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Lithophane Art Process Setting in Using 3D Printing Technology

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Abstract
This study is to develop a 3D printing method for producing lithophane. Images created by Lithophane are three-dimensional and change depending on the light source behind them. By heating the lithophane to the melting point and depositing layer by layer, a 3D-printed lithophane model was created. For the 3D-printed lithophane model, the ideal thickness is 3 mm, white is the appropriate colour, and the light intensity and distance is 50 mm, according to this research. This study is significant because it contributes to the advancement of 3D printing technology's ability to produce high-quality lithophane and opens up new knowledge perspectives.

Keywords: Lithophane, Process Setting, 3D Printing Technology

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1.0 Introduction

The human creative spirit is most clearly manifest in the arts and the sciences. As a result, the combination of scientific research with creative endeavours has the potential to open up fresh avenues for artistic expression. In this study, we show 3D-printed lithophanes that have a creative strategy behind them as well as an aesthetic component. These lithophanes will utilise both artistic innovation and technology advancement. The origin of the word "lithophane" can be traced back to Greek, when it was given the meaning "to emerge in stone." In the western world, porcelain craftsmen are credited with being the first to manufacture lithophanes about the year 1820; nevertheless, it is unknown who first devised the procedure (Sammy, 2020). In addition, there is the hypothesis that lithophanes were first developed in China over two thousand years before they were discovered in Europe. The evidence for this can be found in ancient accounts of "paper-thin ceramics" that have concealed motifs embedded in them (W. Jennifer & I. Todd, 2019). The lithophane, in general, is a very special work of art that was created in the past and has evolved over the course of many years. When illuminated, an engraved or embossed image in a three-dimensional model known as a lithophane will appear in crisp relief. The image that is hidden within of a lithophane is revealed when light is shone through the lithophane. In addition, the lithophane has a three-dimensional image that is brought to life by a light source that is placed in the space behind the lithophane. To put it another way, lithophanes are images that can be made by controlling the amount of light that passes through a substance.

In more recent times, lithophanes have been manufactured with the help of technology known as 3D printing. The process begins with the tones of a black-and-white photograph, and then milling or printing a solid item from a semi-transparent material follows (T. Cavanaugh & N. Eastham, 2017). The technology of 3D printing is utilised for a wide range of products in the industry, including digital modelling, manufacturing, and educational materials (Stephen Hoskins, 2013). Additive manufacturing is another name for the process that 3D

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printing technology uses to create three-dimensional items. This process involves stacking or linking raw components to create the object. With the expiration of the patents covering this technology, three-dimensional printing has developed into a wide variety of applications using technology derived from the information technology industry. One of the most prominent examples is lithophane, which can transform a two-dimensional picture into a three-dimensional object. This study is important because it makes a contribution to the development and growth of knowledge in the field of generating high-quality lithophane through the use of 3D printing technology. This is a topic that has been advancing rapidly in recent years.

2.0 Literature Review

This study is fundamental as it contributes to the development and valuable knowledge perspectives related to the method of producing lithophane using 3D printing technologies. More specifically, the aim was to determine the ideal thickness and suitable color for the 3D printed lithophanes. This research also helped to determine the suitable light intensity and spacing for the 3D printed lithophane.

In the 1820s, a method that was initially developed in France and Germany resulted in the production of lithophane. However, it's possible that Chinese porcelain is where lithophanes got their start (Carney 2007). Long before the development of the camera and the accompanying growth in popularity of photography, this lithophane product was initially created on a big scale for the very first time in the early 1820s. In the past, a picture that changed its look according on the lighting that it was viewed in was depicted by a lithophane. Lithophanes were created using a technique called lithography. The typical way of producing lithophane results in the surface having the illusion of relief; nevertheless, there is actually only a modest amount of depth overall.

This lithophane process has a remarkable capacity to capture the tiniest details and textures. The lithophane has always been seen as inferior to both the etching and the mezzotint, both of which are considered to be the gold standard in the world of fine arts. Unlike the printmaking process that uses colour or ink, the images displayed in lithophanes are generated by altering the thickness of the material when it displays through the light. This is done in contrast to the use of colour or ink in printmaking. Shining a light behind the lithophane reveals every element of the porcelain scene. It like paintings, etchings, and prints, but three-dimensional. The lithophane technique, which resulted in three-dimensional porcelain reproductions, was used to generate an identical replica of the engraving that had been done originally.

The term "3D printing" refers to a technology that enables the creation of three-dimensional things through the successive addition of a large number of thin layers. Printing in three dimensions has seen explosive growth over the past two decades, and it is currently employed by a wide variety of large firms, including Ford, Mattel, and General Electric. It is anticipated that three-dimensional printing will be the next paradigm shifter; however, given that the technology is still in its infancy, this prediction cannot be made with absolute certainty. There is still a lot of scepticism surrounding 3D printing due to the fact that it has a lot of uncharted territory and the fact that the technology has recently sparked worries about security and piracy issues. The term "3D printing" is widely used to refer to an assembly method in which the final form of an object is the result of the addition of several layers to build the object's frame. This approach is also known as "additive manufacturing" or "additive layer manufacturing."

