Artistic Representation with Pulsed Holography

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Abstract. This thesis describes artistic representation through pulsed holography. One of the prevalent practical problems in making holograms is object movement. Any movement of the object or film, including movement caused by acoustic vibration, has the same fatal results. One way of reducing the chance of movement is by ensuring that the exposure is very quick; using a pulsed laser can fulfill this objective.

The attractiveness of using pulsed laser is based on the variety of materials or objects that can be recorded (e.g., liquid material or instantaneous scene of a moving object). One of the most interesting points about pulsed holograms is that some reconstructed images present us with completely different views of the real world. For example, the holographic image of liquid material does not appear fluid; it looks like a piece of hard glass that would produce a sharp sound upon tapping. In everyday life, we are unfamiliar with such an instantaneous scene.

On the other hand, soft-textured materials such as a feather or wool differ from liquids when observed through holography. Using a pulsed hologram, we can sense the soft touch of the object or material with the help of realistic three-dimensional (3-D) images. The images allow us to realize the sense of touch in a way that resembles touching real objects.

I had the opportunity to use a pulsed ruby laser soon after I started to work in the field of holography in 1979. Since then, I have made pulsed holograms of activities, including pouring water, breaking eggs, blowing soap bubbles, and scattering feathers and popcorn. I have also created holographic art with materials and objects, such as silk fiber, fabric, balloons, glass, flowers, and even the human body. Whenever I create art, I like to present the spectator with a new experience in perception. Therefore, I would like to introduce my experimental artwork through those pulsed holograms.

1. Introduction
One of the salient features of holography is the reconstruction of realistic three-dimensional (3-D) images. There are many restrictions associated with shooting holograms, however, if a real subject is chosen. Vibration during shooting is a serious problem to artists from the viewpoint of artistic representation since it restricts subject choice and limits hologram size.

One of the solutions to this problem is to use the pulsed laser for shooting. The pulsed laser makes it possible to shoot such subjects as the human body, fluid and liquid material, moving objects, and falling and floating objects, which are not appropriate for use with a continuous laser. A pulsed hologram records scenes instantaneously at the rate of a few dozen nanoseconds per scene. Observing the reconstructed images of such scenes made this author aware of some interesting phenomena. For
example, some images do not appear as the original subjects. They portray completely different aspects of the real world.
This paper describes the features of reconstructed images of pulsed holograms according to variations in subjects. Additionally, it introduces the application these features for artistic representation through use of the author’s practical works of art.

2. Frozen time

2.1. Liquid subject
One of the early holograms for which this author/artist used pulsed laser was *Crystal White* (Fig.1), a rainbow hologram, measuring 30 cm × 40 cm, produced in 1979 and depicting a breaking egg [1]. This master hologram was shot using a ruby laser. At that time, the author of this study also attempted to shoot several different subjects with the ruby laser, including roses, pineapples, and hands. I became aware that the reconstructed images of those subjects were unchanged from the subjects themselves. On the other hand, the reconstructed image of an egg white does not appear fluid; it looks like a piece of glass that would produce a sharp sound upon tapping. Further, an observer can see different optical effects through the egg white with shifts in vantage points, just as if it were a real glass [2].

![Figure 1. Crystal White, 1979](image1)
Rainbow hologram, 30 cm × 40 cm

![Figure 2. Self-portrait, 2000–02](image2)
Laser transmission hologram, 50 cm × 60 cm

![Figure 3. Frozen Time, 1983](image3)
Rainbow hologram, Handmade Japanese Paper
We recognize phenomena of the real world in the streaming of time. We understand that time flows, but we are not able to understand that it is liquid until an instantaneous scene suggests that all movement has frozen. Suddenly, we are not able to recognize the differences between liquid and solid material. In everyday life, we are unfamiliar with such scenes. The instantaneous world portrays completely different features, notwithstanding reconstructed images coming from the real world. Thus, our vision is extended with holograms.

**Self-portrait** (Fig. 2) is a laser transmission hologram (50 cm × 60 cm, 2000–2002); water was poured into a glass bottle containing two different transparent liquids—water and oil. In the course of pouring the water, the boundary plane between the two liquids (with different specific gravities) was broken and appeared as a complicated shock wave. In this hologram, all liquids froze, and the oil and water in the glass bottle looked like solid crystal glass instead of liquids [3].

**Frozen Time** (Fig.3) [4] is the finished installation work that comprises *Crystal White*. The image of an egg, which has been popular with many artists as an object of artistic representation, is absorbing for me as well because it evokes images of organic/natural/eternal life and fluidity when it is broken. The upper part of this installation, *Frozen Time*, comprises three different holograms (images of eggs); handmade Japanese paper on which the traces of flowing egg fixed with tempera painting represents the basis for the lower part. Albumin in the egg is well known as a strong painting medium; the technique of egg tempera painting has been used for many years by western artists.

The basic concept for creating this installation was the showcasing of contrasts between the new medium (just formed) and the original (historical) medium, as well as contrasts between a real image and a holographic image.

