

UTILIZATION OF DIGITAL TECHNOLOGY TO PRESERVE CHINESE WALL PAINTINGS AS CULTURAL HERITAGE

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Abstract: According to historical records of Admiral Chengho's arrival, Jamblang Indonesia has existed since the fifteenth century. The temple in Jamblang has a very valuable historical heritage. Classic Chinese stories are displayed in paintings that cover every wall of the temple structure. However, the condition of the paintings is not good due to damage from incense smoke, faded colors, and cracked and moldy walls. The Chinese paintings on the temple walls are evidence of traces of Chinese culture which has a long history. The paintings were left unattended due to a lack of understanding and care, increasing the possibility that they would become increasingly blurry or perhaps disappear under the cover of incense smoke. This research aims to utilize digital technology as a solution for documenting these paintings to preserve and revitalize them. The methods used are documentation and digital image processing. Documentation is carried out by taking a photo of each image at eye level to minimize distortion. The difficulties faced were a narrow place to take photos with minimal distance, paintings that were blocked by several temple artifacts, lighting in the room that was very dark, and image tracing that was almost faded. The photos obtained are collected and processed using digital technology. Each part of the wall painting is documented, corrected and traced to obtain a collection of paintings in digital form that can be applied to various types of media. This research produces an image-processing framework for digitizing documentation to preserve cultural heritage. The results show traces of a high-value culture that has existed for a long time.

Keywords: cultural heritage, digitizing documentation, image processing, wall painting

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INTRODUCTION

Chinese culture is one of Indonesia's cultural treasures (Weifen, 2022). When the new order government banned the appearance of Chinese culture and the Chinese language in public places, the existence of temples was still permitted. Human resources have experienced a lost generation of Chinese culture, while the heritage of the building and its contents remains. There is still a lack of cultural provisions owned by the Chinese community to maintain this cultural heritage (Dewi and Debby, 2019; Gunawan et al., 2023). Several temples attempted to preserve their cultural heritage by tracing and making new paintings. However, they lacked the drawing skills and cultural awareness necessary for their efforts to be considered historically valuable. Dharma Rakhita Temple is one of the oldest temples in Indonesia. The temple underwent renovation around 1785, according to the notes scrawled on its walls, although the year of its establishment was not recorded. Based on the myths in the community, it is believed that the temple was built in the 15th century at the same time as the Sang Cipta Rasa Mosque and Cirebon Kasepuhan Palace (Rusyanti, 2012).

On the walls of the temple, there are panels of Chinese paintings containing classical Chinese stories. The condition of the paintings is still reasonably good because most paintings can still be seen. However, unfortunately, some paintings look faded due to a lack of attention and knowledge in cleaning the painting panels. The panels have been cleaned inappropriately, leaving many scratches and causing some details of the paintings to become damaged.

Objects, structures, or buildings can be proposed as Cultural Conservation Objects if they meet the following criteria: at least 50 years old, have an essential meaning for education or culture, and have cultural values that strengthen the nation's personality (Presiden Republik Indonesia, 2010). The paintings on the walls of the Dharma Rakhita Temple are at least 238 years old (1785-2023), have historical and cultural value, and are one of the cultural assets of the Chinese-Indonesian nation (Aly et al., 2024; Gunawan and Lesmana, 2023; Susanti et al., 2022), so these paintings are essential to be maintained and preserved. Until now, there has been no preservation carried out by any party. Weather, rituals, human activities, and lack of maintenance damaged the painting more (Barani et al., 2022; Zhang et al., 2013). There has been research that has restored paintings by making synthetic pixels to repair damaged images (Pei et al., 2004) and color restoration (Nikolaidis and Pitas, 2001; Wei et al., 2003), but this study aims to document existing data before it becomes more damaged because there are not enough human resources to restore and maintain/preserve the paintings. Utilizing information and communication technology as the primary method for organizing, recording, sharing, and promoting cultural sustainability

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is known as cultural digitalization (Rustiyanti et al., 2021). Digitization of cultural heritage will help sustainable development because cultural heritage risks gradual extinction (Macri and Cristofaro, 2021; Ratnayake et al., 2018).

