FUSION OF CULTURES

Abstracts of the XXXVIII Conference on Computer Applications and Quantitative Methods in Archaeology

Fco. Javier Melero, Pedro Cano & Jorge Revelles (Editors)

Granada, Spain
April 6-9, 2010
Edited and written by Francisco Javier Melero, Pedro Cano and Jorge Revelles, with contributions from José Luis Gutiérrez, Juan Gabriel Jiménez, Maria del Carmen Jiménez, y Sergio León

Front cover and logo designed by Jorge Revelles. 3D Lion model courtesy of the Council of the Alhambra and Generalife. Background photo courtesy of José Manuel Rabasco.

The authors are solely liable for the contents of their abstract.

---

Fusion of Cultures.

Abstracts of the XXXVIII Annual Conference on Computer Applications and Quantitative Methods in Archaeology, CAA2010.

ISBN: 978-84-693-0772-4
Depósito legal: GR 1114-2010

IMPRESO EN ESPAÑA –PRINTED IN SPAIN
Contents

Invited Talks ...................................................................................................................... 1

- Out of Asia: A New Framework for Dating the Spread of Agriculture in Europe
  Caitlin E. Buck ................................................................................................................. 3

- GIS Application to Archaeology: a critical view from a Spanish perspective
  Javier Baena ................................................................................................................... 4

- Visualization of CH Models: Seeking for Just Visual Quality or Also Informativeness?
  Roberto Scopigno .......................................................................................................... 5

Full Paper Extended Abstracts ......................................................................................... 7

➢ Recording, Interpretation and Evaluation of High Definition 3D Surface Data in Arts and Cultural Heritage, Archaeology and Anthropology ........................................ 9

- 3D Reconstruction and Visualization of a Roman Theater
  Chacón, R., Domínguez, V., Adán, A., Salamanca, S., Merchán, P. ................................. 11

- An Improved Algorithm for Reconstructing Artifact Model from Multiple-Range Scans
  Shui, W., Zhou, M., Wu, Z. ............................................................................................... 15

- Underwater 3D shape reconstruction by fringe projection
  Bianco, G., Bruno, F., Muzzupappa, M., Luchi, M.L. ....................................................... 19

- Documenting and Monitoring Small Fractures on Michelangelo’s David
  Bathow, C., Breuckmann, B., Callieri, M., Corsini, M., Dellepiane, M., Dercks, U., Scopigno, R., Sigismondi, R. ................................................................. 23

- Evaluation of Historical Coin 3D Models
  Hödlmoser, M., Zambanini, S., Kampel, M., Schlapke, M. ........................................... 27

  Meichelke, K., Schnelle, M. ........................................................................................... 31

- "FACE-R" 3D Database And Morphometrics For Facial Reconstruction
  Kustár, Á., Forró, L., Kalina, I., Fazekas, F., Honti, Sz., Makra, Sz., Friess, M. ................ 35

- Evaluation of Acquisition and Post-Processing Pipeline for 3D Models of Ancient Statues
  Hermon, S., Hadjicosti, M., Pilides, D., Ronzino, P., Pitzalis, D. .................................... 39

- Cylinder Seals Revealed
  Boon, P.J., de Vries-Melein, M. .................................................................................... 43

- 2D open-source editing techniques for 3D laser scans
  Olsen, M.J., Ponto, K., Kimball, J., Seracini, M., Kuester, F. ......................................... 47
• Methodology and Technology for Rapid Three-Dimensional Scanning of In Situ Archaeological Materials in Remote Areas
  Crane, E.R., Hassebrook, L.G., Begley, C.T., Lundly, W.F., Casey, C.J. .............................................. 51

• Arc3D and 3D Laser-Scanning. A comparison of two alternate technologies for 3D data acquisition
  Hermon, S., Pilides, D., Amico, N., D’Andrea, A., Iannone, G., Chamberlain, M. ................................. 55

➢ Databases .................................................................................................................................................. 59

• MUD-Museum UdgravningsData An Excavation database for the Danish Museums
  Meinertz, C. ............................................................................................................................................... 61

• Spatial Data Infrastructures and Archaeological Excavation Data: SILEX, the SDI of the Neolithic Flint Mine of Casa Montero (Madrid, Spain)
  Fraguas, A., Menchero, A., Uriarte, A., Vicent, J., Consuegra, S., Diaz-del-Rio, P., Castañeda, N.,
  Criado, C., Capdevila, E, Capote, M. ........................................................................................................ 63