The technology behind 3D printing has made it quite easy to make 3D models from photographs. The processes of additive manufacturing and 3D printing both allow for the production of three-dimensional solid objects. The term "additive manufacturing" refers to a process in which an object is constructed one layer of material at a time using successive "layers" of material. The principle of addition is employed in fused deposition modelling (FDM), which involves layering molten material to create three-dimensional structures using the additive method. The three-dimensional object is constructed one layer at a time by extruding filament from the spool and then heating it to the point when it melts. The fabrication of the lithophane with the use of 3D printing will use the FDM method. In order to create the lithophane, this procedure requires heating the components until they reach their melting point, after which they are deposited one layer on top of the next.

This method, which is also known by the moniker rapid prototyping, is referred to by still another name: additive manufacturing. The word that more accurately represents what is being done is "additive manufacturing." In any case, the idea that is commonly referred to as "3D printing" emerged not too long ago and has been a significant factor in the development of contemporary innovations across a wide variety of fields, including the field of art (Adam, 2021). Printing in three dimensions is becoming into an increasingly mainstream practise all across the world. The fields of agriculture, healthcare, automotive, and aerospace are just some of the industries that are increasingly making use of the technology of 3D printing for mass customization and the manufacture of open-source designs. Other industries that are also increasingly making use of this technology include the entertainment industry (N. Shahrubudin, 2021). The process of three-dimensional printing has evolved into a method that is highly versatile and effective in the business world over the course of the past few years. This technology has been put to use in a significant number of different countries, most notably in the manufacturing sector of those countries. As a direct result of this, the primary focus of this paper is on the suitable application of technology for 3D printing to the manufacturing of lithophane.

The future poses considerable problems for the methods of mass production due to the rise of 3D printing. It is anticipated that this form of printing would have an impact not just on businesses but also on hobbyists.

3.0 Methodology

3.1 Research Design and Approach

Observational approaches involve personally visiting various sources in order to locate, acquire, and gather information on those sources. The findings are documented in a variety of ways, including still images, video recordings, handwritten notes, and others. The purpose of

this research is for the researcher to attempt to watch the procedure of generating 3D printed lithophane utilising the correct way. A conversation will be held after an experimental project that is a part of the research. It is intended to establish a viable process for producing 3D printed lithophane that validates the following three hypotheses:

H1 The ideal thickness for the design of the lithophane is 3 mm.
H2 White is the most suitable color for the 3D printed lithophane model.
H3 The best light intensity and distance for the 3d printed lithophane is 50mm.

3.2 Experiment

3.2.1 Lithophane Design
In this research, the software that has been used is from 3drocks/Lithophane website to create the lithophane model.

3.2.2 Model Slicing and G – Code Generator
For model slicing and G- Code Generator, Ultimaker Cura was used. This slicing software is an open-source software that is compatible with any type of 3D printer. Moreover, it is a free software and easy to use. The STL or OBJ file can then be imported into the Cura software. There, the model is sliced into layers to create a file known as G-code. This is the code that a 3D printer understands.
This G-code is simply a text document with a list of commands for the 3D printer. The Cura Slicing software requires these hardware details in a printer profile. Once it knows the required details, you can specify settings like layer height and thickness. Using the printer's vital statistics and your settings, Cura calculates the path the printhead needs to take to print your model and creates a list of instructions for the printer. These instructions are stored in this G-code file. The G-code can then be stored on a SD card or sent directly from Cura to the printer over wireless or cable, depending on the printer. Here are the steps to create the model slicing and G-Code Generator for 3D printed lithophane.

*3.2.3 Lithophane Printing Proces***s**
In this research, the software that has been used is from 3drocks/Lithophane website to create the lithophane model.

3.3 Validation
3.3.1 Physical Kit of Experiments Project and Assembly
In the course of this study, the researchers devised a straightforward method of assembly for the purpose of illuminating the completed 3D-printed lithophanes from within so that they can be exhibited on the three lightboxes that have been built. The researchers developed three lightboxes, each of which has a distinct distribution of light intensity throughout its surface. In order to set it up, you will want not just the lithophane that was manufactured using a 3D printer, but also a DC voltage of 12 volts and an extension plug. The thickness of the design, the colour of the 3D printed lithophane model, as well as the light intensity and distance of the 3D printed lithophane are all taken into consideration when displaying the part of the 3D lithophane. The part is displayed in three light boxes. In place of viewing mapped and lighted images is presented here a fascinating alternative perspective. During the course of the experiment, the researchers will validate the 3D lithophane model and decide the differences between it and its quality. At the conclusion of the experiment, the most optimal 3D printed model will be identified based on the thickness or pixels in the design, the colour of the 3D printed lithophane model, as well as the light intensity and distance for the 3D printed lithophane.