Digitization is the process of transferring conventional things into a digital format. Nowadays, almost everything is digitized, including works of art. Using the help of devices, artists can create works of art digitally without reducing the value of their work. In addition, digital works last longer because of their digital-based format. This digital-based format also makes storage and deployment easier. Digitizing paintings can be a solution for preserving images from paintings and can be stored for an extended period (Kamposiori et al., 2019). The digitization of the paintings is essential to preserving the paintings on the temple wall panels. Of course, digitizing paintings can also be used as learning material, such as knowledge of the techniques used by ancient painters that might be implemented in contemporary works of art to add to the uniqueness of a work. Even as time goes by, digital recordings will continue to maintain their quality, and in the future, they can continue to be viewed by the public. It can also be an attraction for Jamblang Village to try to attract the attention of tourists who like works of art. Compared to the restoration technique, the advantage of this research is that the results are in the form of PNG files (Portable Network Graphics). PNG format reserves all the information on image quality, preventing data loss during compression. Since the PNG format supports transparent backgrounds, any background for various media, especially for promotional media such as souvenirs can be used with a PNG image.

MATERIALS AND METHODS

The process of documenting the paintings on the walls of the Jamblang temple was carried out two times. The first data collection uses a 3D scanner, digital SLR camera, and drone camera to document the painting. There are 92 panels of paintings that cover all sides of the walls of the temple. The left wall is the story of the Three Kingdoms (三国演义 *Sanguo Yanyi*), and the right wall represents the Chronicles of the Eastern Zhou Kingdoms (东周列国志 *Dongzhou Lie Guozhi*). These Chinese classical works are usually used as a philosophy of life. Each side of the wall is photographed in one whole photo (Figure 1) as a guide for the order of the painting panels, and then the panels are photographed one by one.



Figure 1. One side of the Jamblang temple wall is filled with Chinese paintings

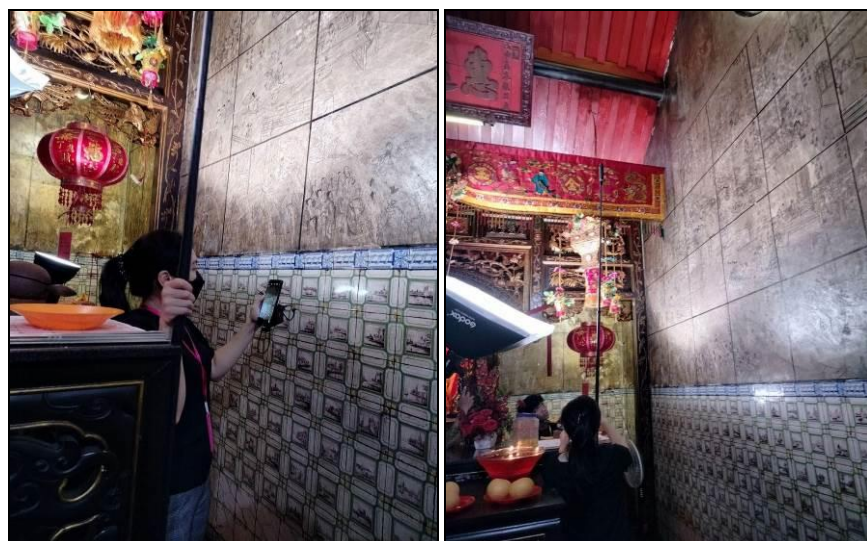


Figure 2. The process of taking pictures with a 360 camera in Jamblang temple

The documentation process took approximately four hours. A 3D scanner was used to obtain a more detailed image of the painting panel, but the results were ineffective due to the lack of light and the position of the painting panel being too high, as well as the scanning process, which took quite a long time. Several shots were not recorded because the cloth trim on the walls obstructed them, the harsh wall lighting reflecting off the shiny surface of the paintings. The second image was taken using a 360 camera, a 2-meter selfie stick, studio lights and a softbox (Figure 2). The results of the second shot with Insta 360 are more apparent and complement the previous data.

Parts of a mural photo that are not clear due to light reflection because the surface of the wall is shiny or has been damaged by hard rubbing when the wall was cleaned can be shown more clearly by changing the brightness and contrast levels in certain parts using digital software and adding lines and colors on the missing frescoes.

