We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Non-Photo Realistic Rendering for Digital Video Intaglio

Kil-Sang Yoo, Jae-Joon Cho and Ok-Hue Cho
*Department of Advanced Image,
 Graduate School of Advanced Imaging Science, Multimedia and Film,
 Chung-Ang University
 Republic of Korea*

1. Introduction

The recent surge of interest in non-photorealistic rendering is a testimony to our fascination with distinctive artistic style. Rendering algorithms have been introduced to mimic various classical art forms, ranging from pen-and-ink illustrations and line art drawings to expressive paintings. Classic printmaking offers another suite of styles that can be effectively applied to images. We shall be interested in transforming digital images into renderings that resemble the work of traditional engravers.

Engraving is a classic graphic technique originating in the printing industry of the fifteenth century. It is actually one of several intaglio printing techniques, whereby the image is inscribed into a metal plate with the use of sharp instruments. The resulting recessed lines are filled with ink and the image is transferred to paper by means of a press. Another common technique is etching, whereby acid is used to achieve the inscription. Although engraving has a technical definition that is closely coupled to the manner in which an image is inscribed, loose colloquial usage has come to make it synonymous with intaglio printing. Each method places different demands on the printmaker, giving rise to distinctive styles. We shall be interested in imbuing digital images with the stylistic effects of intaglio printing, which include the familiar styles of engravings and etchings. This process is familiar to anyone who has looked at modern currency. Figure. 1 illustrates several examples of physical intaglio that conform to the characteristic styles we seek to emulate.

In our study we realized real-time digital intaglio image system. We realized digital Intaglio NPR system that can get result immediately from any kinds of image source. For example, picture images or real-time video streams from video camera. Until present, there have been many kinds of NPR systems by graphic programmers and media artists. But our algorithm will be very new approaching using traditional etching technique. We analyzed traditional etching to two directions of line. Each vertical lines and horizontal lines have all different width to express etching style image.

Rest of this paper is organized as follows: previous works are described in Section 3; Section 4 presents proposed algorithm and experimental results are shown; and conclusions are shown in Section 5.

Source: Digital Video, Book edited by: Floriano De Rango,
 ISBN 978-953-7619-70-1, pp. 500, February 2010, INTECH, Croatia, downloaded from SCIYO.COM

Fig. 1. Exemplae of physical intaglio

2. Previous works

In order to place our discussion in proper context, we now review the four major printmaking processes and their histories. We shall confine our attention to the stylistic advances introduced by intaglio printing.

Printmaking dates back to the fifteenth century where it was first used to reproduce illustrations. It played a supportive role in the growing book-printing industry at that time. Great demand for technical achievement in this area has resulted in four major printmaking processes: relief printing, intaglio printing, lithography, and serigraphy. These processes are outlined below.

- **Relief printing:** A wooden block or metal plate is carved such that the nonprinting background areas are cut away below the surface, leaving the image areas of the print in relief. After ink is applied to the raised surface with a roller, paper is pressed against the block and the image is transferred.
- **Intaglio printing:** The image areas are depressed below the surface of the plate. Lines are incised into a metal plate with the use of sharp tools or acids. The plate is covered with ink, and then wiped clean leaving ink in the recessed lines. A press forces the paper into these ink-filled lines and the image is transferred.
- **Lithography:** Images are drawn in greasy crayon on a flat slab of limestone, or a metal plate. The stone is treated chemically so that ink, when rolled onto the stone, adheres only where the drawing was done. A high pressure press is used to transfer the image onto paper.
- **Serigraphy:** Image areas are drawn on a fabric mesh, usually silk or nylon, and the nonimage areas are nonporous. A squeegee pulled across the screen forces ink through the image areas and onto the printing paper directly below. Also known as silkscreen or screen printing. Adaptation of the basic stencil-making technique.

Relief printing uses a raised surface to represent the image. Carved reliefs capable of making an impress were the precursors to relief printing. They predate actual printing by three thousand years. There were wooden stamps in Egypt, brick seals in Babylonia, and clay seals in Rome. The first use of carved reliefs to print images onto paper originated in China, where hand cut wood blocks were used for printing as far back as the T'ang dynasty (618 - 906 A.D.). Woodcut and typographic printing are now the most common form of relief printing.

The intaglio process is distinguished from relief printing in that the image areas are depressed below the surface of the plate. This distinction is reflected directly in the word intaglio, which comes from the Italian and means to engrave or cut into. Intaglio techniques include engraving, etching, drypoint, mezzotint, and aquatint. These techniques differ only in the manner in which they incise lines into the plate. Engraving, drypoint, and mezzotint use sharp tools, while etching and aquatint use acid solutions. Several intaglio techniques are outlined below.

