ULTRA-REALISTIC IMAGING AND
OptoClones™

Hans I. Bjelkhagen

Hansholo Consulting Ltd
United Kingdom

www.hansholo.com
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Ultra Realistic Imaging ISDH 2015
What is an Ultra–Realistic Image?

- It looks “identical” to the real object observed by eye
- Very accurate colour rendition
- Same scale – no magnification
- Resolution corresponds to the eye resolution
- No detectable image blur (spatial or chromatic)
- No field-of-view limitations
- Image light reflections move like they do on the object
- In principle – recording light waves reflected off an object, store and recreate them later

**ONLY COLOUR DENISYUK HOLOGRAPHY** can accomplish this
What is an OptoClone™?

It is a Denisyuk hologram recorded with a minimum of three RGB lasers. Since “hologram” and “holography” are used for many non-holographic applications today it is important to introduce new terms which describe real holograms and ultra-realistic imaging. OptoClone™ has been world-wide trade-marked by HiH.

In particular, since we holographers are not able to fight the misuse of the words holograms and holography by big companies, such as Microsoft, for example, we need to use new words to describe real holograms. This may not be that bad, since OptoClones may not be hijacked by “2D Peppers Ghost” - and Computer companies.
The beginning

1974 Coronation Crown of Erik XIV in Sweden at STOCKHOLMIA'74

1980 Gold Collar in a museum display in place of the real artefact

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Ultra-Realistic Imaging

Monochrome and Colour Deniszyuk Holograms
**Colour Rendering Error**

More than three laser wavelengths needed

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<th>Number of wavelengths</th>
<th>Optimal laser wavelengths (nm)</th>
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<td>7</td>
<td>445, 482, 522, 560, 599, 645, 655</td>
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</table>
Image Blur in Display Holograms

Image blur less than the resolution of the eye at the hologram viewing distance
New Lasers

- Many wavelengths from blue to red
- High output power
- Long coherence length
- Low power consumption
- No water cooling needed
- Suitable for mobile recording equipment
New CW Lasers

RGB lasers
Demonstration of (blue) laser light scatter in holographic SH emulsions

Old holographic emulsion
40 to 50 nm grain size
Agfa, Ilford, Kodak

Ultra-fine-grain emulsion
5 to 15 nm grain size
Slavich, Sphera-S, Colour Holographic, Ultimate, SilverCross
First OptoClone™?

With regard to the development of colour reflection holography, the work by **Kubota** in 1986 was a breakthrough, demonstrating the potential of colour holography. Kubota made a Denisyuk colour hologram with the image recorded in a SH plate (Agfa SE75) and the green (515 nm) and blue (488 nm) images in a DCG plate, sandwiched together.

Ultra-Realistic Imaging

Panchromatic materials needed:

*Ultrafine-grain silver-halide (SH) materials*

- Slavich (improved versions by the end of 2013)
- Sphera-S (only custom orders)
- Ultimate (new 4-nm emulsion introduced – limited production)
- Colour Holographic (recent improved materials)
- SilverCross (limited manual production)
An analogue colour hologram recording involves the use of lasers of different wavelengths to create a holographic image. The diagram illustrates the process:

- **Krypton Ion Laser (647nm)**
- **CW Nd:YAG Laser (532nm)**
- **Argon Ion Laser (476nm)**

The setup includes mirrors, a beam combiner, a white laser beam, a spatial filter, and a holographic plate with an object behind it.
OptoClone™ of Russian Egg
Bringing the Artefacts Back to the People

One of the first artefacts to be recorded was the 14,000-year-old *Decorated Horse Jaw Bone* from the ice age.

The bone was discovered in Kendrick's Cave in Llandudno and is the only piece of artwork dated to the end of the last Ice Age or Late Glacial period in Britain. It was dug up by Thomas Kendrick in 1880.

Acquired by the *British Museum* in 1959. A hologram of the jaw bone was recorded at CMO on 21 April 2009.
Jaw Bone Hologram Recording
Jaw Bone **OptoClone™**

Decorated horse jaw bone from the last ice age (about 13,500 years old).
Bringing the Artefacts Back to the People

Recording setup

Elisabeth Royles, Grosvenor Museum, Chester

The recording of the *Tudor Owl Jug* (16th Century) and *Sergeant at Arms Ring*

The Artefacts from Grosvenor Museum in Chester.

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Bringing the Artefacts Back to the People

Tudor Owl Jug and Sergeant at Arms Ring OptoClone™
Bringing the Artefacts Back to the People

Close-up of the Owl head

Tudor Owl Jug OptoClone™
HiH Mobile Recording Equipment

Mobile recording equipment essential for applications, such as, e.g. museum artefact recording. Thanks to the new lasers on the market, it is now possible to build the necessary recording equipment.

The Hellenic Institute of Holography in Greece has a portable three-colour analogue holographic camera, the ZZZyclops™ camera.

The three lasers:
- Red laser: 638 nm at output power 80 mW (CrystaLaser laser)
- Green laser: 532 nm at output power 100 mW (Cobolt Samba laser)
- Blue laser: 457 nm at output power 50 mW (Colbolt Twist laser)
HiH Mobile Recording Equipment

Recording Camera
HiH Mobile Recording Equipment
HiH Mobile Recording Equipment

Object: One of a pair of golden bracelets, 9-10c. AD, origin: Thessaloniki (excavations at Dodekanisou Str.), gold/enamel (cat # K/MBII/54/602).
HiH Mobile Recording Equipment

Recorded in-situ at the Thessaloniki Museum of Byzantine Culture in October 2013 by A. Sarakinos on ‘Ultimate’ glass plate, size 20x25cm.