RESULTS AND DISCUSSION

Enhancing the Images

One of the complex problems in image processing is picture enhancement. The goal of the image enhancement approach is to improve the visual attractiveness of the digital image by making it smooth or sharp. In the field of digital image processing, this is a crucial subject (Papadakis et al., 2010). It can facilitate reliable information extraction from the augmented images for people and machine vision algorithms. Several options are available for enhancing photos' visual quality thanks to digital image enhancement techniques. Image deblurring, image sharpening, brightness, contrast, signal-to-noise ratio, resolution, and color correctness are some methods to enhance the visual quality of an image (Mustafa and Abdul Kader, 2018; Shukla et al., 2017). This study proposes steps for an image processing framework for digitizing documentation (Figure 3). Most of the photos taken have perspective distortion due to the high position of the painting panel. The painting panel photo is transformed by pulling the four corners so that the distorted painting panel returns to the correct size ratio. The painting panel is then cropped around the border of the frame (Figure 4).

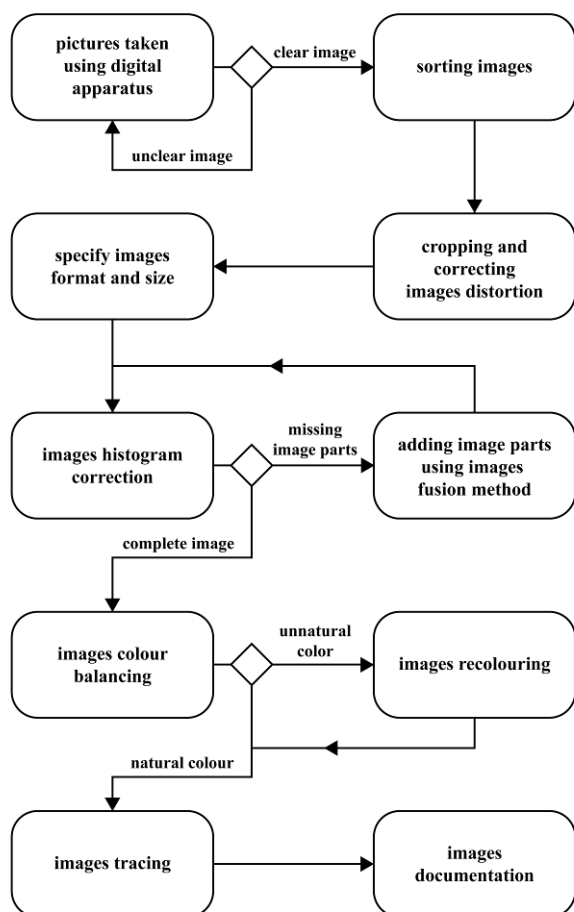


Figure 3. Image processing framework for digitizing documentation

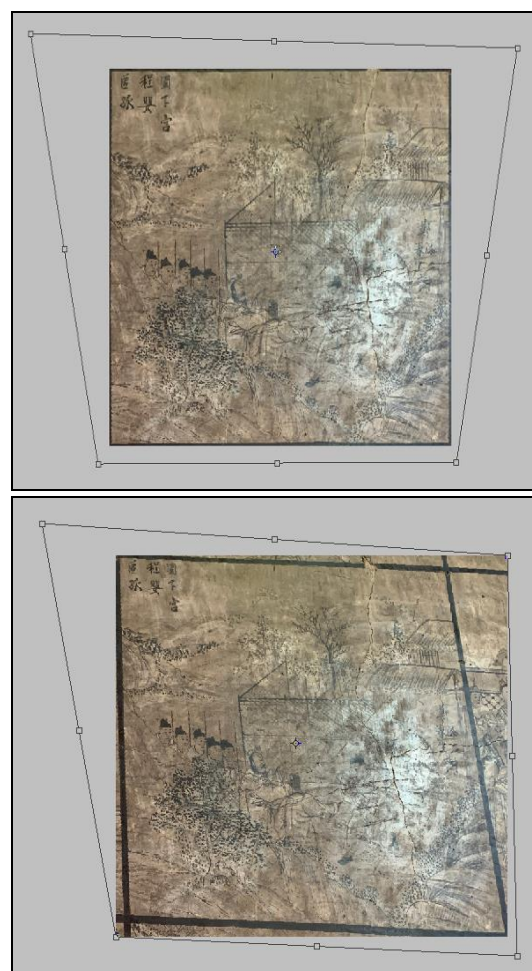


Figure 4. Correcting distorted images using transformation tools

