IMAGE ENHANCEMENT CHALLENGES

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Introduction

A number of engineering applications of signal processing algorithms involve the enhancement of an impaired signal, e.g. separating a desired signal from an additive interferer or neutralizing the effect of undesired filtering. Such signal enhancement problems are also common in art historical analysis of painted images.

Deciphering x-rays that display at each pixel the accumulation of effects, in this case of attenuation, of various layers of the object through which the radiation travels prior to its measurement is one example. With a desire to enhance a painted over image revealed by an x-ray, the removal of x-ray absorbing effects of paints used in the surface image would help reveal the radio-absorbent portions of the underpainting. The surface and underpainting image effects on the x-ray can be viewed as a combination we wish to separate, given a template for the surface image from a color photograph, which is not an exact map of the radio-absorbency of the surface painting.

In engineering such signal separation tasks can also be tackled in a blind mode, i.e. without the second related signal. For example, since the introduction of the use of x-rays on paintings, the desire has existed for an image enhancement procedure that removes the "shadow" of the wood stretcher, along with the detail of its grain, for which there is no template, or second signal, as there is of the surface image in considering the enhancement of an x-ray to reveal an underpainting.

Another blind signal separation, or decomposition, task in art historical painting analysis is a desire to understand the artist's technique in terms of the sequence of application of marks on the canvas. Can the final painting with its color, texture, and chemical compositon clues revealed by various images be sequentially deconstructed?

Frequently the reverse of signal separation is an objective in art historical painting image analysis. The overlay of x-ray and infrared images with the surface image can reveal invaluable information aiding the conservator in making precise repairs to paint loss and damage. The challenge here is that the images from different spectral bands do not necessarily contain the same landmarks, which complicates the subsequent registration task.

This document provides a description of specific challenges, for which high quality data is available to selected academic teams of researchers, covering all of the types of issues mentioned above.

Revealing Painting Beneath F583

The x-ray and the infrared reflectograph of the painting

- F583 :: "Patch of Grass", 30.8 x 39.7 cm (H x W), April-June 1887

in the collection of the Kröller-Müller Museum each reveal a woman's head oriented at a 90° angle to the surface landscape. The woman's head in the underpainting of F583 is similar to paintings from Neunen, such as F154 "Head of a Peasant Woman with a Brownish Cap" in the Kröller-Müller Museum collection. The challenge is to enhance the x-ray image to increase the readability of the radio-absorbent paints in the original painting and to enhance the infrared reflectograph reproduction to increase the readability of its preparatory underdrawing using materials containing carbon.

The enhanced x-ray and infrared images can be seen as a complement to recent results in reconstructiong the underpainting in F583 from x-ray fluoresence image processing described in Dik, Janssens, Van Der Snickt, van der Loeff, Rickers, and Cotte, "A Lost Painting by Vincent van Gogh Visualized by Synchrotron Radiation based XRF Elemental Mapping", May 2008. A copy of this report can be obtained from its first author (Joris Dik, `j.dik@tudelft.nl`).

Deconstructing Pollock

Two Jackson Pollock paintings

- "Full Fathom Five", 129.2 x 76.5 cm, 1947
- "One: Number 31", 269.5 x 530.8 cm, 1950

in the collection of the Museum of Modern Art in New York City provide rectangular excerpts (drawn from across each painting and comprising 10 to 25% of the painting surface) for mark sequence assessment. A difference in method and materials can be noted in comparing details from these two paintings only three years apart. For

example, in the later painting, Pollock had shifted to a more absorbent ground which leads to paint marks that soak into the support. Plus, the earlier painting appears to employ a more complex range of subpatterns than the later painting.

The image processing technique sought would be one that was able to identify which strokes preceded others, in order to determine, e.g., if color or mark type was key in this sequencing.

Multispectral Registration

The visible light, x-ray, and infrared reflectograph images of F583 offer a trio of images that will need to be aligned in order to position the surface image adequately for desired extraction of undesirable surface features from the x-ray or infrared reflectograph. The data for F583 could be used as data for a three-image multispectral registration task (before or after the enhancement of the x-ray and infrared reflectograph). The three images are slightly different in size (with dimensions indicated as height x width): (a) front: 1819 x 2313 pixels, (b) x-ray: 2811 x 2229 pixels, and (c) infrared: 3060 x 2416 pixels. Plus, the images each appear to exhibit a slightly different tilt.

As another multispectral overlay challenge, we consider the false color infrared and x-ray images for

- F482 :: "Vincent's Bedroom in Arles", 72 x 90 cm, October 1888

in the collection of the Van Gogh Museum. F482 has not been treated for over 70 years and previous restoration has aged differently from original paints producing "discolored" patches in the floor and elsewhere. A precision overlay is useful in clarifying the extent of later retouches (visible in the false color infrared) beyond the edges of paint loss (defined by the x-ray).

Dataset

The x-ray of F583 was made by the Röntgen Technische Dienst (RTD) and the infrared reflectograph by Prof. Molly Faries. Access to these two images and the visible light surface image of F583 was provided by the Kröller-Müller Museum in Otterlo. Access to the details from Jackson Pollock's paintings was provided by the Museum of Modern Art in New York City. Access to the x-rays and false color infrared image of F482 was provided by the Van Gogh Museum in Amsterdam. The infrared image of F482 was made by Lumiere Technology.