• Spatial assessment of early human expansions using GIS and Database techniques: Examples from Southern Africa
  Märker, M., Schmidt, P., Hochschild, V., Kanaeva Z. .............................................................................. 67

• The hidden database
  Lund, K. .................................................................................................................................................... 71

➢ Analytical GIS and Spatial Analysis ...................................................................................................... 73

• Dynamic Models to Reconstruct Ancient Landscapes
  Kormann, M., Lock, G. ............................................................................................................................. 75

• In conspectu prope totius urbis: an application of different visual methods at the ager Tarraconensis landscape.
  Fiz, I., Gorostidi, D., Prevosti, M., Lopez, J., Abela J. ............................................................................. 79

• Integrative Distance Analysis: A Spatial Statistical Toolkit for Analyzing Complex Archaeological Datasets
  Clark, T.N. ................................................................................................................................................ 83

• Spatial analysis of the Bronze Age sites of the region of Paphos in southwest Cyprus with the use of Geographical Information Systems
  Agapiou, A., Iacovou, M., Sarris, A. ......................................................................................................... 87

• Observations of land use transformations during the Neolithic using exploratory spatial data analysis: contributions and limitations
  Pillot, L., Saligny, L., Moreau, C. ............................................................................................................. 91

• Archaeological Evaluation of Ground Disturbance Activities for Planning and Development in Patras, Greece
  Simoni, H. .................................................................................................................................................. 95

• Mashed up culture? interpretation, authenticity, technology and reinvention
  Morel-EdnieBrown, F.A. ....................................................................................................................... 99
New Technologies in Archaeological Museums ......................................................... 103

• Enhancing the experience
  Baeza, U., Barrera, S. ........................................................................................ 105

• Project Malmö 1692: a Didactic Resource in the Video Games World
  Dell’Unto, N., Wallergård, M., Eriksson, J. ....................................................... 109

• Digital Reconstruction and Immersive Exploration of the Entrance of the Ripoll
  Monastery
  Besora, I., Brunet, P., Chica, A., Moyés, J. ....................................................... 111

• Piloting Time-Tours: Experiences from the Development and Implementation of a
  Computer Based Exhibition in West Sweden
  Stenborg, P., Tornberg, J., Ling, J., Söderström, M., Sevara, C., Thuander, L. ......... 115

Human evolution, a long trip without end: The application of data recovery,
data management and computer analysis in Paleolithic sites .................................. 119

• Computer applications in the study of Paleolithic sites. Methodological approach to
  innovative methods and their use on earlier settlements
  Sanudo, P., Fernández, J., Vaquero, M. .............................................................. 121

• ArqueoUAB: A systematic archaeographic approach for the analysis of Palaeolithic
  sites
  Mora, R., Martínez-Moreno, J., Torre, de la, I. ............................................... 125

• Neumark Nord 2/2: Spatial Analysis of an Eemian open-air Site
  Klinkenberg, M.V. ............................................................................................ 129

• Assessing Changes in Palaeo-Coastal Morphology Using 3D Surface Modelling.
  Dresch, P.Z. .................................................................................................... 133

Refining Remote Sensing for archaeological environments: image processing
 techniques compared ............................................................................................ 137

  A State of the Art.
  Travaglia, A. .................................................................................................. 139

• Investigation of the Urban-Suburban Center of Ancient Nikopolis (Greece) through
  the Employment of Geophysical Prospection Techniques
  Sarris, A., Teichmann, M., Seferou, P., Kokinou, E. ........................................ 143

• Modelling the spatial distribution of Paleontological sites in the Makuyuni region,
  Tanzania
  Märker, M., Bachofer, F., Quénéhervé, G., Hertler, C., Saanane, C., Giemsch, L., Thiemeyer, H. ...... 147

• The potential of hyperspectral and multispectral imagery to augment archaeological
  cropmark detection: a comparative study.
  Aqdus, S.A., Hanson, W.S., Drummond, J. ..................................................... 151

New Technologies in Archaeology Higher Education ........................................... 155

• GIS as Geophysical Data Processor: Learning from the Ground Up
  Kramme, K.L. ............................................................................................... 157
- Multilayered Virtual Reality System for the Comparative Study of Measuring and Representation Methods of an Archaeological Site
  Lucet, G., Casas, A., Hernández, I. ................................................................. 161

- Cooperative Learning in Archaeological Projects for Higher Education
  Schramm, T., Acevedo Pardo, C., Farjas Abadía, M. ........................................ 165

