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Conservation and Preservation of Cultural Properties Based on Spiritual Materials

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A painting of the Buddha, which is an invaluable cultural property in both Korea and Japan, was imaged using an optical scanning and digitizing method. An enlarged replica of the Buddha imaging was prepared, and exhibited as a high-resolution image similar to the original painting. The replica, which includes a QR code or IC tag, was demonstrated as a smart material. Furthermore, the basic concept of spiritual materials was proposed and discussed using reproduced images of the Buddha painting. This mind catching and transmission technique was demonstrated using Buddha images and *Siddham* scripts.

Key words: Cultural heritage, Buddha painting, Spiritual material, Mind transmission, Optical scanning

1. INTRODUCTION

The government of Japan recently decided that the Agency for Cultural Affairs will be moved from Tokyo to Kyoto. In Kyoto, which used to be the capital city of Japan for approximately 1,000 years, many cultural heritages have been preserved and protected. The government has taken various measures to protect cultural properties by providing subsidies for their preservation or repair, and for building disaster-proof facilities. Throughout a long history, cultural properties have been created, fostered, and passed down through the generations. They are invaluable assets for people. To pass cultural heritages to future generations, the conservation and preservation of cultural properties should be promoted. In particular, for cultural properties that disappear with the passing of time, the preservation of their imaging data is important, and the archiving information should be passed on. In addition, the restoration and reproduction of cultural heritages demand advanced materials research and technological applications. Therefore, it is important to promote the development of advanced imaging technologies for the preservation of cultural properties.

Advanced material technologies for the preservation of cultural heritages have attracted significant attention, and beam technology has an important role in the development of new materials [1-4]. With beam technology, three types of beams, namely, ion, electron, and photon, are available. These beams can be applied to the surface treatment and analysis of various materials including cultural properties [5, 6]. Each beam has its own characteristics, and a photon beam (or laser beam) has lower energy compared with ion and electron beams. In addition, photons do not have any mass, and their irradiation damage is extremely low. Therefore, a photon beam can be used to achieve non-destructive and non-invasive irradiation on valuable objects such as important cultural properties. In addition to beam technology, printing technology has an important role in the preservation of cultural heritages. For example, 3D printers have been applied to reproductions of various statues with complicated shapes [7], and technological applications have been investigated in various fields. Furthermore, information technology (IT) such as artificial intelligence (AI) has attracted significant interest in the development of advancing materials, and IT has had an important role in the preservation of cultural heritages. For example, digitizing is of great importance in the imaging of cultural properties, and big data are acquired using large-scale and high-density digital information.

On the other hand, different structural materials have been used based on their intrinsic properties, and new materials developed through the addition of various properties such as functional, intelligent, and smart properties have recently attracted significant attention [8-10]. With regard to cultural properties, spiritual materials have attracted greater interest because they can contain a spiritual property as an additive element. For example, a spiritual property is contained in religious paintings representing the Buddha or God mind, as well as the human mind. Although material and spirit are contradictory concepts, both of them are described in terms of energy. Material is an aggregation of energy, and spirit is an energy flow. Therefore, religious paintings such as Buddha paintings can generate a flow of spiritual energy between the human mind and the Buddha mind. It can

provide special and spiritual feelings to those who view them. Therefore, it is important to transfer the spiritual mind of a Buddha image to the reproduced object, resulting in the re-preparation of spiritual materials.

In this paper, Buddha paintings, which are important cultural properties in both Korea and Japan, are reviewed, and a spiritual material based on this painting is proposed as a new type of material. Furthermore, the optical scanning and digitizing method applied to imaging a Buddha painting [11-13] is reviewed, and a mind catching and transmission method is proposed as an advanced technique for the preservation of cultural properties. In more detail, a beam scanning and digitizing method with photon beams is used for the imaging of Buddha paintings, and the characteristics of the reproduced images are described. In addition, both spiritual and smart materials are described, and the mind catching and transmission technology is discussed based on the spiritual materials.