The image size of the painting panel is changed to the specified width, height, and image resolution format. In this case, the width is 225 mm, the height is 225 mm, and the resolution is 150 pixels/inch. This size follows the bottom row of panel photo formats, which can still be photographed in parallel. Image retouching steps start with the histogram equalization technique. Histogram Equalization (HE), according to many academics, is a quick and easy way to boost contrast and enhance image quality (Kong et al., 2013; Longkumer et al., 2014). The average intensity value was applied as a separating point to differentiate between dark and bright areas. A predominantly dark image would tilt towards the grey scale's lower

end. The histogram's dark end would be filled with image detail (Figure 5). The image would be considerably clearer if it could extend the grey levels at the dark end to make a more evenly distributed histogram (Figure 6) (Kaur and Kaur, 2015).

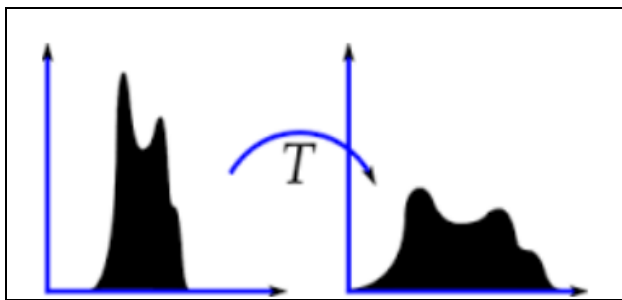


Figure 5. Histogram stretching/equalization technique to get a clearer image (H. Kaur and Sohi, 2017)

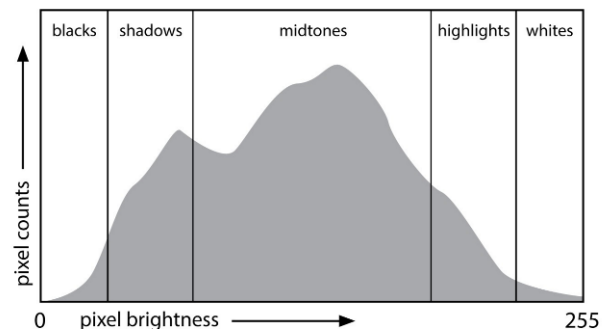


Figure 6. Proper exposed image histogram

Histogram is a tonal range of the pixel in a picture/image, the distribution of dark and light pixels—black pixels on the far left and white pixels on the far right. The middle represents the mid-tones. Most of the excellent image has a histogram shaped like a mountain in the centre, with enough mid-tones, balanced shadows and highlights, and contrasting black-white areas. Images captured by digital cameras in automatic mode are already in the direction of a good histogram, which is neutral / balanced. Still, the tracing process requires more visible detail and contrast.

