Evaluating Reflectance Transformation Imaging (RTI) for Enhanced Visualisation of Artefact Surfaces

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Reflectance Transformation Imaging (RTI)

- Method of structured light photography
- Digital images taken of target object with camera in fixed position; illumination applied systematically from different locations
- Multiple captures combined to produces interactive, relit records of surface
- Improved visualisation, archival record, conservation tool, preservation method
  - Legibility, material surface details
- First algorithm for photo amalgamation developed by Tom Malzbender et al. of HP labs in 2000: Polynomial Texture Mapping (PTM)

RTI examples
(Egyptian stela, Roman lead curse tablet)
RTI Methods

1. Lighting dome RTI
   - Fixed camera
   - Light array
   - Computer controlled capture

2. Highlight-based RTI (H-RTI)
   - Fixed camera
   - Handheld light source
   - Reflective spheres
   - Optional computer control
   - 36-60 exposures sufficient

See Cultural Heritage Imaging’s Guide to Highlight Image Capture

RTISAD dome setup in Oxford and the British Museum

Highlight RTI setup in Oxford
RTI Lighting Dome Example

• RTISAD design (Earl et al. 2011)
• Plastic dome in four quarters
• 76 LEDs
• Nikon D3x camera (24.5 megapixel resolution), with 105mm, 50mm and 35mm lenses
• Dome capture: c.5 min., image amalgamation into PTM file: c.1 min.

RTISAD dome with quarter removed to reveal LEDs (above), preparing to image a shabti (below), setup in British Museum stores for imaging Vindolanda tablets (left)
RTI for Conservation

Dome setup in British Museum

Roman mummy portrait, Fayum, Egypt, AN299549001, © Trustees of the British Museum
Reflectance Transformation Imaging for Conservation

• Non-destructive acquisition of data
• Clear representation of 3D shape
• Better discernment of surface detail than direct physical examination
• Enhanced visualisation through interactive viewing tools
• No data loss from shadows and specular highlights
• Higher resolution on the object surface than obtainable with 3D scanners
• Data sharability

Highlight RTI (H-RTI) in Museum Contexts

Horizontal setup, Neues Museum and Papyrus Sammlung stores, Berlin

Vertical setup, University of Pennsylvania Museum, Philadelphia
Highlight RTI (H-RTI) in Field Contexts

Documentation of portable artefacts during excavation

Documentation of fixed outdoor surfaces (Old Kingdom tomb inscription, Aswan, Egypt)
RTI Capture Sequence
Fitting H-RTI Captures

See Cultural Heritage Imaging’s Guide to Highlight Image Processing
RTI with Other Techniques

• With flatbed scanning
  • Cuneiform tablets, lighting requirements of stylus vs. seal impressions
• Structure from Motion
• Laser Scanning
  • MacDonald, L. 2011

RTISAD setup in Ashmolean Museum, Oxford
Case Study on Egyptian Vessel Fragment

Setup at Liverpool World Museum, vessel fragment 1977.112.296
Recording light position

Reflective spheres in left side of frame for recording light position

Blended image shows highlights from flash
Documenting Graphical Practice

- RTI reveals complex process of image making / inscription
  - Tool use
  - Ductus
  - Scribal habit

Evenly-it digital photograph of incised gneiss(?) vessel fragment, c.2800 BCE, WML1977.112.296
Pros and Cons

**Dome Pros**
- Artefacts in quantity
- Fast capture and processing speed
- Precision (some metric information possible)

**H-RTI Pros**
- Accommodates variable target sizes
- Orientation (vertical, horizontal, etc.)
- Field as well as museum use
- Easier integration into teaching and learning

**Dome Cons**
- Size restriction
- Fixed distance from object
- Restriction on object orientation
- Less portable
- Cost

**H-RTI Cons**
- Slower capture and processing
- Less precise (less potential for extraction of metric data)
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