4.0 Findings

Throughout the process, researchers were able to test the feasibility of lithophane using 3D printing technology and validate the three hypotheses.
a. The ideal thickness or pixel in the design of lithophane.
To observe how the surface thickness behaves, the researchers conducted experiments with different thicknesses, namely 3 mm, 6 mm, and 9 mm.

According to the researcher's observations, 3 mm is the ideal thickness or pixel for the design of lithophane because the thicker parts within the lithophane block are lighter than the thinner parts. Changing the thickness of the material will result in contrast in the amount of light transmitted. Instead of assuming a lithophane, choose the "darker is higher" concept so that less light passes through the darker parts of the image.
b. The most suitable color for 3d printed lithophane model.
To find the most suitable color for the 3D printed lithophane model, the researchers experimented with different colors, including white, blue, red, and yellow. For blue, we use two different types of colored filament.

According to observations, it is best to use a natural filament color such as white. The way the light shines through the colors looks better, more natural, and transparent. If you use a white filament, you can make higher quality lithophanes. Also, the white filament is translucent, and it's hard to get contrast when you use colored filament like blue, red, and yellow. If you use a colored filament, the light will not be transmitted in the same way as a white filament, but rather unbalanced.

c. The light intensity and distance for the 3d printed lithophane

To analyse the proper light intensity and distance for 3D-printed lithophane, the researchers conducted experiments with different intensity types and spacing of 50 mm, 100 mm, and 150 mm.

According to the observation, 50 mm is the best light intensity and distance for 3D printed lithophane because the image is not overexposed at this scale, and we can see the images of the lithophane. We can see the result as the light spreads from the lithophane. So, the closer you are, the denser the image will be on the lithophane. The further away you are, the further the image has spread to fill the larger area. The brightness of light as a function of distance from the light source follows an inverse square relationship that describes the intensity of light at different distances from a light source. There are different types of light sources, but the intensity changes in the same way. In other words, the intensity of light depends on the light source and the distance from the source. The greater the distance, the lower the intensity, and the shorter the distance, the greater the intensity.

5.0 Discussion

Based on the result, the researchers have concluded that:

i. The ideal thickness for the design of lithophane is 3 mm. This is because the less thick the lithophane, the brighter the image penetrates and the deeper and more transparent it is.

II. White is the most suitable color for 3D printed lithophane models. By using white, the lithophane image becomes more natural, shaded, transparent, and high quality.

III. The light intensity and distance for 3D printed lithophane are 50mm. This is because the image is not overexposed at these distances, and we can see the images of the lithophane. The shorter the distance, the more intense the image of the 3D-printed lithophane. Even when the light is off or on, we can see the image clearly because it is less thick. The image of the 3D-printed lithophane is also more transparent and not overexposed because the distance is less.

This research is important as it contributes to the development and valuable knowledge perspectives related to the method of producing high-quality lithophane using 3D printing technologies.

6.0 Conclusion & Recommendations

To develop a more scientific aesthetic consciousness that hovers over the art itself.

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References

Brooks, H., Lupeanu, M., & Abram, T. (2012). Production of Personalized Lithophane Lighting Products Using AM. Published by DAAAM International Scientific Book.

Jung, Soonchul & Choi, Yoon-Seok & Kim, Jin-Seo. (2020). Stencil-based 3D facial relief creation from RGBD images for 3D printing. *ETRI Journal. 42. 10.4218/etrij.2018-0371.*

J. Weiler et al. (2019). Lithobox: Creative practice at the intersection of craft and technology. TEI *'19: Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction. ACM ISBN 978-1-4503-6196-5/19/03.*

Ngo, Tuan & Kashani, Alireza & Imbalzano, Gabriele & Nguyen, Kate & Hui, David. (2018). Additive manufacturing (3D printing): A review of materials, methods, applications, and challenges. Composites Part B Engineering. 143.10.1016/j.compositeb.2018. 02.012

Nulty, A.B. 3D Printing Part 1 - A History and Literature Review Of 3D Printing in Dentistry. Preprints 2021, 2021050221 (doi: 10.20944/preprints202105.0221.v1).

Sammy Ekaran, 3D Printed Lithophane- Turn Your Art and Photos into Lithophanes, Retrieved from https://3dwithus.com/3d-printed-lithophane-art-photos-into-lithophanes, date of access 11th August 2020.

Shahrubudin, N., Lee, T. C., & Ramlan, R. (2019). An overview on 3D printing technology: Technological, materials, and applications. *Procedia Manufacturing*, *35*, 1286–1296. https://doi.org/10.1016/j.promfg.2019.06.089

Stephen Hoskins,"3D Printing for Artists, Designers and Makers. (2013). Published by Bloomsburg Publishing Picture.