Reconstructing Narrative Space: A Design-Oriented Interpretation of Borobudur Reliefs Using Formal Linear Perspective

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Abstract

The Buddhist scriptures carved into the Borobudur Temple reliefs are presented in 2D form, but they do not yet have a corresponding 3D visual interpretation. The condition of the Borobudur reliefs is significantly degraded due to exposure to weather, human touch, and natural weathering, making it difficult for ordinary people to understand and identify the visual appearance of the reliefs. The aim of this research is to find a spatial interpretation method that can be used as an alternative in identifying the spatial layout of the reliefs from existing methods and to design 3D works from the spatial interpretation results. The research method used is the interpretation of relief images into a 3D point of view. Spatial interpretation uses the Formal Linear Perspective method with the height of the character in the relief as a reference for measuring the distance to other characters. As a result, the researchers found a way to calculate distance using the Formal Linear Perspective method. The researchers implemented the distance calculation results into 3D form. All 3D objects are created using sculpting techniques which are then made into low-poly shapes and rendered images. The result of this research is 3D relief renderings of Borobudur Temple which has implemented spatial interpretation.

Keywords: Borobudur Temple, interpretation, spatial, perspective, three dimensional

1 Introduction

Borobudur Temple is a monumental stone structure. The construction method is indeed very impressive to study. There is a stone locking system that makes Borobudur Temple remain sturdy until now. Borobudur Temple was built on a modified natural hill. The peak of the evidence is the foundation of this great temple. Borobudur Temple is widely recognized as a result of most sophisticated thinking in the construction of monumental architecture and the development of the most sophisticated stupa [1]. Borobudur Temple was built around 760 - 850 AD by the Sailendra Dynasty. This monumental architecture was initially carried out when the Srivijaya Kingdom expanded its territory from Sumatra to Central Java during the Hindu - Buddhist era. Borobudur Temple was built close to Hindu temple sites that were constructed by the previous Hindu Mataram kings. [2].

Borobudur Temple has 1212 decorative relief panels and 1460 narrative relief panels. Each relief panel at Borobudur Temple presents a visual interpretation of stories from Buddhist scriptures [3], [4], [5], [6], [7], [8]. The teachings of Buddha that are the visual narrative of the relief are Laltitavistasa Sutra (the story of Gotama before he was born until he became Buddha), Gandavyuha Sutra (the story of Prince Sudhana seeking a way to enlightenment by visiting and meeting 54 spiritual mentors (kalyanamitra)), Jatakamala (the story of Bodhisatta who transformed into several animals, contains teachings about the power of truth, good deeds, sacrifice and other life values that eventually lead to enlightenment, becoming Bodhisatta), Avadana (meaning religious achievement through good deeds or great achievements, this teaching tells stories of wise deeds), and Maha Karmavibhangga (teachings about the law of cause and effect of human actions) [9], [10]. The Buddhist scriptures carved into the visual interpretations of the Borobudur reliefs are represented in 2D images, and there are no 3D interpretations available [8], [11].

The current condition of the Borobudur reliefs has deteriorated due to weather, human contact, and natural erosion , making it difficult for the public to understand and identify the visual appearance of the reliefs. Despite this, the Borobudur reliefs are intended to convey stories to visitors. The Borobudur Temple was visited by 2.5 million tourists per year motivated by the beauty of architecture, history, and philosophy [12]. On the other hand, the Borobudur's foundation is sinking annually by 1.7 mm due to the high volume of visitors [13]. In addition, environmental factors such as weather, earthquakes and volcanic gases can trigger potential damage to the Borobudur temple [14], [15]. The above facts provide potential problems. These problems will affect the next generation. They will not be able to visit Borobudur Temple. Therefore, a new visiting method is needed to reduce the risk of damage to the temple. One of them is by creating a digital Borobudur temple exploration experience.

As an initiation for the development of virtualization of Borobudur Temple, through this study the researchers investigate the relief by interpreting 2D reliefs into a 3D perspective. This study is important to investigate the interpretation method into a 3D perspective. In addition, the results of this 3D storytelling interpretation are in the form of a digital diorama. It is hoped that this 3D digital diorama will make it easier for connoisseurs to understand the contents of the story in a relief. Clear depictions are made on each component/asset of the Borobudur relief and its spatial layout.

2 Related Work

Previous studies have addressed various aspects of 3D reconstruction from images, digital archiving of cultural heritage, and visualization through narrative techniques. This study focuses on reconstructing the spatial structure of relief artworks by interpreting the composition and arrangement of characters based on the narrative embedded within them. To position our artwork, there is a summary of several relevant existing studies.