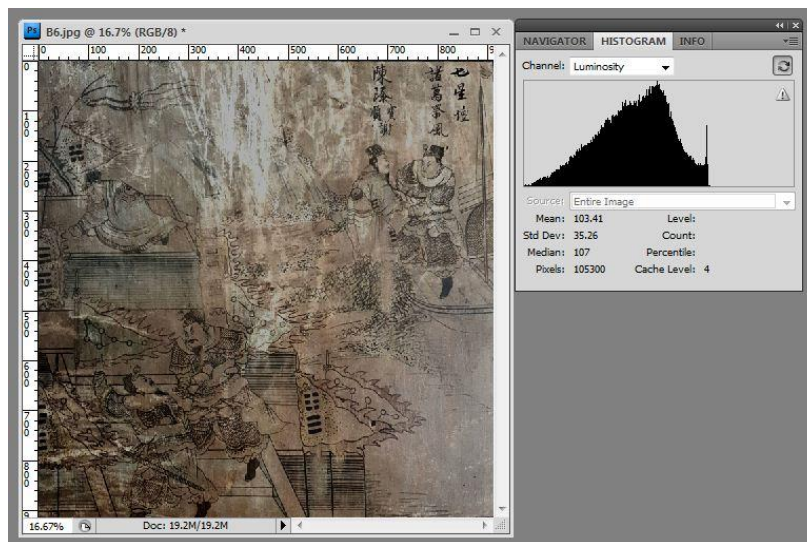


Figure 7. First step in the HE process

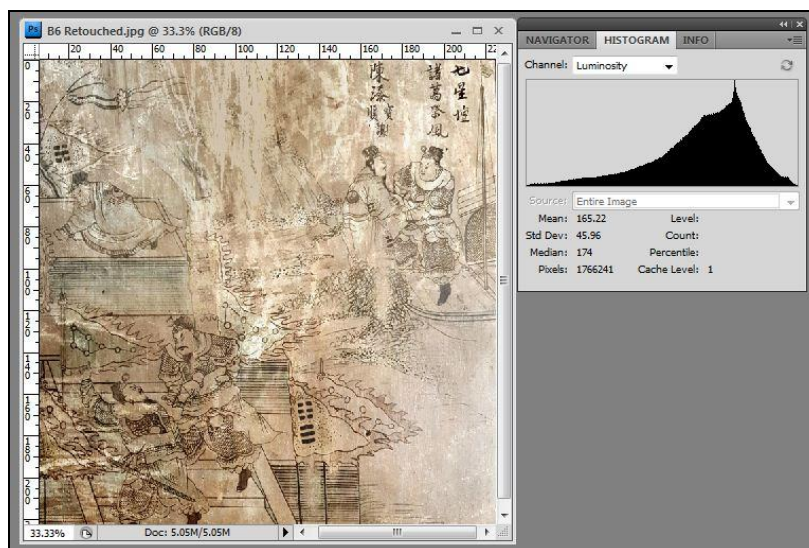


Figure 8. Second step in the HE processes

The initial histogram is very lacking in highlights and has no white areas. Therefore, the mean and median must be added to exceed 150 points. Mean and median values are 0-255 points (Figure 7). A clearer image is obtained by

shifting the Histogram boundaries using levels or curves in the Adobe Photoshop program. The figure forms a graphic like a mountain touching both ends of the black and white sides, with a mean of 165 and a median of 174. A good mean and median score is between 150 and 180 points (Figure 8). This measurement is based on the brightness of the monitor or tablet screen during the tracing process. It only applies to flat images (without foreground and background).

Contrast enhancement techniques are used to increase the brightness levels in an image's range so that it can be displayed effectively. Using color-balancing procedures based on the theory of Retinex (Guo et al., 2023), the base color of the image was transformed from reddish or bluish to more natural (Figure 9).



Figure 9. Color-balancing procedures for natural color

The fusion approach was used to fix areas of the image that were altered by light reflection or harmed by vigorous rubbing (Figure 10). The process of integrating several images into one while maintaining the relevant characteristics of each image is known as the image fusion method. The approaches based on image fusion often use images captured under various exposure circumstances as input to get multiscale features. Numerous generated images are typically combined in multiple exposures with fusion-based image enhancement to recover features and correct color biases (Guo et al., 2023).



Figure 10. Image fusion method to recover lost details

There are some images where the lanterns are so close that they are exposed to an intense red glow. For images in such conditions, the initial step is to remove all the colors from the image (converting the image to grayscale) then colorize the

image to close to the natural color (Figure 11). Pictures of painting panels are arranged in the order of their placement so as not to get confused in the naming and discussion, according to the storyline (Figure 12).