- Teaching 3d-documentation in situ - ruins - example from Turku Finland
  Uotila, K. ....................................................................................................... 169

➢ Taking the Long View: Putting Sustainability at the Heart of Data Creation ......... 171

- EDNA II, Taking the Electronic Archive for Dutch Archaeology to the Next Level
  Wansleeben, M. .............................................................................................. 173

- Methodological keys for the acquisition and long-term use of photographic collections representing elements of Heritage
  Valle, J.M., Rodriguez, A. .................................................................................. 175

- Raising Standards: Creating Guides to Good Practice for the Archaeology Data Service and Digital Antiquity
  Niven, K. .......................................................................................................... 179

- Towards the Development of a Sustainable National Record: a View from Scotland.
  McKeague, P. .................................................................................................... 183

- Sustaining Database Semantics
  Kintigh, K.W. .................................................................................................... 187

➢ From New Generations of Web Services to Archaeological Knowledge .............. 191

- WikiBridge: a Semantic Wiki for Archaeological Applications
  Chevalier, P., Leclercq, E., Millereux, A., Sapin, C., Savonnet, M. .................... 193

- Towards the Web Process: Urbanizing the Archaeological Information System
  Djindjian, F. ..................................................................................................... 197

- ScotlandsPlaces: Accessing geo-spatially enabled archaeological and historical datasets
  Beamer, A., Gillick, M. ....................................................................................... 199

- A Web3D tool for online exploration of underwater sites
  Bruno, F., Bruno, S., Angilica, A., Muzzupappa, M., Drap, P. ............................ 203

- TOPOI2.0 – a Virtual Research Environment for Academics
  Lieberwirth, U. .................................................................................................. 207

- Challenges in the Archaeological ePublishing in the Context of the New Generations of Web Services
  Ștefan, D., Sirbu, V., Barnea, Al., Ștefan, M.M. ................................................. 211

- OF WORK “WITH” IN WORK “TOGETHER WITH”. The Impact of the GIS in the French Institution of the Archaeology
  Costa, L. ........................................................................................................... 215
• Knowledge Bases and Query Tools for a Better Cumulativity in the Field of Archaeology: The Arkeotek Project
  Roux, V., Ausseneac-Gilles, N. ................................................................. 219

• Cochasquí, Ecuador: A Multi-faceted Approach
  Baird, B., Okabe-Jawdat, E., Burbano, I. .................................................. 223

➢ Agent-Based Social Simulation in Archaeology ........................................ 227
  • Simulating social, economic and political decisions in a Hunter-gatherer group. The case of “Prehistoric” Patagonia.
    Barceló, J.A., Del Castillo, F., Mameli, L., Quesada, F.J.M. ................................. 229
  • Late Bronze Age Mediterranean Urbanism and Depth Map Software: The Cases of Ugarit (Syria) and Enkomi (Cyprus).
    Kontolaimos, P. ............................................................................................ 233
  • Norms in H-F-G societies. Grounds for agent-based social simulation.
  • Potentiality, Prediction, and Perception: Using Caloric Landscapes to Reconstruct Cognitive Patterns of Subsistence and Social Behavior
    Whitley, T.G. .............................................................................................. 241
  • Large-scale agent-based simulation in archaeology: an approach using High-performance computing
    Rubio, X., Cela, J.M. .................................................................................. 245

➢ Semantic Infrastructures in Archaeology ................................................. 249
  • A Very Short Introduction to the Semantic Web
    Isaksen, L., Earl, G., Martinez, K. ............................................................... 251
  • Methodology for CIDOC CRM Based Data Integration with Spatial Data
    Hiebel, G., Hanke, K., Hayek, I. ................................................................. 255
  • ArchaeoKM: Managing Archaeological data through Archaeological Knowledge
    Karmacharya, A., Cruz, C., Boocbs, F., Marzani, F. ....................................... 259
  • Semantic Technologies for Archaeology Resources: Results from the STAR project
    Binding, C., May, K., Souza, R., tudhope, D., Vlachidis, A. ....................... 263
  • Recent Developments in the ArcheoInf Project – Towards an Ontology of Archaeology
    Lang, M., Türk, H. ....................................................................................... 267
  • A Framework for Transforming Archaeological Databases to Ontological Datasets
    Hong Y., Solanki, M. ................................................................................ 271
  • Accessing, Visualizing and Annotating Geographical Information in Archeology
    Eckart, T., Förtsch, R., Kruse, S., Büchler, M. ............................................. 275
  • Atom Feeds and Incremental Semantic Annotation of Archaeological Collections
    Kansa, E.C., Elliott, T., Heath, S., Gillies, S. ................................................. 279
  • Interoperate with whom? Archaeology, Formality and the Semantic Web
    Isaksen, L., Earl, G., Martinez, K., Gibbins, N., Keay, S. ............................ 283
• Metadating: dates as complex information
  Johnson, I. ................................................................. 287