2. EXPERIMENTAL PROCEDURE

2.1 Beam Technology

Beam technology utilizes various beams such as photon, electron, and ion beams. As shown in Figure 1, such beams have several features, one of which is that the beam can be scanned in one-, two-, and three-dimensional directions. As a result, the line, area, and volume scanning are available in the imaging of objects. For example, a scanning electron microscope (SEM) is a useful instrument, and has been used for the surface analysis of various materials in various fields. In addition, a scanning focus-ion beam has been applied to the surface etching of the materials, and 3D etching was performed [14, 15]. Another feature is that the beam can be separated into several energy beams. For example, photon beams can be separated into different energy beams by using different color filters. In addition, ion beams with different masses can be separated using a mass separator. A separated ion beam has been applied to ion implantation [16, 17]. Another feature is that various beams can be combined together as a single beam. As a result, unique irradiation effects are obtained through the simultaneous use of several beams. For example, the simultaneous use of monomer and cluster ion beams has been applied to the surface treatment of biomaterials with good cell adhesion [18]. In another case, photon-assisted ion beams have been applied to a surface treatment with less irradiation damage [19]. Thus, beam technology with three beams exhibit unique features, which can be applied to the surface treatment and analysis of various materials. For example, AES (Auger electron spectroscopy), SIMS (secondary ion mass spectroscopy), and XPS (X-ray photoelectron spectroscopy) are a useful method for analyzing material composition of cultural properties. These data obtained are of significant importance for preservation of cultural heritages.

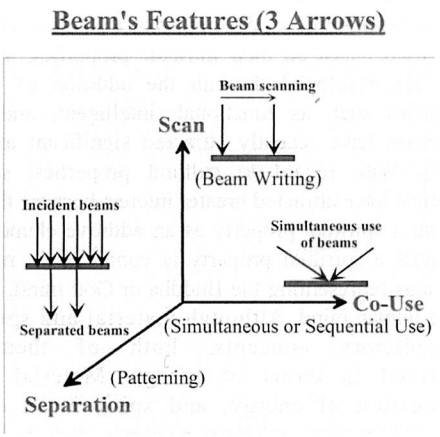


Fig. 1: Characteristics of beam technology.

2.2 Digital Imaging Technology

Imaging technologies have been advancing, and imaging data are digitized using IT technology. For example, a charged couple device (CCD) receives light signals, and the pulse signals are then digitized. This type of device consists of a huge number of pixels such as tens of millions of pixels, and high-resolution imaging can be performed. In addition, digital information on an object can be applied to an electronic recording, and electronic archiving is available. Such information is stored in a memory device as big data, including at the tera-byte scale. Compared with analog information recorded on films, digital information will not degrade over time, and can be preserved more stably for the long term.

Furthermore, the digital imaging technology has several features, one of which is that several images are easily overlapped in a computer. Another is that the image obtained can be divided into several parts, which can be enlarged at any size within the allowed resolution. In addition, the image can be restored and reproduced. As a result, the reproduced replica might have additional significance, which is unavailable for the original objects.

2.3 Optical Scanning and Digitizing Method with Photon Beams

Figure 2 shows a schematic view of the optical scanning method (a) and its system (b, c), which was developed by A. Ide et al. [20, 21], and which was used for the preservation of cultural heritages in various fields. As shown in (b) and (c), an LED light source and a CCD detector are combined as a set in a metal frame. The photon beams emitted from the LED are irradiated onto the object as a narrow beam, and the refractive photons are detected using the CCD. The LED and CCD are parallel scanned along the frame, and the frame is moved in the direction perpendicular to the scanning direction. The CCD has high sensitivity, and it consists of a mega-sized number of pixels. The output signals are digitized, and high-resolution imaging is achieved. The quality of images is improved by high-resolution imaging. In addition, the photon beams for visible light can be separated into different energy beams, and multispectral imaging is available using different color

filters. Furthermore, a specific energy beam such as an IR photon beam can be selected and irradiated onto an object.

The optical scanning and digitizing method has several advantages, one of which is that parallel scanning in a large area or at a long distance is available. The edge area of an object scanned can be imaged without any obscuring. For the case of a scroll (approximately 70 cm long and approximately 30 cm wide), it takes one scan per filter to capture all necessary multispectral information for analytical imaging. Another advantage is that it is non-destructive and non-invasive, which is of great importance for the imaging of cultural heritages and significant archives. Furthermore, digitized information can be memorized for the long term, namely, longer than the analog memory of films taken by a conventional camera. Digital information can achieve wide applications, such as the division, combination, and overlapping of the memorized information.