OptoClone™
New LED Lights for OptoClones™

The progress in LEDs has opened new possibilities for the display of colour holograms. The ideal situation would be if the wavelengths of the LED light source could match the recording laser wavelengths used. This would guarantee that only the light from the source (mixture of the wavelengths) to illuminate the hologram is the same as the one used to create the holographic image. Using a halogen spotlight, which is the common practice today, a large part of the light spectrum emitted is illuminating the surface of the plate without having any impact on the intensity of the image. Instead it creates light scattering, lowering the image contrast.
AutoTech LED Light

The Hellenic Institute of Holography in Greece has developed a special LED spotlight, the HOLOFOS for OptoClones™.
The Fabergé EGG OptoClone™ Project

Carl Fabergé (1846 -1920)

Photo by H. Aubert, about 1900
The Fabergé EGG OptoClone™ Project

To introduce this imaging technique to the world, we selected to record the most beautiful artefacts we could think of, namely the Imperial Fabergé Easter Eggs. The jewelled eggs with enamel and painted details were made by Carl Fabergé (1846 – 1920) in his workshop in St. Petersburg. Each egg often took a whole year to complete. One of the most famous eggs is the Coronation Easter Egg which was given to Empress Alexandra in 1897 by the Emperor Nicholas II as a memory of the coronation in 1896. This egg has a surprise inside: a model of a tiny gold carriage.
The Fabergé EGG OptoClone™ Project

The Easter Eggs from the Malcolm Forbes’ collection
The Fabergé EGG OptoClone™ Project

Viktor Vekselberg
Chairman of Tyumen Oil, Russia’s third-largest oil and gas company. He is worth some $10 billion, making him Russia’s fourth richest businessman according to Forbes Magazine.

Photo: Mikhail Metzel/AP
The Fabergé EGG OptoClone™ Project

The Forbes Fabergé collection in the USA contained nine of the Imperial Easter Eggs. In 2004 these eggs were acquired by Viktor Vekselberg for about $100 million. He brought them to Russia to be displayed to the general public in St. Petersburg. In November 2013 the Eggs were finally put on display in St. Petersburg at the new Fabergé Museum located in the Shuvalov Palace in the centre of St. Petersburg. The museum contains a total of approximately 4000 works of fine art and decorative applied art, including gold and silver items, paintings, porcelain, and bronze.
The Fabergé EGG OptoClone™ Project

Vladimir Vasilyev, Rector of ITMO,
Vladimir Voronchenko, Director of the Fabergé Museum
and Alkis Lembessis, Director of HiH
at the Fabergé OptoClone meeting

On 25 September 2014 an agreement of partnership between the Fabergé Museum, the Hellenic Institute of Holography (HiH) and the University of Information Technologies (ITMO) was reached

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The Fabergé EGG OptoClone™ Project

The mobile equipment from HiH in Greece was sent to the museum in St. Petersburg. During a few weeks in the spring of 2015 the recording took place in the basement laboratory of the museum. A recording tent was installed there and outside the tent the ZZZyclops camera was positioned, sending “white” laser light into the tent.

Andreas Sarakinos and the ZZZyclops
The Fabergé EGG *OptoClone™* Project

Inside the tent there is a tripod with a front-silvered mirror to send the laser light down at a platform with a box in which the Eggs are placed for the recording.
The Fabergé EGG OptoClone™ Project

The excellent quality of the recordings was achieved thanks to Andreas Sarakinos.

He spent long hours every day during several weeks, recording a total of about 200 OptoClones™.

In the Fabergé Museum Lab there was a sink with water, which was convenient for the processing.
The Fabergé EGG OptoClone™ Project

One example of how the recording of the OptoClones™ was performed.

The 1911 Bay Tree Easter Egg is shown positioned in the recording box.
The Fabergé EGG OptoClone™ Project

The recorded Egg being carried out of the tent by Museum Curator Alexey Pomigalov
The Fabergé EGG OptoClone™ Project

A photo of the recorded Bay Tree Egg OptoClone™
The Fabergé EGG OptoClone™ Project

A photo of the 1900 Cockerel Easter Egg-Clock OptoClone™
Fabergé Project Acknowledgements

The *Bowater Fabergé Collection of OptoClones*™ was made possible only with the support of *ITMO University* of St. Petersburg and the personal sponsorship of James Bowater, founder of *Bowater Holographics*.

BB-PAN plates were used primarily for the recording of the *OptoClones*™ under exclusive license to HiH by *Colour Holographics* (UK) in addition to a limited number of ULTIMATE04 plates from *Yves Gentet* in France.

*OptoClones*™ is a registered trademark of the *Hellenic Institute of Holography*. All rights reserved.
Book Published in 2013

It covers interferential imaging techniques, Lippmann photography, analogue and digital colour holography, including in-depth details about panchromatic recording materials and recording equipment, including RGB lasers and digital printers as well as applications of colour holograms.
Contact Details

Professor Hans I. Bjelkhagen

Hansholo Consulting Ltd

13 Rhodfa Gofer
Dyserth LL18 6LP
North Wales, UK

Email: hansholo@aol.com
Telephone: +44 (0)1745 571780

www.hansholo.com