➢ 3D Scanning Case Studies ................................................................. 291
• Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia
  Patay-Horváth, A., Végvári, P. ............................................................. 293

• 3-Dimensional Documentation of the Hadrian’s Temple in Ephesus/Turkey
  Quatember, U., Kalasek, R., Breuckmann, B., Bathow, Ch. ............................................................. 297

• 3D Documentation in Architectural History: A case study of the 16th c. Church of Stavros tou Missirikou in Nicosia, Cyprus
  Solomidou-Ieronymidou, M., D’Andrea, A., Bakirtzis, N., Iannone, G. ................................................ 301

• Combination of Different Surveying Methods for Archaeological Documentation: the Case Study of the Bronze Age Wooden Chest from Mitterberg
  Hanke, K., Kovács, K., Moser, M. .......................................................... 305

• Terrestrial Laser Scanning for the Documentation of Archaeological Objects and Sites on Easter Island
  Kersten, Th., Lindstaedt, M., Meichelke, K., Vogt, B. ................................................................. 309

• Reconstruction of Exhibits of the Egyptian Collection at the Ethnological Museum in Hamburg, Germany
  Acevedo, C., Sternberg, H., Schramm, T., Wilhelm, J. ............................................................... 313

• Digital mediation from discrete model to archaeological model: the Janus Arch
  Ippolito, A., Borgogni, F., Pizzo, A. .......................................................... 317

• Digital mediation from discrete model to archaeological model: the Monumental Complex of Merida
  Senatore, L.J., Inglese, C., Pizzo, A. .......................................................... 321

• The Hill of Agios Georgios, Nicosia: 3D analysis of an on-going archaeological excavation
  Pilides, D., Hermon, S., Amico, N., Chamberlain, M., D’Andrea, A., Iannone, G., Ronzino, P. .... 325

➢ Image Processing and Rendering .......................................................... 329
• Vectorizing Hand-Drawn Vessel Profiles with Active Contours
  Hörr C., Kienel, E., Brunnett, G. .......................................................... 331

• Detection of Archaeological Features in Geophysical Images Based on Enhancement of Curvilinear Patterns
  Panagiotakis, C., Kokinou, E., Sarris, A. .......................................................... 335

• Text Detection in Ancient Manuscripts using Orientation and Frequency-Signatures of the Texture
  Garz, A., Sablatnig, R. ................................................................. 339

• A new CBIR technology to help reassembling moorish ornamental carvings
  Molina, F.J., Mora-Merchan, J.M., Barbancho, J., Leon, C. ........................................................ 343

• Improved gamma ton tracing technique using height field profile tracing
  Zhang, J.Y. ................................................................. 347
Analysis and Interpretation of Ancient Art ................................................................. 351

• The Digital Sculpture Project: Casting light on ancient sculpture with new 3D technologies
  Koller, D., Frischer, B. .............................................................................................................. 353

• Interactive Visualization of the House of the Vettii and the House of the Tragic Poet in Pompeii
  Cole, K., Fredrick, D., Merced, J., Newberry, R. .................................................................. 357

• Mapping the senses: Perceptual and social aspects of Late Antique liturgy in San Vitale, Ravenna
  Paliou, E., Knight, D.J. ............................................................................................................. 361

• Modeling Hypotheses in Pompeian Archaeology: The House of the Faun
  Dobbins, J. J., Gruber, E. ........................................................................................................... 365

• A Formal Language for the Description of Historic Architectural Elements
  González-Pérez, C., Blanco-Rotea, R., Mato-Fresán, C., Camiruaga-Osés, I. ......................... 369

Quantitative Methods in Archaeology ................................................................. 373

• Web based statistical data processing
  Heinz, G., Mees, A.W. ............................................................................................................... 375

• Gappy Data Reconstruction and Applications in Archaeology
  Stephan, R., Carlb erg, K. ......................................................................................................... 379

• Information entropy for archaeological research
  Laužikas, R. ............................................................................................................................ 383

• Sexual Size Dimorphism: A Test of Methods
  Jiménez-Arenas, J.M., Esquivel, J.A. ..................................................................................... 385