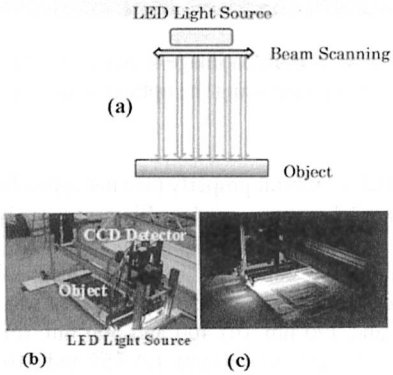


Fig. 2: Schematic view of the optical scanning method (a) and its system (b, c).

3. RESULTS AND DISCUSSION

3.1 Spiritual Material

Figure 3 shows a schematic illustration of a spiritual material, which could be a new material containing a spiritual mind in addition to intrinsic material property. For example, for a Buddha painting, a spiritual mind corresponds to the Buddha mind, which is expressed in terms of a purified mind. It can provide special feelings to the observer viewing the Buddha painting. It should be noted that the operators used for scanning the painting and/or printing out the scanned data are included and assigned as the observer. Furthermore, the feelings may change depending on the mind of the observer. On the other hand, the human mind might be defined as an information organ with various sensors, which are distributed throughout the whole body. The sensors consist of extremely large numbers of cells with various sensing capabilities such as seeing, hearing, scenting, tasting, and touching abilities [22]. In addition, various sensing signals transmitted to the brain from the cells react positively, negatively or independently with each other, and various feelings are generated in the mind. If the mind of the observer is purified in emptiness, the human mind can become resonant with the Buddha mind. As a result, the observer can catch the spiritual energy flow between the human mind and the Buddha mind. It should be noted that the human mind is different from the brain [23, 24], which is considered an information organ localized in the head. It performs information processing such as controlling and memorizing information through rational thinking. Thus, spiritual materials, i.e., paintings of the Buddha or God, contain a spiritual mind that generates an energy flow between the observer and the object.

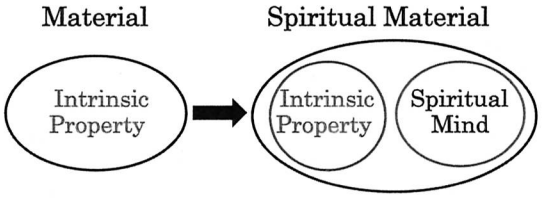


Fig. 3: Schematic illustration of a spiritual material.

With regard to a purified mind in emptiness [25], it has attracted significant interest for both religious people and scientists. As shown in Figure 4, existence (A) is in a state of emptiness through the following equation [26]:

$$A + A^* = 0 \tag{1}$$

where A^* is "not A," which is expressed in terms of "$-A$." The zero (0) on the right hand side of Eq. (1) represents emptiness, and the equal symbol "=" represents the word "in." According to Eq. (1), A should be zero, if A^* is zero. In another words, the Buddha mind, which is expressed in terms of A*, is a purified mind, and is zero. In this case, the human mind can also be zero, which is described through the following equations:

$$A^* = -A = 0 \tag{2}$$

$$A - A = A + 0 = 0 \tag{3}$$

As a result, the human mind is purified in emptiness, and is resonant with the Buddha mind.

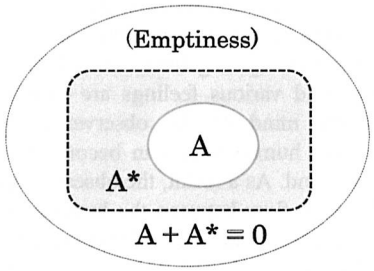


Fig. 4: Schematic illustration of the existence in emptiness.

Furthermore, advancing information technology (IT), which can catch and transmit the Buddha mind as information signals, has attracted significant interest. Seeing consist of three elements, namely, color, shape, and movement [27]. For the optical scanning system used, the color is composed through a multi-spectral analysis in accurate imaging. In addition, the accurate shape is imaged by parallel scanning of the LED light source and the CCD detector along the object. With regard to the movement, it is related to the change in mind. It is important to catch the Buddha mind through movement, which can be achieved through an accurate imaging of a Buddha painting with much a higher resolution. Accurate imaging can provide as much information as possible regarding the Buddha mind. In an actual case, the mind signals, which could be very weak, might be included in the information signals, and it is important to separate the two as carefully as possible. It should be noted that the spiritual feeling of the observer varies depending on the mind signals. In addition, the human mind changes depending on their purification, which is expressed in Eq. (1).

