



ULTRA-REALISTIC IMAGING AND
OptoClones™

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Ultra Realistic Imaging ISDH 2015





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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*TM?

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*TM 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

Ultra-Realistic Imaging



Monochrome and Colour Denisyuk Holograms

Colour Rendering Error

More than three laser wavelengths needed

Number of wavelengths	Optimal laser wavelengths (nm)	Error
3	466, 545, 610	0.0137
4	459, 518, 571, 620	0.0064
5	452, 504, 549, 595, 643	0.0059
6	451, 496, 544, 590, 645, 655	0.0040
7	445, 482, 522, 560, 599, 645, 655	0.0026

Image Blur in Display Holograms

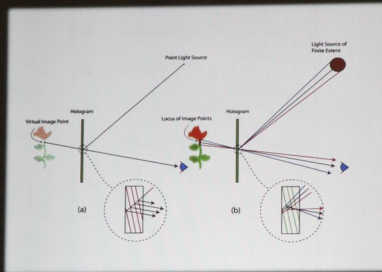
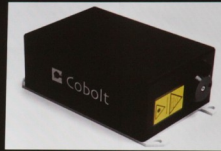


Image blur less than the resolution of the eye at the hologram viewing distance

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 brake through, demonstrating the potential of colour holography.

Kubota made a Denisyuk colour hologram with the **red (633 nm)** image recorded in a SH plate (Agfa 8E75) and the **green (515 nm)** and **blue (488 nm)** images in a DCG plate, sandwiched together.



T. Kubota, *Appl. Opt.* **25**, 4141-4145 (1986)

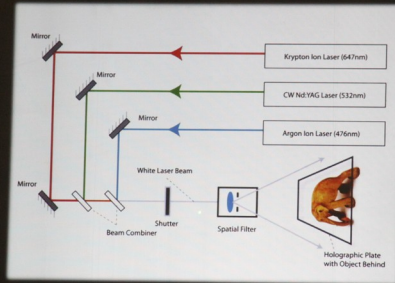
Ultra-Realistic Imaging

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)

Analogue Colour Hologram Recording



OptoClone™ of Russian Egg



OptoClone™ of Watches



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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.

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

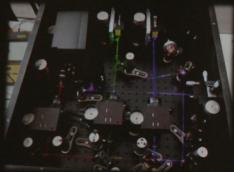
Mobile recording equipment essential for applications, such as, e.g. museum artefact recording. Thanks to the new lasers on the market, it is now possible to build the necessary recording equipment.

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/MBΠ/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*TM

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



for *OptoClones™*



The Fabergé EGG *OptoClone*TM Project

Carl Fabergé
(1846 -1920)



Photo by H. Aubert, about 1900

The Fabergé EGG *OptoClone*TM 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*TM Project



The Easter Eggs from the Malcolm Forbes' collection

The Fabergé EGG *OptoClone*TM 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*TM 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*TM 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

The Fabergé EGG *OptoClone*TM 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.



The recording tent



Andreas Sarakinos and the *ZZZyclops* 35

The Fabergé EGG *OptoClone*TM 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*TM 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*TM



In the Fabergé Museum Lab there was a sink with water, which was convenient for the processing

The Fabergé EGG *OptoClone*TM Project

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

The *1911 Bay Tree Easter Egg* is shown positioned in the recording box.



The Fabergé EGG *OptoClone*TM Project

The recorded Egg
being carried out
of the tent by
Museum Curator
Alexey Pomigalov



The Fabergé EGG *OptoClone*TM Project

A photo of the
recorded

Bay Tree Egg
*OptoClone*TM



The Fabergé EGG *OptoClone*TM Project

A photo of the
1900 Cockerel
Easter Egg-Clock
*OptoClone*TM



Fabergé Project Acknowledgements

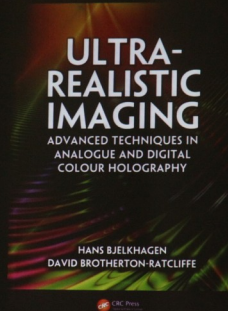
The *Bowater Fabergé Collection of OptoClones™* was made possible only with the support of *ITMO University* of St. Petersburg and the personal sponsorship of James Bowater, founder of *Bowater Holographics*.

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.



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