Firstly, a methodology for extracting 3D geometry and texture from photographs was proposed for the purposes of modelling and rendering architectural scenes [16]. However, because their artwork emphasizes geometric accuracy, this method provides a foundational technique that contrasts with our interpretive, narrative-based approach. Secondly, a study introduces an AI-based method for reconstructing and analyzing relief heritage from an old photograph, combining viewpoint estimation with semantic segmentation [17]. Despite the fact that both studies concentrate on relief reconstruction, Pan's work places emphasis on automatic semantic recovery, whilst our approach is oriented towards interpretive and compositional spatial structuring.

Finally, Batjargal et al. develop a multimodal digital archival system for Borobudur Temple using photogrammetry, 3D scanning, and multilingual metadata [18]. Although this project shares our focus on digitising cultural heritage, its main purpose is to support documentation and conservation rather than narrative reinterpretation.

3 Narrative Spatial Reconstruction as a Design-Oriented Approach

In the field of narrative spatial reconstruction, several studies have been conducted. A project has proposed a visualization-based narrative workflow." It uses a cultural knowledge graph [19]. Meanwhile, Barzaghi and colleagues have connected RDF metadata with 3D models for semantically structured storytelling [20]. These artworks complement our approach, which reinterprets narrative spatiality from within a single visual relief. In addition, another study critically explores the philosophical notion of authenticity in 3D virtual replicas, supporting the rationale for our interpretive reconstruction [21]. Furthermore, Aiello et al. demonstrate the educational potential of virtual museums, enhancing visitors' understanding of the material they see [22]. Tost and Champion redefine "presence" in the context of VR heritage - an insight that informs our user-centered design philosophy about construction of a new paradigm of interactivity [23]. Building upon prior artworks, our study takes a novel approach, reconstructing narrative spatiality through symbolic composition and character alignment based on formal linear perspective.

4 Formal Linear Perspective (FLP) Method

Some projects have produced and presented 3D models of Borobudur Temple reliefs [17], [18]. However, these projects did not attempt a narrative spatial reconstruction focusing on the content, meaning, and structure of the stories depicted in the reliefs. This research, however, emphasizes how storytelling can be achieved from a 3D perspective based on 2D reliefs.. This research aims to find a method for interpreting relief narratives in 3D perspective. As an initial design experiment, this study uses the Formal Linear Perspective (FLP) method to demonstrate its efficacy for interpreting narratives in 3D perspective.

Formal linear perspective (FLP) is a method for creating a grid of one vanishing point with accurate measurements [24]. The formal linear perspective method uses a grid with a viewing angle of 45 degrees which is a reference for near of far distances [25]. This study uses formal linear perspective to create the grid with slight modifications to the length of the room box and sets one grid square to represent 16 cm. The grid is used to calculate the distance between one object and another. This artistic experiment chose the Avadana relief "On Ship, on Shore" as a study case for interpreting the spatial arrangement using the formal linear perspective method. This relief was chosen because it shows figures of varying heights. The height of people who are far away is smaller than people who are close.

Since practice-led research emphasizes practices as an important part of data collection, this investigation begins with an experiment that adopts the formal linear perspective (FLP) approach. First of all, the researchers make a grid of 1 cm per square in the Adobe Illustrator application with a large enough paper size, then inserted the relief photo that has been added a little of the roof and walls so that it was not cut off. The researchers then determine the location of the vanishing point and horizon line on the relief. At the vanishing point, the researchers create a vertical line extending downwards. This line will later be used to determine a 45^0-viewing angle and create depth of space in the vanishing point perspective. The following is a view of this stage.

In the next stage, the researchers make a box that was bigger than the relief photo to provide enough space for the stilt house object on the left and the ship object on the right. Providing space is essential so that the two objects do not collide with the walls of the imaginary room at a later point. After creating the box, the researchers draw lines from each corner of the box to the vanishing point. The researchers then created a second smaller box to show the depth of the room. To determine the position of the second box, the researchers draw a line at a 45-degree angle until it hit the horizon and then draw another line from the point of intersection to the lower left corner of the large box. The result will be the intersection point in the large box, precisely at the bottom right (Fig. 1).

The intersection point becomes the position of the right bottom corner of the small box which shows the depth of the room. The other corner will follow from the position of the right bottom corner. The following is the picture of this stage. In the next stage, the researchers make the lines that will become the floor of the room. The method is to draw a line from the intersection of the blue grid line with the bottom line of the large box, then draw it to the vanishing point until it reaches the bottom line of the second box.

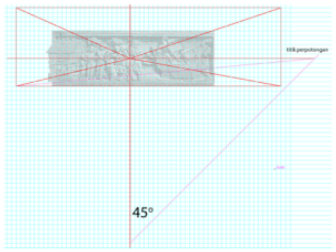

Figure 1 Help point

After the vertical line of the floor is finished (yellow line), the researchers create the horizontal floor line, by drawing a line from the 45^0-intersection point to the intersection point of the blue grid line with the bottom line of the large box. Below is the picture of this stage. The pink line that has been created will indicate an intersection point with the right side of the room.