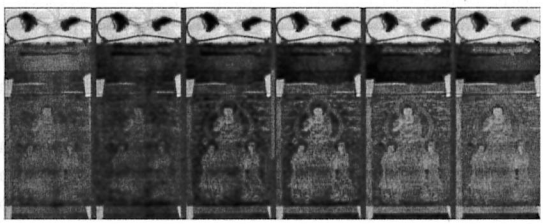
3.2 Buddha Imaging

Figure 5 shows a Buddha image scanned at high resolution. It was conducted based on digital information obtained using a CCD detector. As shown in the figure, the Buddha image consists of upper and lower parts. In the upper part, the main Buddha (*Amitaabha*), in a sitting style, was painted in a gold color. It exhibits two types of rings as a radiant aura, one of which is a head light. The other is a body light, which consists of three rings. In the lower part, *Bodhisattvas* (*Avalokitesvara* on the right side and *kSitigharbha* on the left side) are described in a standing style of a *Bodhisattva* beside the main Buddha. This is the typical Korean style of a *Bodhisattva* arrangement. In the Japanese style, *Mahaasthaamaprapta* is described together with *Avalokitesvara* instead of *kSitigharbha*. In addition, some kanji characters, including the name of the painter, are shown on the right side of the *Avalokitesvara*. They spell out the name of Le Ja Sil, who was a famous painter in the 16th century in Korea [28]. He painted many Buddha images as requested by the Emperor. The original Buddha painting has been preserved in Saimyoji Temple in Kyoto, and it is of significant importance as

Fig. 5: Buddha image scanned at high resolution using the optical scanning system.

an invaluable cultural property (see the appendix).

A parallel scanning and multi-spectra analysis were applied to the Buddha painting. Figure 6(a)-(f) shows Buddha images composed of color filters. The most probable wavelength region for the filters was between (a) 380 and 490 nm, (b) 400 and 500 nm, (c) 460 and 570 nm, (d) 510 and 630 nm, (e) 555 and 710 nm, and (f) 605 and 780 nm. As shown in the figure, all images lost their color, and appear monochromatic. In addition, for the case of the blue color filters, such as in (a) and (b), the Buddha image is weaker, and the reflectance is lower compared with that for the red color filters, such as in (e) and (f). It should be noted that the background part behind the Buddha (*Amitaabha*) image was painted in a red color. Therefore, the reflectance was larger, and the Buddha image was shown more clearly.



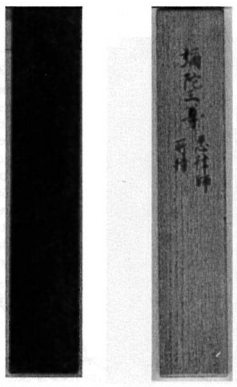
(a) (b) (c) (d) (e) (f)

Fig. 6: Buddha images composed of six color filters.

Furthermore, a special and spiritual feeling can be generated in the observer through a mind transmission. With regard to such a mind transmission, a spiritual energy flow can occur between the Buddha mind and the human mind. When the mind of the observer is purified in emptiness, a resonant energy is transferred between the observer and the Buddha image. The amount of energy transferred depends on the amount of purification, and the resonant energy can be expressed as a function of the wavelength. Therefore, the Buddha image changes at different wavelengths.

On the other hand, the overlapping of six monochromatic images was exhibited in the colored image which was previously shown in Figure 5. The emission spectra of the different energy photon beams exhibited a mixture of additive primary colors, resulting in a visible light emission. Therefore, the simultaneous use of six photon beams exhibits a unique irradiation effect such as a coloring ability.