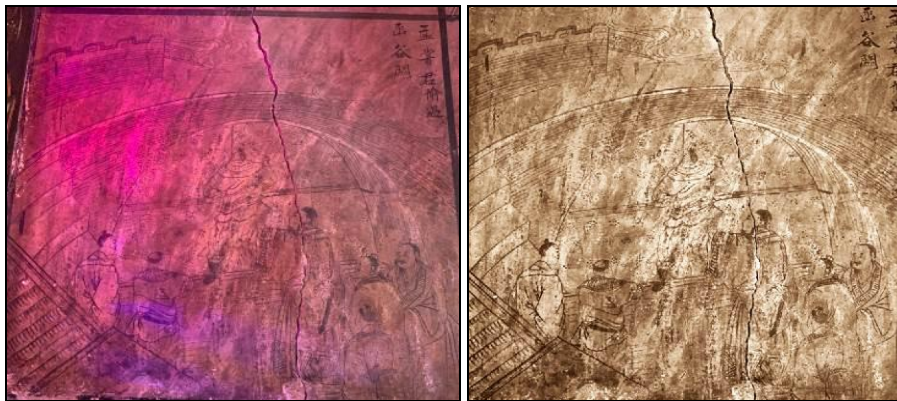


Figure 11. Re-coloring the image in natural color

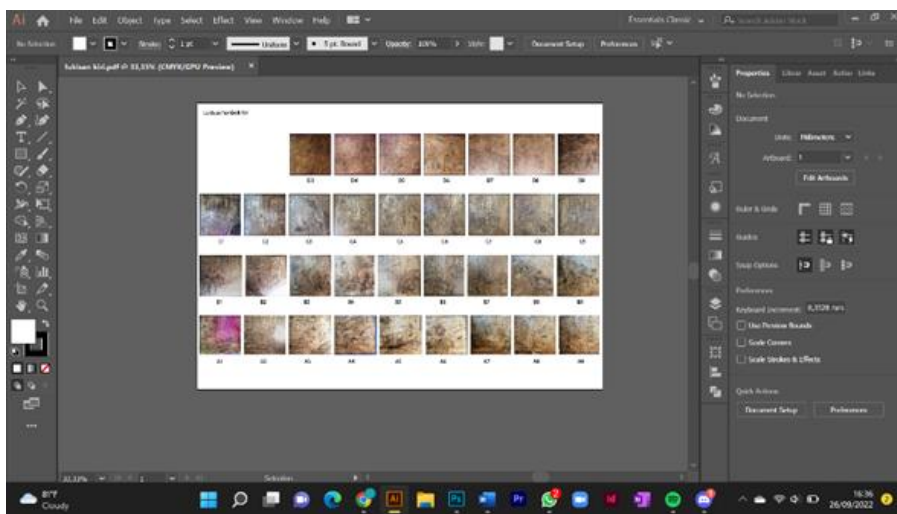


Figure 12. Painting panel arrangement

Images Tracing Method

The tracing procedure is generally straightforward, but knowledge of Chinese painting techniques is required for optimal results. The tracing procedure requires much time because several minor details cannot be overlooked.

The tracing process uses the Procreate and Adobe Illustrator applications. Procreate is a digital drawing application that includes many brushes (Figure 13). Before starting the tracing process, research is carried out on references to ancient Chinese paintings with an era similar to the stroke style seen on the painting panels. It is used to know the shape/type of lines and the shape of the characters and motifs in the painting.

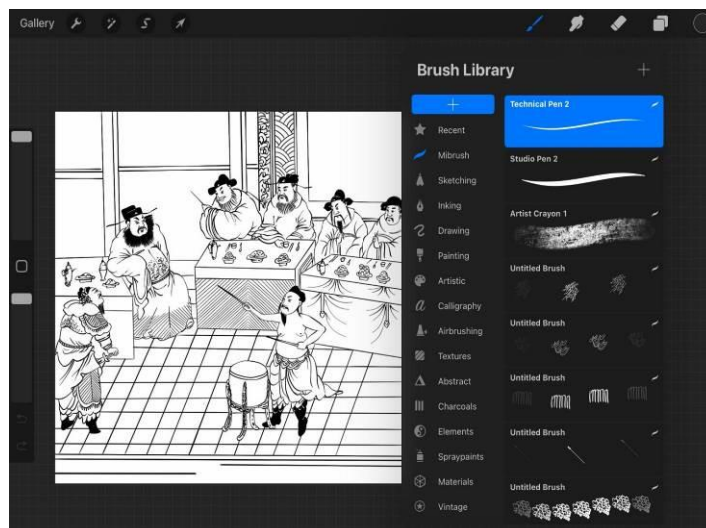


Figure 13. Tracing with various digital brushes

Traditional Chinese painting has two brush methods, namely fine strokes (工笔 *gongbi*), drawing with detailed strokes, and spontaneous strokes (一笔 *yibi*), drawing with free strokes (Zhou and Hang, 2006). The technique used in wall paintings of the Dharma Rakhita Temple use a fine strokes technique that emphasizes neat and thorough strokes.