Archaeological Architecture: a challenging fusion of scientific cultures .............. 389

• Archaeological Architecture: a challenging fusion of scientific cultures
  Bianchini, C., Mateos Cruz, P. .................................................................................................. 391

• Virtual Roman Leicester (VRL): An interactive Computer Model of a Romano-British City
  Cawthorne, D., Watson, G., Hugill, A. .................................................................................... 395

• Democratization of 3D applications in Archaeology. A case of study: The Roman Dam of Muel (Zaragoza).
  Angás, J., Uribe, P., Magallón, M.A. ..................................................................................... 399

• The Figure of the Architect-Archaeologist. The Bauforschung, the Realization of the Model and the Anastylosis of Ancient Architecture
  De Mattia, D. .......................................................................................................................... 403

3D Modelling and Virtual Reconstructions ............................................................... 407

• The Tower of Hercules: A walk through time and space
  Noya, R., Otero, A., Goy, A., Flores, J. .................................................................................... 409
• Virtual Archaeology and Scientific Communication  
  Gómez, J.L., Alonso, M.A. .......................................................... 413

• Virtual Windows to the Past: Reconstructing the ‘Ceramics Workshop’ at Zominthos, Crete  
  Papadopoulos, C., Sakellarakis, Y. ........................................... 417

• Illuminating Historical Architecture: The House of the Drinking Contest at Antioch  
  Gruber, E., Dobbins, J. ................................................................. 421

• The Church of the Charterhouse of Miraflores in Burgos: Virtual reconstruction of an artistic imaginary  
  Bustillo, A., Martínez, L., Alaguero, M., Iglesias, L. S. .................. 425

➢ Issues in Least-Cost Analysis ...................................................... 429

• Theory and Practice of Cost Functions  
  Herzog, I. .................................................................................. 431

• Cost-Distance Histograms and Their Use in the Study of Ancient Architecture  
  Hacıgüzeller, P. .......................................................................... 435

• On the road to nowhere? least-cost paths and the predictive modelling perspective  
  Verhagen, P. ............................................................................. 439

• Time geography, GIS and archaeology  
  Mlekuž, D., Vermeulen, F. .......................................................... 443

• Least-Cost Kernel Density Estimation and Interpolation-Based Density Analysis Applied to Survey Data  
  Herzog, I., Yépez, A. ................................................................... 447

➢ Integrating and Comparing Technologies for Archaeological Applications ................. 451

• An Introduction to Computational Epigraphy – Methodology of using Computational Algorithms for deciphering Archeological Texts  
  Rajendu, S. ................................................................................ 453

• Finding the Language of Stereoscopic Technologies for Archaeological Sites and Artefacts  
  Georgiou, R. ............................................................................... 457

• Integrating 3D data acquisition techniques for comprehensive study of the ancient Hellenistic-Roman Theatre of Paphos, Cyprus  
  Amico, N., Angelini, A., D’Andrea, A., Gabrielli, R., Iannone, G. ........ 461

• Towards an integrated platform for urban planning rescue archaeology and public inclusion  
  Hermon, S., Kaptzan, I., Vassallo, V. .......................................... 465

• Vector 3D Mapping and Visualization Techniques for Multi Story Structures in Montezuma Castle National Monument  
  Trigoso, E., Holmlund, J., Nicoli, J., Scott, R. .............................. 469

• Western Han Dynasty Mural Tombs: from the use of integrated technologies to the cybermap  
  Di Giuseppantonio Di Franco, P., Galeazzi, F. .............................. 473
• Spatial data for large size archaeological projects – an example
  Cramer, A., Heinz, G., Müller, H. ........................................................................................................ 477

• Methodologies and techniques for the reconstruction of ancient architectures
  Vico, L., Vassallo, V. ................................................................................................................................ 481

• Combining photogrammetric survey and 3D laser scanner of archaeological remains. First campaign in the Alberca Rota and Pozos Altos of the Cerro del Sol archaeological site at the Alhambra

• Towards the Collaborative Algorithmic Rendering Engine (CARE) Project
  Mudge, M., Rusinkiewicz, S., Ashley, M., Schroer, C. ......................................................................... 489

➢ 3D Information Systems. Documenting the Past ................................................................. 493

• Discourse on the Use of a 3D Model as a Record of Excavation.
  Avern, G.J. ............................................................................................................................................. 495

• A novel approach to 3D documentation and description of archaeological features
  D’Andrea, A., Lorenzini, M., Milanese, M. .............................................................................................. 499