IR light has more reflectance than visible light, and is used for objects that are hard to be seen with human eyes. In an optical scanning system, a photon beam can be separated into multiple energy beams using different filters, and IR spectra are available. The wooden box that contained the scroll of the original Buddha painting was scanned for imaging using visible and IR light. As shown in Figure 7, IR imaging for the box is clearer than the visible light imaging. Because Indian black ink absorbs all of the light, IR reflectance for the ink is almost zero. Thus, IR spectra are useful for a multi-spectra analysis, and the multiple photon beams have a wide range of applications.



(a) Visible Light Image (b) IR Light Image

Fig. 7: The image of wooden box scanned using visible and IR light.

3.3 Buddha Replica

In general, the replica of an original Buddha painting has an important role in terms of the preservation of cultural properties. To preserve such properties, the replica should maintain the same quality as the original painting because some of the goodness of the original painting is lost in the replica. On the other hand, Buddha images painted outside on wood or stone substrates might disappear as time passes. The value of replicas of outside paintings could increase if the replica can maintain the same quality as the original painting. Furthermore, the feeling of an observer viewing the replica will be different depending on the mind transmitted between the observer and replica. Mind transmission and mind catching have attracted significant interest, although it is necessary to overcome the technological difficulties in achieving mind transmission.

(a) Enlargement

The optical scanning system used is capable of high resolution, and it is possible to enlarge an image ten folds without any obscuring [20, 21]. In addition, printing technology has been advancing, and it is possible to print colored inks onto various materials such as paper, silk, wood, stone, and plastic. The replica of the original Buddha painting was prepared by Nakamura Fine Arts and Crafts Co. in Kyoto. Figure 8 shows the replica of the Buddha painting. The Buddha imaging data were printed out on a silk material, and the replica was put in a wooden frame instead of a scroll. The size of the frame was 98.0 cm long and 72.0 cm wide. The reproduced Buddha image was compared with the original image. Figure 9 shows the image of the Buddha painting enlarged two fold in both length and width. The size of the original Buddha painting was 40.8 cm long and 26.0 cm wide. Comparing the reproduced image with one the same size as the original, the enlarged image has still a high resolution without obscuring. Furthermore, the spiritual property of the Buddha replica was evaluated based on the energy flow emitting from the image. Because the size of the Buddha image is larger, more energy is emitted from the image. Therefore, the energy can be transmitted to the observer, and the replica can contain more spiritual property relating to the Buddha mind.

Fig. 8: Replica of the Buddha painting.

(a) Original Size (b) 2 x 2 Size

Fig. 9: Image of the Buddha painting enlarged two fold in both length and width.

(b) Overlap

The mind transmission can be achieved using sounds and characters, which represent the Buddha mind. Breath causes an energy flow through the throat, which results in the generation of voice and sound [26]. Furthermore, the voice is described in the characters, and each character has a certain meaning. Characters such as in a *Siddham* script carry a special meaning. Figure 10 shows the *Siddham* scripts for *Amitaabha*, *kSitigharbha*, and *Avalokitesvara*. The script represents the Buddha himself, which is expressed as the Buddha mind. On the other hand, the voice and sound play an important role in mind transmission. In Shingon Buddhism, for example, a special sound expressed through a mantra is used for newly opening the Buddha's eyes. Monks chant mantras to a Buddha image, and an energy flow into the image can be achieved. Thus, both their voices and the scripts might be useful for a mind transmission into the reproduced image. As a result, the Buddha mind can be manifested by attaching and overlapping the image of scripts onto the Buddha replica. As another way for transmitting the mind, the imaging data of a script can be overlapped over the Buddha imaging data in a computer. As a result, the overlapped image shown on the computer screen can provide a spiritual feeling to the observer.

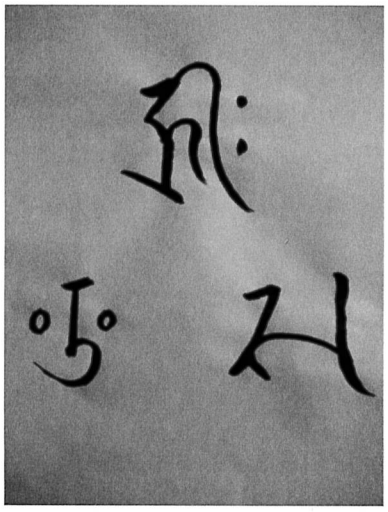


Fig. 10: *Siddham* scripts for *Amitaabha*, *kSitigharbha*, and *Avalokitesvara*.