Engraving: Crisp lines are incised into a metal plate with the use of a burin. Heavier and wider lines are produced by pushing the burin deeper into the metal. Tonalities are achieved by engraving parallel lines close together (hatching), by making parallel lines that intersect at various angles (cross-hatching), or by many closely spaced fine dots (stippling).

Etching: The metal plate is first covered with a layer of wax or acid-resistant ground into which the artist scratches a design with a stylus or needle, revealing the bare metal below. The plate is then dipped in acid, which etches the exposed metal, leaving the impression permanently on the plate. This corrosive property is reflected in the root of the word etching, which is derived from the German *aetzung*, which means to eat away or corrode. Etched lines are usually sharply defined, having uniform thickness.

Drypoint: Similar to etching, but the hard point of a needle is scratched directly onto the metal plate to produce soft, thick lines. No acids are used.

Mezzotint: A drypoint process in which a metal plate is textured with many fine dots so as to hold a great deal of ink and print a solid black field. The texture is produced with a rocker, essentially a large curved blade with many fine teeth. After the blade is rocked back and forth, the stippled texture is scraped away where lighter tones are needed. Areas that are vigorously scraped hold less ink and are printed whiter. Unlike other intaglio techniques, the image is developed from dark to light.

Aquatint: An etching technique that creates areas of tone through the use of powdered resin that is sprinkled on the metal plate before applying the etching acid. The result is a finely textured tonal area whose darkness is determined by how long the plate is bitten by the acid.

The earliest engravings can be traced back some 17,000 years in the Lascaux Caverns in the Dordogne region of France. Widely regarded as the most outstanding of known prehistoric art, the paintings and more than 1000 engravings found on the walls and ceilings of these caves indicate that engraving was as widely practiced and respected among primitive man as the technique of painting. Sharp flint implements and stone scrapers were used to carve images into cave walls. Later, engraved bronze vessels and mirrors made by Etruscan artisans became highly regarded and prized objects in ancient Greece and Rome.

Although the underlying principles of intaglio were known to goldsmiths in the Middle Ages, it was not until the fifteenth century, when paper became more generally available, that intaglio printing emerged as a specific art medium. Engraving and etching were two

intaglio techniques that flourished under the early masters. Durer was a master engraver and pioneered the use of variable thickness lines that elegantly swell and taper. A classic example of his work is shown in Fig. 2.

Fig. 2. A classic durer engraving

Fig. 3. Etching of two peasants by Leibl (Goeorge Wolberg)

Etching as a graphic arts technique was perfected in the early seventeenth century. Unlike engraving where lines may swell and taper, etched lines have uniform width. Dark regions are created by modulating the spatial frequency of the lines. This effect is demonstrated in Wilhelm Leibl's etchings of two peasants in Figure 3. (Wasserman, Y., 1995)

3. Proposed algorithm

We propose a new technique which is user driven, providing a versatile tool to the digital artist. Using our technique we are able to simulate etching by modulating. Our digital intaglio etching system using images or video frames has five step processes.

Step 1) Acquisition video streams from video camera or digital image.

First we acquire video streams from video camera.

Step 2) The affine transformation in color space.

In step2 [R G B] are changed to [YUV] and we extract the luminance component. Step2 is to extract the luminance component from the color image size. If the color image format is in RGB, then we need to convert it to YUV color space to get the luminance. The new value $Y=0.299*R+0.587*G+0.114*B$ is called the luminance. One of the main advantages of this format is that gray-scale information is separated form color data, so the same signal can be used for both color and black and white sets. It is the value used by the monochrome monitors to represent an RGB color. Physiologically, it represents the intensity of an RGB color perceived by the eye.

Step 3) Decomposed luminance through DWT in one level.

The Haar wavelet transform (Albert Bogges Francis J Narcowich., 2001) is identical to a hierarchical sub band system, where the sub bands are logarithmically spaced in frequency. An image frame is first decomposed into two parts of vertical etchings and horizontal etchings by critically sub-sampling horizontal and vertical channels by following equation:

Basic one Step function

$$\psi_n(t) = \begin{cases} 1 & 0 < t < 1/2 \\ -1 & 1/2 \leq t < 1 \\ 0 & \text{Otherwise} \end{cases}$$

A video frame and its DWT decomposition are shown in Fig. 4.