There are six principles in understanding Chinese painting written by Xie He, a Chinese Art Historian, in the book Ancient Paintings (古画品录 *Guhua Pinlu*) circa 550 (Briessen, 1962). This principle can be applied in the painting tracing process:

1. Spirit Resonance (气韵生动 *qiyun shengdong*): energy displayed through animation so that the image looks alive. The tracing process needs to be assisted by referencing Chinese paintings and the characters written in the story to find out the description of personality and gestures in the shape of the character's face or limbs (Figure 14).



Figure 14. Gestures to suggest fighting animation; Figure 15. Rendering shadows and textures; Figure 16. Objects based on appropriate shapes

2. Bone Method (骨法用笔 *gufa yongbi*): a method of rendering shadows and textures such as rock and mountain textures using light ink. Even though the panel photo that has been taken from the painting documentation shows a vague painting, the traces of ink on the painting show how detailed and precise the painting is. Clothing details and environmental textures such as leaf, rock, soil, and water textures are still there and can be traced back in detail (Figure 15). Painting references are used mainly to help draw facial structures and stroke techniques. It is because the painting is starting to fade, and the details of the character's face are not visible enough. The opacity of the photo panel is lowered so that the tracing results on the layer above can be seen. Tracing is done using a brush technical pen and studio pen. Custom brushes are created for repetitive parts such as leaves, bushes, and other images to make tracing easier and faster.

3. Correspondence to the Object (应物象形 *yingwu xiangxing*): Understanding shape first before tracing lines so that you can draw the appropriate shape. Image references according to the characters in the story will significantly assist the tracing process. The tracing process is done by placing a retouched painting panel photo on the background, then using a Wacom tablet, the visible image lines are traced by drawing directly on top of the image layer. Decorative details on clothes or tables and less visible walls are drawn based on the reference images obtained (Figure 16).

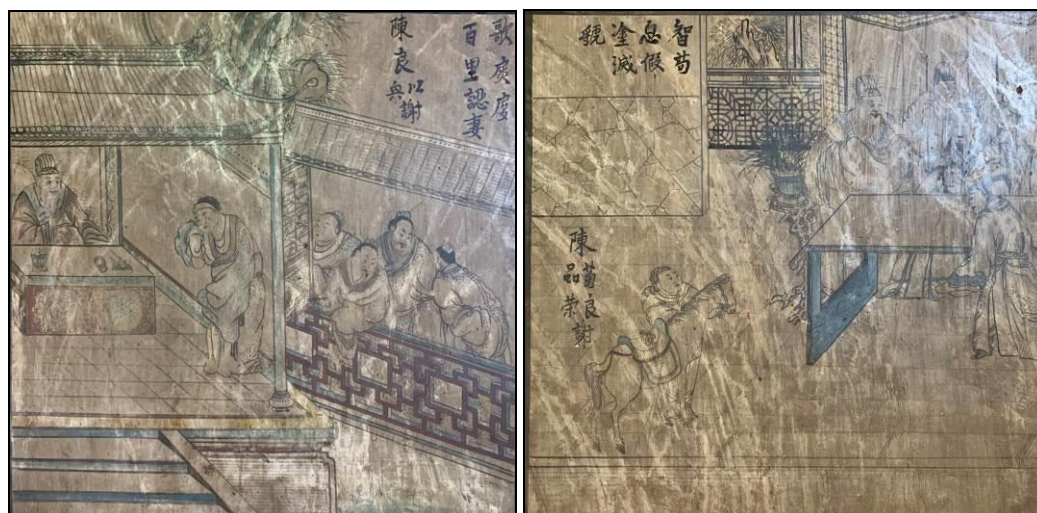


Figure 17. Panel with traces of colors

4. Suitability to Type (随类赋彩 *suilei fucai*): application of color. Only a few panels of the painting are still very light in color. The colors used are blue, red, and yellow (Figure 17). In tracing, only thick and thin strokes are applied. To make the image uniformly colorless, colored images are not displayed in color

5. Division and Planning (经营位置 *jingying weizhi*): Position settings such as composition, space, and depth. Tracing several panels of the painting with more explicit details gives the impression of space and depth (Figure 18).