(c) Smart Replica

The value of a replica increases with an increase in additional properties that are not present in the original painting. For the case of old writings, additional information contained in a replica has an important role in increasing its value. For example, archiving information such as who, when, where, what, why, and how can be added to the replica using the IT technology. As a result, a replica differs from the original writing, and can be defined as a smart material that contains information as well as the intrinsic properties of the material.

Figure 11 shows a replica of a Buddha painting. It has a symbolic mark on the lower and right sides, which indicates an information symbol such as a QR code or IC tag including a URL address. When the observer places their smart phone over the mark, an access signal is transmitted to the data file. The archived information, which is described in the appendix, is recorded in the data file. Thus, a digital information network is formed, and it is possible to obtain additional information for the observer viewing the replica. Therefore, a smart replica is not simply a copy of an original painting, and includes additional information.

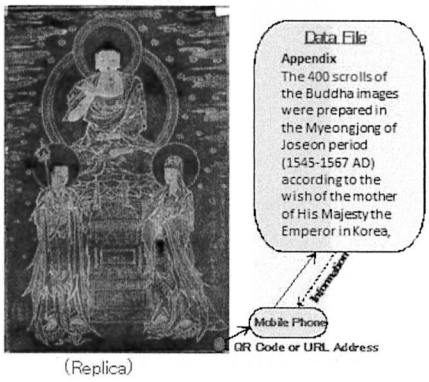


Fig. 11: Smart replica of the Buddha painting.

4. CONCLUSION

The conservation and preservation of cultural heritages have an important role in passing cultural properties to future generations. This requires research into advanced materials as well as advanced technological applications. A Buddha painting, which may become invaluable cultural property in Korea and

Japan, was reproduced using an optical scanning and digitizing method. This method can be applied to the imaging of large-sized artworks and long scrolls. In addition, it can be applied to the imaging of important cultural heritages and significant archives as a non-destructive and non-invasive method. It can also be applied to high-resolution and multi-spectral analytical imaging. The replica of a Buddha painting was prepared through an enlargement, and the enlarged replica showed a high-resolution image similar to the original painting. In addition, a replica with a QR code or IC tag including a URL address was demonstrated as a smart material. Archiving information (see the appendix) can be accessed through the QR code.

Furthermore, the basic concept of spiritual materials was proposed and discussed based on reproduced images of a Buddha painting. Mind catching and transmission technology was demonstrated using Buddha images and *Siddham* scripts. Such advancing technology has attracted significant interest in its application because it might be able to respond to the spiritual energy flow between the Buddha image and the observer. Therefore, the reproduced image was not only a replica of an original Buddha painting, but also a spiritual material providing special feelings to the observer.

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APPENDIX

A total of 400 scrolls of Buddha images were prepared in Myeongjong during the Joseon period (1545-1567 AD) according to the wishes of the mother of His Majesty the Emperor in Korea, but only six remain as they were at that time. Seoul National museum holds one of them, which shows *BhaiSajya-guru* as the main Buddha. With regard to the 400 scrolls, four kinds of *Tathagatas* as the Main Buddha, namely, *Amitaabha*, *BhaiSajya-guru*, *Shakyamuni*, and *Maitreya*, were painted on 100 scrolls each. The main Buddha for the remaining scrolls was *BhaiSajya-guru* (4 scrolls) and *Shakyamuni* (2 scrolls), and no other *Tathagatas* have been discovered thus far in the world.

Saimyoji-Temple, which has preserved an original Buddha (*Amitaabha*) painting, is located in the north-west area of Kyoto, Japan. The temple was founded during the Heian period (824-834 AD) by a Japanese monk named Chisen. He was one of the disciples of the saint monk Kukai. The temple was damaged several times during different wars. It was burned down prior to 1,600 AD, and another monk named Myonin appearing at the beginning of the Edo period reopened the temple. The present main hall was built in 1,700 AD. Myonin died on Tsushima Island in 1,615 AD on the way to Daimeiji-Temple in China while passing through Korea. When he died, he carried a scroll of the Buddha painting. The painting has had an important role in cultural exchanges between Japan and Korea and China.

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