2.2. Reality

Soft-textured materials such as feathers or wool differ from the abovementioned liquids. Reconstructed images from these materials appear just the same as they appear in the real world. We can experience the sense of soft touch with the help of realistic 3-D images, despite the fact that only visual information is available (Fig. 4, Fig. 5). These images provoke an absorbing experience in perception.

![Figure 4. Visible Temperature α (part)](image)
Subject: Feather

![Figure 5. Visible Temperature α, (part)](image)
Subject: Wool
Wall hanging art pictured in Visible Temperature α (Fig. 6.) comprises reflection-type image holograms (Fig. 4, Fig. 5); dimensions of each are 30 cm × 40 cm. They exhibit various textures, such as those of feathers, wool, cotton, hemp, rope made of chemical fiber, steel wire, and nails [5]. A reflection-type hologram is excellent for reproducing texture, and an observer will surely memorize an illusion from which a soft feel is transmitted. This experience is attained by placing an actual finger on the reconstructed image of feathers or wool, which loom several centimeters away from the glass side of the hologram. Thus, Visible Temperature α is a work that affects vision and the tactile sense [6]. It indicates that a realistic holographic image enables one to experience the sense of touch as if he or she is touching an actual object. A contrast is presented between texture and the sense of touch for different materials, as well as for real objects versus reconstructed 3-D images.

2.3. Subject: Scene of floating in the air
The following images (Fig. 7, Fig. 8) are instantaneous scenes of a feather and popcorn scattering into the air.

Figure 6. Visible Temperature α (complete view), 1987–88, 220 cm × 750 cm

Figure 7. Subject: Feather,
Multi-color, multi-channel hologram
85 cm × 110 cm

Figure 8. Subject: Popcorn,
Multi-color, multi-channel hologram
85 cm × 110 cm
Each work is a pulsed master hologram transferred to a multi-channel, multi-color hologram [7]. Reconstructed images appear on both sides, in front of, and behind the holograms. As mentioned above, the feather has been reconstructed into a realistic 3-D image. It appears to float on the wind, giving a natural impression. On the other hand, the reconstructed image of popcorn portrays an unfamiliar scene.

We also attempted to shoot soap bubbles as subjects of interest. We were able to shoot several, from a few to 10 cm across on a 50 cm × 60 cm hologram. When we carefully observed the reconstructed images with a laser, we found that they differed completely from the familiar ones. In everyday life, we look at soap bubbles under white light, sunlight (outdoors), or artificial white light (inside). A large floating bubble on the breeze changes form continuously and organically. Its unique and beautiful colors come from the effect of interference colors under white light. These colors undergo kaleidoscopic changes. On the other hand, the reconstructed holographic image loses the array of colors and looks like a transparent glass ball. The edge of the sphere is barely recognizable, as are the two reflected bright points, one on the outside surface and the other inside.

If we shoot the real soap bubble as the subject by using three lasers each oscillates different wave length (red, green, blue), is it possible to reconstruct the beautiful realistic soap bubble colors? In the near future, is it possible to create a natural color hologram from real soap bubbles? This is an absorbing theme for prospective research.

3. **Body Wrapped with Fabric**

The most popular subjects of pulsed holograms are portraits and human bodies. Historically, these subjects have been important to painters and sculptors.

![Figure 9. Body Wrapped with Fabric A](image1)

![Figure 10. Body Wrapped with Fabric B](image2)

- **Figure 9. Body Wrapped with Fabric A**, Multi-color, multi-channel hologram 2000–08, 110 cm × 134 cm,
- **Figure 10. Body Wrapped with Fabric B**, Multi-color, multi-channel hologram 2000–08, 110 cm × 134 cm

*Self-portrait – Body Wrapped with Fabric A (Fig. 9) and Fabric B (Fig. 10) are multi-color, multi-channel holograms (110 cm × 134 cm); each hologram comprises about 20 different images. Each image has its own limited field of view, and reconstruction images of the hologram appear to occupy their own positions in space. Each scene appears dissimilar when observed from a different viewpoint. When our perspective shifts vertically upward or downward, we observe a change in the hologram’s color combinations. When our viewpoints shift horizontally from left to right, we notice different*
images. Three-dimensional collage can be produced using this method. Since it is not possible to look at all images in the hologram from one vantage point simultaneously, we unconsciously interact with the holograms. If we want to discover the various embedded images, we have to interact voluntarily with physical movement. Holography gives a new understanding of the physical space in which we live; this aspect makes it an attractive art medium [8].

4. Conclusion
The examples described in this paper have conclusively shown that the various characteristics of pulsed holography enable new expressions that cannot be realized through existing mediums of expression. The illustrations indicate that realistic 3-D holographic images affect the relationship between vision and the tactile sense. Some instantaneous scenes reconstructed with the pulsed holograms portray a completely different aspect of the real world. Our vision is extended with holography.

On the other hand, there are presently several difficult problems associated with the creation of the pulsed hologram. First, amateurs will find that the pulsed laser is expensive and difficult to operate. Secondly, recording materials must be improved for appropriate sensitivity and durability. More devoted and astute scientists and engineers are needed to solve these problems.

References
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