• 12 years of archaeological data digital registry at the Santa Maria Cathedral of Vitoria-Gasteiz (1997-2009)
  Koroso, I., Muñoz, O. ............................................................................................................................... 503

• Model of sources: a proposal for the hierarchy, merging strategy and representation of the information sources in virtual models of historical buildings
  Fernando de Fuetes, A., Valle, J.M., Rodríguez, A. .................................................................................. 507

• ELKowmGIS: A New Program for the Documentation of Archaeological Sites
  Schuhmann, D., Le Tensorer, J.M. ........................................................................................................... 511

• Perspectives of a True 3D Visualisation and Measuring System in Archaeology
  Stuber I., Szenthe G., Korom C., Varga Z., Szabó L., Eleki F., Eleki N. ................................................... 515

• Approaching 3D Digital Heritage Data from a Multitechnology, Lifecycle Perspective
  Limp, W.F., Payne, A., Winters, S., Barnes, A., Cothren, J. ......................................................................... 519

• Integrated system for the study and management of the historical buildings
  Parenti, R., Vecchi, A., Gilento, P. ............................................................................................................. 523

➢ GIS Application ................................................................. 535

• Geospatial Characterization of Archaeological Sites in La Serena Region (Badajoz) by Direct Methods (DGPS): Capturing and Analyzing Data.
  Martínez, J.A., Uriarte, A., Mayoral, V., Pecharramón, J.L. ................................................................. 537

• Getting Answers the Easy Way - Intrasis Explorer and Intrasis Analysis
  Jansen, J. ............................................................................................................................................... 541
• GIS Applications in Developing Models of Rock Art Protection in the Valencian Community
  Hernández, M.S., García, G., Barciela, V., Molina, F.J. ................................................................. 543

• Excavation in Grumentum-South-Italy: GIS and Photogrammetry; application of 2D and 3D
  Thaler, H. ........................................................................................................................................ 547

• The management of archaeological information at the site of Vascos (Navalmorallejo, Toledo): Approach, data integration and representation in an intra- and intersite model
  Sánchez, I., Varela, A., Bru, M.A., Iniesto, M.J., Izquierdo, R., de Juan, J., Carballo, P. .................. 551

➢ Open Source in Archaeology ........................................................................................................ 555

• Free and Open Source Software in archaeological research processes: an application to the study of African Red Slip Ware in Northern Italy
  Costa, S. ........................................................................................................................................... 557

• Aramus Excavations and Field School. Experiences in Using, Developing, Teaching and Sharing Free/Libre and Open Source Software
  Bezzi, A., Bezzi, L., Gietl, R., Heinisch, S., Kuntner, W., Naponiello, G. ........................................ 561

• Open Source Software in Archaeology: beyond passive users
  Costa, S., Bianconi, L., Pesce, G.L.A. ............................................................................................. 565

• An Experiment of Integrated Technologies in Digital Archaeology: Creation of New Pipelines to Increase the Perception of Archaeological Data

➢ 3D Databases ................................................................................................................................ 571

• Reconstruction 3D Model of Chinese Ancient Buildings Basing on Components Database
  Ru, W., Mingquan, Z., Yuhua, X., Xuesong, W. ............................................................................... 573

• A procedural approach to the modelling of urban historical contexts
  Pescarin, S., Pietroni, E., Ferdani, D. .............................................................................................. 577

• WILD-GOAT. Towards a virtual “Corpus Vasorum” of wild-goat style vessels of museum collections
  Damnjanovic, U., Hermon, S., Coulie, A. .......................................................................................... 579

• 3D Shape Matching and Retrieval for Archaeological Analysis
  Jiménez, D., Ruiz, S. .......................................................................................................................... 583

Short Paper Abstracts ...................................................................................................................... 587

Poster Abstracts ............................................................................................................................... 699

Authors Index ................................................................................................................................. 733

Traviglia, A.
Dept. of Ancient History, Macquarie University, Sydney, Australia
Arianna.traviglia@humn.mq.edu.au

1. Introduction

Since the introduction of multispectral and hyperspectral remotely sensed data in archaeological investigation, the significance and the implications of the image processing activity have been clear to archaeologists employing remote sensing in their research activity.

Image processing, by improving the quality or the contrast of the image or transforming it in a new set of images where relevant information can be more easily detected, often produces results far more useful than the ones that visual analysis of the original, raw data guarantee, providing an enhanced visualization of the studied landscapes and promoting the recognition of not yet identified ephemeral archaeological marks.