- Scaled and translated: scaling the transformed image to double of its original size

$$\psi_{jk}(t) = \psi_H(2^j t - k)$$

Step 4) Modulating line thickness to produce varied tones

The goal of this work is to emulate the distinctive style of intaglio printing for artistic effect. We define digital etching to be the effect of modulating line density to produce varied tones. According to the following equation, it is very simple, fast, easy, understandable and very effective and expressive. The flow of engraved lines is determined by following:

Fig. 4. Transformed coefficients of DWT magnitude

```
for i=1 : 3 : display_width
    for j=1:11: display_height
        for k=0:1:9
            if (j,i) >= 128 then ImageX(j+k,i)= ImageX(j+k,i) + 100 ;
            else Image X(j+k,i)= 0
            end
        end
    end
end
```

Depending on the image pixel values along those lines (and between them), the output is converted into black and white pixels. An example is shown in Fig. 6 and 7.

Step 5) Displaying Video Digital Intaglio on real-time

Other experimental results of digital intaglio are given below. Our process is not only tedious and demanding, but also do not require great artistic skill and time. We performed some numerical experiments from web camera (15 frames per second).

Fig. 5. Original source image

Fig. 6. Result image in horizontal

Fig. 7. Result image in vertical

Fig. 8. Result images in both horizontal and vertical

Fig. 9. Result images

5. Conclusion

In this paper, we proposed in transforming digital video streams with the etching effects of intaglio printing, which include the familiar styles of engravings that conform to the characteristic styles we seek to emulate. It displays instantly two types of etchings video art: vertical etchings and horizontal etchings. Experimental results show that proposed algorithm close to physical etching. The resulting recessed lines are filled with black and the video frame is transferred to monitor by means of

the algorithm on real time. The newest features are preview video window while real time, saved drawing time, displayed two types of etchings video art which are vertical etchings and horizontal etchings at once.

We plan to further develop the software for use in the visual effects industry. The potential markets include advertising, television, and film production. There are currently no commercially available systems that robustly offer such tools. A successful implementation of the proposed work has great potential for introducing a high impact visual effect to the marketplace. Such tools can be offered as Adobe Photoshop plug-ins or as a stand-alone product. We also have to plan to augment the graphical user interface in response to additional testing among artists.

6. References

- Albert Bogges Francis J Narcowich. (2001). *A First Course in Wavelets with Fourier Analysis*, Prentice Hall, ISBN 0-13-022809-5, Upper Saddle River.
- DigiDurer. (1993). a digital engraving system. *The Visual Computer: International Journal of Computer Graphics archive*, Vol. 10 , Issue 5 (1993) , pp. 277 – 292, ISSN:0178-2789
- Goeorge Wolberg, Digital Engraving Techniques For Artistic Rendering, City College of New York.
- Line Art Rendering via a Coverage of Isoparametric Curves, *IEEE Transactions on Visualization and Computer Graphics archive*, Vol. 1 , Issue 3 (September 1995) table of contents, pp. 231 – 239, ISSN:1077-2626
- Wasserman, Y. (1995). Integrated Single-Wafer RP Solutions for 0.25-micron Technologies. *IEEE Trans-CPMT-A*, Vol. 17, No. 3, pp. 346-351.

Digital Video

Edited by Floriano De Rango

ISBN 978-953-7619-70-1

Hard cover, 500 pages

Publisher InTech

Published online 01, February, 2010

Published in print edition February, 2010

This book tries to address different aspects and issues related to video and multimedia distribution over the heterogeneous environment considering broadband satellite networks and general wireless systems where wireless communications and conditions can pose serious problems to the efficient and reliable delivery of content. Specific chapters of the book relate to different research topics covering the architectural aspects of the most famous DVB standard (DVB-T, DVB-S/S2, DVB-H etc.), the protocol aspects and the transmission techniques making use of MIMO, hierarchical modulation and lossy compression. In addition, research issues related to the application layer and to the content semantic, organization and research on the web have also been addressed in order to give a complete view of the problems. The network technologies used in the book are mainly broadband wireless and satellite networks. The book can be read by intermediate students, researchers, engineers or people with some knowledge or specialization in network topics.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Kil-Sang Yoo, Jae-Joon Cho and Ok-Hue Cho (2010). Non-Photo Realistic Rendering for Digital Video Intaglio, Digital Video, Floriano De Rango (Ed.), ISBN: 978-953-7619-70-1, InTech, Available from:
<http://www.intechopen.com/books/digital-video/non-photo-realistic-rendering-for-digital-video-intaglio>

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2010 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike-3.0 License](https://creativecommons.org/licenses/by-nc-sa/3.0/), which permits use, distribution and reproduction for non-commercial purposes, provided the original is properly cited and derivative works building on this content are distributed under the same license.

IntechOpen

IntechOpen