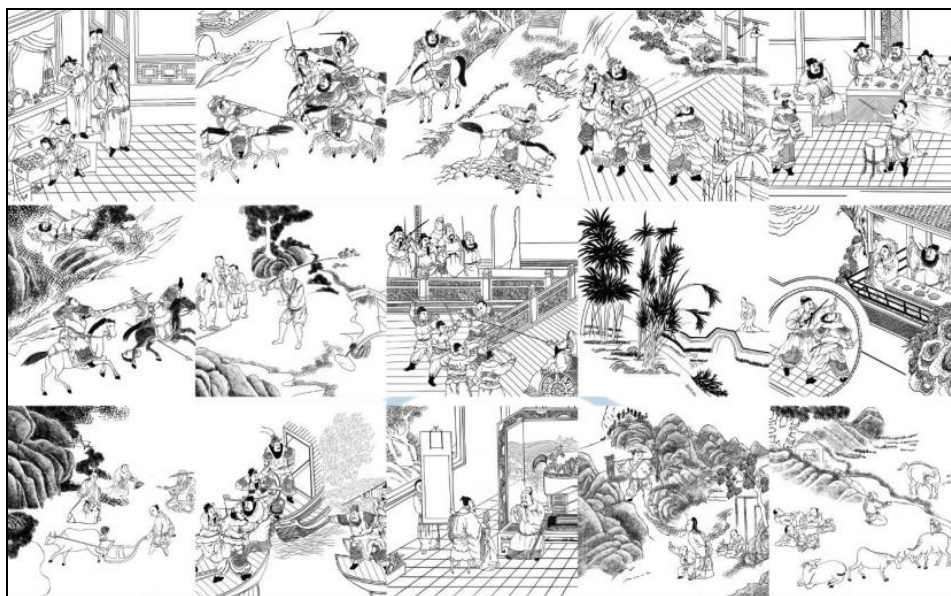


Figure 18. Panels showing composition, space, and depth

6. Transmission by Copying (传移模写 *chuanyi moxie*): copying ancient works to preserve and support heritage sustainability. The results of digitizing the main heritage images (Figure 19) will be used as digital documentation and research references. However, they can also be applied in souvenir items, such as postcards, drinking bottles, and t-shirts, to support the sustainability of local culture and economy (Susanti et al., 2022).



Figure 19. Original and traced painting

<p>A1 玄德进位汉中王</p> <p>Liu Bei becomes the king of Hanzhong.</p> <p>Liu Bei and his troops succeeded in seizing the city of Hanzhong from Cao Cao's rule. Liu Bei crowns himself king of Hanzhong in order to unite the generals and officials.</p> <p>Moral of the story: Big achievements give birth to big responsibilities.</p>	

Figure 20. Description and comparison of the painting

Traced images are arranged hierarchically and coded to determine the order in which they are placed. Results from the tracing are matched with readily apparent images. The title is given according to the image's code, and the subject matter and the painting's meaning are described (Figure 20). Then the image data and descriptions are arranged in a documentation sheet.

CONCLUSION

Over time, these cultural heritages rich in ornaments will gradually wither away. Utilizing digital technology to preserve cultural heritage is a solution that can be done today. There are 92 paintings on the temple's walls, and tracing took about three months to complete. Of the 92 paintings, 18 cannot be obtained, with a different level of damage in each. Although digitization can be preserved, a completely damaged image cannot be traced to the original image. This research aims to obtain digital data from wall paintings so that with their current existence still far from restoration experts, at least this digital data can one day be used as data for restoration. This research method can also be used to digitize various other cultural heritage sites that cannot yet be reached by restoration experts. This technology result has been done to document all the Dharma Rakhita Temple's walls and applied as promotional media such as souvenirs. The public and researchers can use digitization results to understand the existing narrative. For the government, this is reference data for revitalizing building ornaments. Paintings that have been digitized can be used as a medium to attract tourists, especially groups of tourists who are attracted to works of art. Through digitization, the existence of the wall paintings at the Dharma Rakhita Temple will also be better known by the public, both the people of Jamblang Village and the outside community. The limitation of this research is that the tracing process of the image is not completely clear, resulting in image distortion from the original image. For further research, it is necessary to do research regarding the application of digitization assisted by AI technology, which can speed up, simplify and produce images with more optimal tracing results.

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