In the past 20 years a consistent part of the projects involving the use of multispectral and hyperspectral data have included image processing as part of their routines activities in preparatory steps before under-taking visual analysis and interpretation.

The extensive use of a vast range of techniques, however, does not translate yet into a coherent methodological strategy for the application of this important set of practices to particular archaeological situations and environments and their application is often left more to attempts than being planned and targeted. Consequently, despite the high potential offered by the enhancement and transformation of digital images, the adopted approach subsides often to a series of well-established, routine techniques that often do not consider fully the characteristics of a territory or the peculiarities of each portion of it.

The present paper will cover the use of both the most commonly adopted image processing methods and the ones that, although not frequent, have produced relevant outcomes, and it will try to analyse the strength of the different techniques, the bias and issues encountered in their implementation, the ambi's and the physical environments in which they can be better used and exploited.

2. Defining a work strategy

It is unquestionable -and long accepted- that it is impossible to define a priori what type of image processing will provide the best results for archaeological research. It is also well recognized and quite obvious that the results that have been reached in a specific landscape context are peculiar to that ambit only and to such a determinate spatio-temporal situation and that different outcomes could be achieved applying similar processes to other areas (even similar ones).

Nevertheless this does not prevent researchers from planning accurately a strategy for implementing the best and most suitable image processing techniques that apply to specific factors like, for example but not limited to, type of environment (crop land, bush land, bare soil, sandy soil etc), morphologic characteristics of the landscape, specific goals of the research (e.g. identification of quarries by searching for the concentration of a rock type) etc.

Thus, for example, in a territory that is mainly devoted to agriculture a large application of Vegetation Indices (VI) should be necessarily planned, but these should be selected on the basis of the defining characteristics of the fields, which are often not homogeneous: next to fields where the crops are dense and thick, where DVI or NDVI can work effectively, there could be fields less productive with a different, looser plant density, where the reflectance of the soil introduces a significant bias on the overall pixel reflectance. Consequently, in those situations it
be-comes necessary to apply Vegetation Indices that take this factor into consideration (e.g. SAVI or MSAVI2).

Like the density of crops and vegetation, it is necessary to tackle beforehand many other aspects of the target landscapes, like the morphological, ecological, seasonal ones or even particular situations related, for example, to the presence of shades on imagery: all these conditions in fact can alter significantly the spectral content of the pixels.

Consequently the recognition of a targeted set of procedures should become the gateway of a remote sensing analysis rather than applying the same image processing as standard practise on vast territories with no real connection with the investigated landscape.

It is sometime hard to judge, based on the current literature devoted to the topic, the level of improvement of the features visibility given by image processing. This is mainly related to the fact that we mostly tend to speak about our successful research, forgetting that even information on the failure of a technique or of an approach can be really valuable in the advance of the archaeological application of the discipline. Thus, in perusing the by now vast bibliography on the subject, one gains often the impression that all the applied image processing techniques multiply exponentially the capacity of features identification, but this is not always reflected in the exponential growth of number of identified and recorded features.

That the application of image processing techniques is always successful is not possible or credible. There is doubtless a bias introduced by the fact that most of the articles on the subject (frequently restrained to a short number of pages allowed by Proceedings) deal more with technical aspects illustrated by few examples than with overall statistics on the number of detected features, so the real impact of image processing is simply not described. Nonetheless, a lack of quantification of the obtained results makes it hard to judge in the right perspective the adequacy of an application, its effectiveness and the level of improvement it can guarantee if compared to the raw data or other similar procedures.

3. Image processing: a brief resume of common and less common techniques

Among the most common procedures adopted in archaeological remote sensing Vegetation Indices, Classifications, Ratios, Principal Component Analysis (PCA) and Tasselled cap Transformation (TCT) are to be included. These methods of processing have been adopted since the 80’s (or in few sporadic cases even before) and exerted to different types of remotely sensed data, including Landsat, ARIES, ASTER and more recently Quickbird and Ikonos, among the most common.

3.1. Assessing vegetation quality: Vegetation Indices

Vegetation Indices find wide application in the archaeological research, since studies about the quality of the vegetation, monitoring deviations in its vigour, can enable the detection of subterranean archaeological deposits that promote or, on the contrary, reduce the development of the vegetation.

The largest part of the archaeological researches involving the use of VIs has entailed primarily the use of the Normalized Vegetation Index (NDVI) (CHALLIS, HOWARD 2006, ESTRADA-BELLI, KOCH 2007, LASAPONARA, MASINI 2006), especially when using hyperspectral data (EMMOLO et al. 2004, MEROLA et al. 2005).

