A new dimension in Fine Art (re)production

Prof. dr. ir. Jo Geraedts
A new dimension in Fine Art (re)production

- Technical Partners (TU Delft)
  - Prof.dr.ir. Pieter Jonker
  - Dr.ir. Boris Lenseigne
  - Prof.dr. Joris Dik
  - Tim Zaman, MSc
  - Willemijn Elkhuizen, MSc

- Data Visualization Partner (Océ 3D Fine Art Reproduction)
  - Prof.dr.ir. Jo Geraedts
  - Ing. Wim Verhofstad

- Museum Partners
  - Mauritshuis
  - Kröller-Müller Museum
  - Rijksmuseum
Content

- Paintings and reproductions
- 3D scanning
- 3D reproduction
- Feedback on reproductions
- Creating new 3D artworks and graphics
‘What is a painting?’
Is this a painting?

No, it’s a 2D image of a painting
Paintings

The artistic explanation of a Painting

A painting is a **3D landscape of paint.**

**The texture/relief adds** just as much to the uniqueness of a painting as **the composition.**

**We visually perceive these indirectly;** by the way light is reflected from objects. The illumination, object shape, and the reflectance contribute to the shading pattern that reaches the retina.

Painters understand this process.
Van Gogh applied paint in an *impasto* way, creating additional shadows and highlights in his work.
Paintings and Reproductions

The technical explanation of a Painting

- Paint is a compound of binder (as medium) and pigment (as colorant).
- A painting is made out of deposits paint, applied on a planar surface. Often coated with glossy varnish.

![Diagram of a painting structure]

Paint is a compound of binder (as medium) and pigment (as colorant). A painting is made out of deposits paint, applied on a planar surface. Often coated with glossy varnish.
Paintings and Reproductions

The (Current) Reproduction

- Current reproduction techniques don’t capture the physical presence of a painting

Google art project

Posters
Content

- Paintings and reproductions
- 3D scanning
- 3D reproduction
- Feedback on reproductions
- Creating new 3D artworks and graphics
Research objective 3D scanner

- ‘Design of a topographical imaging device for the near-planar surfaces of paintings’

  For the purpose of moving towards a non distinguishable* reproduction.

  Because:
  This goal can only be achieved if the material aspect of the painting is thoroughly understood:

  ‘What makes it look the way it does?’

*to a regular observer
Design Requirements 3D Scanner

- Non invasive, portable
- Size (XY) 2 x 2 m
- Depth (Z) ± 20 mm
- Resolution 500 ppi (50 μm/pixel)
- Color Accuracy ΔE conform guidelines

[1] Human eye’s effective resolving power at 75 cm
Main Challenges for 3D Scanner

- Very small depth versus plane-size ratio
- High spatial resolution
- Simultaneously capture depth and color
- Large dynamic range in color intensity
- Varnish induces specular reflections
Depth Perception Methods

I. Stereo Vision (passive method)

II. Fringe Projection (active method)

We developed:

Hybrid: Fringe Projection & Stereo Vision
Stereo Vision

- Similar to that of the human eye
- Camera calibration very important

**Pro’s**
- Passive method.
- Very accurate on ‘salient’ points -> characteristic features
- Excellent color reproduction

**Con’s**
- Dependent on good ‘saliency’
Fringe Projection

- Profilometric approach
- Requires a projector and a camera

**Pro’s**
- Independent of projector resolution
- Complete data map (active method)

**Con’s**
- Relative coordinates
- Phase unwrapping problem
- Harmonic artifacts
Hybrid: Fringe Projection & Stereo

- Use the projected phase image to aid dense stereo matching
Practical Tests

Overview

• Selected paintings (in order of scanning):
  • *Self-Portrait*, Rembrandt (1669), Mauritshuis
  • *Flowers in a Blue Vase*, Van Gogh (1887), Kröller Müller Museum
  • *Jewish Bride*, Rembrandt (c. 1667), Rijksmuseum
Practical Tests

- **Problem area:**
  - Dark surface.
  - Fluctuations in background illumination.

- **Solution:**
  - High dynamic range capture.
  - Account for background lighting fluctuations.
Practical Tests

cross section

Y (mm)

depth (micron)

Y (mm)

x (mm)

x (mm)
Practical Tests

Flowers in Blue Vase, Van Gogh, Kröller Müller Museum
Practical Tests

The Jewish Bride, Rembrandt, Rijksmuseum
Challenge the future
Content

- Paintings and reproductions
- 3D scanning
- 3D reproduction
- Feedback on reproductions
- Creating new 3D artworks and graphics
3D Fine Art Reproduction

Capture

Processing

3D Printing

Original

3D Fine Art Reproduction

Challenge the future
Content

- Paintings and reproductions
- 3D scanning
- 3D reproduction
- Feedback on reproductions
- Creating new 3D artworks and graphics
Feedback on reproductions

Expert feedback

- Reproductions were compared to original paintings
- Gathered feedback from museum experts
Feedback on reproductions

Expert feedback

- **Texture**
  - Impressive addition to a print
  - Impasto adds depth effect
  - Edges not crisp/sharp

- **Colour**
  - Mismatch in color, i.e.
    - Jewish Bride - dress too red
    - Self-portrait - background too green, black not intense enough
  - Resolution of color - at close range you can see the pixels
Feedback on reproductions

Expert feedback

- **Gloss**
  - Gloss too uniform
  - ‘Plastic’ look
  - Self-portrait – overall gloss comparable to painting

- **Transparency**
  - Jewish bride – transparency of lacquer is missing in the dress
  - Self-portrait – contrast between ground layer and paint is too high
Future research

- Characterize **texture**
- Improve **color** capture and printing procedure

- How to measure & print **gloss**
- How to measure & print **layers** & **transparency**

- How to create **reconstructions of paintings**
  - Recreate original color
  - Recreate missing pieces

Sample to scan and print texture

Current digital reconstruction of color @ Van Gogh, My Dream Exhibition
Applications of Fine Art reproductions

Expert feedback

- Commercial product
- Overview exhibitions
- Education in museums
- Use in restoration studies
- Print reconstructions
- Use data to make a condition report (when painting travels)
- Replace missing pieces in a painting?!
Challenge the future

Is there more?
Content

- Paintings and reproductions
- 3D scanning
- 3D reproduction
- Feedback on reproductions
- Creating new 3D artworks and graphics
High Resolution 3D printing

Replication

Creation
Graphic Designs Reproduction

Design  Processing  3D Printing

Original

3D High Resolution Reproduction
Applications in Art & Design

• Add texture to surface designs
  • To decorate
  • To add information

• Add texture to digitally created art
How to create High Resolution 3D

- Plug-in for Adobe Illustrator (developed by Océ)
- Elevation layer -> gray level bitmap indicating the relative height
  - E.g. use gradients and patterns
- The design + the elevation layer combined into 1 file
Viewer: Interactive design process
You can do it.
High Resolution 3D design printed by Océ?

• Designers can upload the High Res 3D designs to Océ

• Océ will send a quotation based on the specific file and requested media and dimensions

• Upon order, Océ will produce the requested number of prints

Low entrance barrier!
Join the early adapters

• Visit the booth

• Location: Klokgebouw, Strijp hall 2, booth 4

• For information: stephan.koopman@oce.com
Thank you