-2100: D.G. 2014-2015 prof. Giancarlo Spezie; D.G. 2017-2018 dott. Luciano Lucania. Rotary and Rotaract Club Reggio Calabria and Nicotera-Medma. Special thanks to: arch. Salvatore Patamia, MIBACT; arch. Pietro Vicentini (Terna); ing. Giusseppe Fedele (UICI Reggio Calabria); Prof. Giuseppe Lacquaniti (Historian and Journalist).

[2] The Project has been carried out by a group of young resources selected by public evidence from the Rotaract area and the Mediterranean University: Angela Balestrieri, Gabriele Candela, Barbara Cusato, Giuseppe Cutrupi, Roberta De Clario, Fabio Panella, Danila Puntuniero, Verdiana Quattrocchi and Peppe Sorrenti. The operational coordination has been performed by Technical Tutors with consolidated experience: Antonio Gambino, Marilù Laface, Andrea Manti, and Roberto Prampolini for the web content.

[3] The 'EcoMedma' consortium consists of Ecolandia SCARL (Leading Company, Pres. Prof. Antonio Perna), The PAU Department of the Mediterranean University of Reggio Calabria (Research body, Dir. prof. Tommaso Manfredi), CADI SRL (Dir. ing. Piero Milasi).

#### References

Kimiko Ryokai (ed.) (2019). *Augmented Reality for Visually Impaired People (AR for VIPs)*. University of California, Berkeley, School of Information, MIMS Capstone Project Report.

Lacquaniti Giuseppe (2014). *MEDMA Colonia di Locri Epizefiri*. Tropea: Romano.

Lending Mari (2018). *Plaster Monuments: Architecture and the Power of Reproduction*. Princeton: Princeton University Press. 7

Manduchi Roberto, Kurniawan Sri (eds.) (2017). *Assistive Technology for Blindness and Low Vision*. Boca Raton (USA): CRC Press.

Minto Simone, Remondino Fabio (2014). Online access and sharing of reality-based 3d models. In *SCIRES-IT : Scientific REsearch and Information Technology*, 4 (2), pp. 17-28.

Orsi Paolo (1913). Rosarno Medma. Esplorazione di un grande deposito di terrecotte ieratiche. In *Notizie e Scavi di Antichità*, suppl., pp. 55-144.

Paoletti Maurizio, Settis Salvatore (eds.) (1981). *Medma e il suo territorio. Materiali per una carta archeologica*. Bari: De Donato.

Sudano Fabrizio (2019). Per un'archeologia dei culti nelle colonie locresi: gli spazi sacri di Calderazzo a Medma e del Còfino a Hipponion alla luce delle recenti scoperte. In *ASNp*, 5, 11/2, pp. 36-50.

#### Authors

Franco Prampolini, Dept. PAU – SuMMA Lab, Mediterranean University of Reggio Calabria, franco.prampolini@unirc.it

Dina Porpiglia, Operational manager of the project, dina.porpiglia@gmail.com

Antonio Gambino, Dept. PAU – SuMMA Lab, Mediterranean University of Reggio Calabria, antonio.gambino@unirc.it