Such use, however, appears in certain cases to be more dictated by conventions than from the conviction that it represents the most appropriate process in the given circumstances, based, for example, on the particular environmental and morphological characteristics of the target site. In spite of its common adoption over every type of environmental conditions, other VIs (namely RVI, DVI, MSAVI2, to cite some) have demonstrated better results for archaeological purposes (MEROLA et al. 2006, TRAVIGLIA 2005). In those cases the vegetation coverage type, the density of the canopy or other more complex factors have been preliminarily taken in consideration when selecting them as the most appropriate processes to evaluate the biomass of a certain area. Such factors in fact can strongly affect the results of the process itself.

This process selection activity tailored to the landscape cannot always ensure by default successful results (TRAVIGLIA 2005) but can support avoiding inevitably incorrect outcomes delivered by mistaken assumptions.

3.2. Classifications

Another largely applied image processing technique is classification, in the forms of supervised and unsupervised. Since the beginning of the image processing activity related to archaeology, researchers have tried to automatically extract meaningful information from the imagery by correlating spectral content with distinctive archaeological features through the clustering of sets of pixel with similar spectral characteristics (one of the first examples dates back to the 70’s. HAMLIN 1977).

Classification devoted to recognise a specific spectral response characterising archaeological features, however, seems to fail to fulfill completely the expectations and to deliver invalid and
questionable results in archaeological applications, (BECK 2007, TRAVIGLIA 2006), largely less rewarding than the successful results for other classes of materials in different disciplines (geology, for example). Where classification can instead support effectively the archaeological research is in locating environmental settings with similar characteristics, e.g. types of soil or other environmental variables, whose presence can be correlated to archaeological sites (CUSTER et al. 1986).

3.3. Principal Component Analysis

Principal Component Analysis is another highly implemented image processing techniques (ALTAWEEL 2005, ESTRADA-BELLI et al. 2007, GIARDINO, HALEY 2006, to mention a few). This is due to the fact that the application of the PCA to archaeological study can be of great utility since it may provide in many cases supplementary information compared to the original bands and allows a better discrimination of different surfaces that become more distinguishable in visual analysis.

Despite the recognizable advantages obtainable applying the PCA, it is rarely stressed that many details that are visible analysing singularly the original bands cannot always be recognized in the PCs -single components or composites- because they are covered by the overlying information from other bands. Consequently in specific cases, e.g. when dealing with hyperspectral data, improved outcomes in terms of detectable features can be achieved through the computation of spectral subsets, referred as SPCs (Selective Principal Components): these are obtained through a PCA computed for groups of bands, detected by a single spectrometer of the sensor or belonging the same spectral region (MEROLA 2005, TRAVIGLIA 2005).

3.4. Tasselled cap Transformation

Quite considerable potential has been shown by the recourse to the Tasselled Cap Transformation. The TCT is a linear transformation of bands that defines a new coordinate system in terms of which the soil line and the spectral region of vegetation are more clearly represented. After performing TCT, the majority of information is contained in few components or “features”, directly related to physical scene characteristics. Brightness axis is associated with changes in the soil background reflectance. Another “feature”, the Greeness, is closely orthogonal to brightness and is a contrast between NIR and visible bands: this means that it is correlated with variations in the vigour of green vegetation and related to the amount present in the scene. The Wetness axis provides information about the level of humidity of the soil. The implications of the use of the Tasselled Cap in archaeological research appear clear: contributing in identify humid areas, ancient riverbeds, artificial and natural canalisations etc. this transformation concurs to reproduce the hydro-morphologic conditions of the ancient landscape (BRIVIO, et al. 2000, RICHASON, HRITZ 2007, WILLIAMSON et al. 2002).

3.5. Even more processes...

Filters and Stretches are common methods to highlight and enhance tonal variations between neighbouring pixels and have found vast application over a variety of spectral data. Edge enhancement filters have been lately quite efficiently used (DE LAET 2007, LEUCCI et al. 2002) in several projects.


The list of other image processing techniques includes more methods (HIS transform, Brovey and Fourier transformations, data fusion etc), bringing the total amount to several tens of applied techniques. This fact is sufficient to understand that due to the high number of possible applicable methods some sort of pre-selection must be applied in advance. The choice can be affected by several factors embedded with the research program and has to be driven by landscape characteristics and the goals of the project.

References


CUSTER J.F., EVELEIGH T., KLEMAS V., WELLS L., 1986. Application of LANDSAT data and synoptic