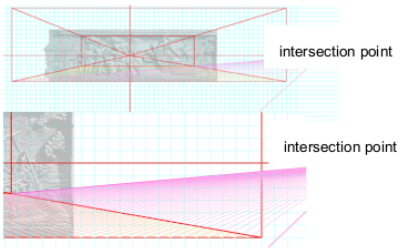

Figure 2 Intersection point

From the intersection point, create horizontal lines that extends to the left side of the floor. The green color is used for the horizontal lines of the floor (Fig. 3a). The intersection of the green line with the left side of the room is used to create a vertical line that will become the left wall of the room (Fig. 3b).

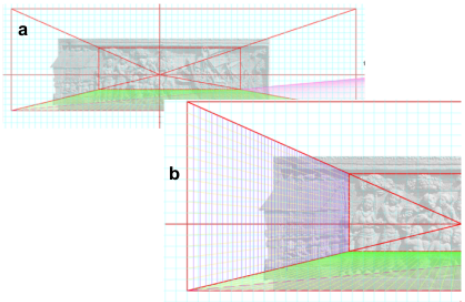

Figure 3 Horizontal lines

The grid creation stage has been completed. Next, the distance between the stilt houses and the ships is calculated based on the height of the people in the relief. Then, boxes are drawn to represent the height of each character in the foreground. According to the average height of Javanese people, male characters are set at 160 cm, with one grid box equal to 16 cm [26].

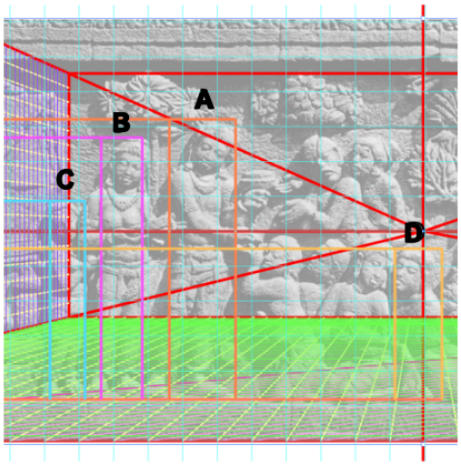

Figure 4 Character height calculation

Box A is the male character, box B is the female character, box C is the child character, and box D is a character who is kneeling (as shown at Fig. 4 above). Male characters are set to be 160 cm tall, so one grid box is 16 cm. The female character is 9.5 squares tall, therefore her real height is 152 cm. The child character is 7 squares tall, therefore his original height is 112 cm. The character who is kneeling is 5.5, therefore his actual height is 88 cm.

$$G = \frac{T}{10}$$

G = 1 Grid

T = average person's height

This calculation determines a maximum of 10 grids to represent a height of 160 cm for humans, as this makes distant grids easier to calculate. The further away the object is in the grid, the denser the grid will be. The researchers do not use height measuring with the head by Spencer's concept because the head measurement used is from the Caucasian race, while in the relief the race used is the Asian race [27]. Additionally from that, in the reliefs the size of the heads is inconsistent, and some are damaged, making it difficult to use as a reference for measuring human height.

To measure the distance between people who are close to people who are far below the stilt house, the height of the person who is kneeling is used as a reference because the people who are under the stilt house are kneeling. Fig. 5 below shows the picture and steps of calculating the distance.

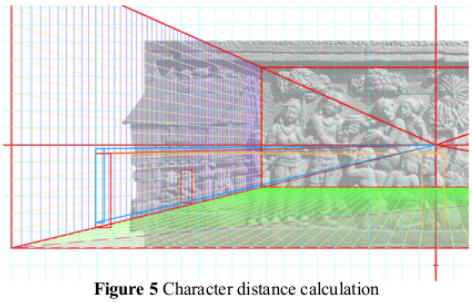

Figure 5 Character distance calculation

Since the servant's position under the stilt house (red box) is positioned slightly higher than the kneeling reference figure (orange box), a 5.5-unit box was constructed above the floor line. The blue box and line indicate the adjusted position. The red box representing the servant was duplicated and shifted to the right to align with the blue line, ensuring that the servant and the kneeling figure are the same height (Fig. 6).

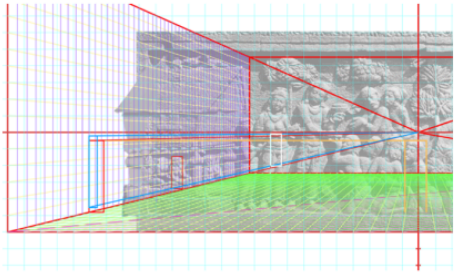

Figure 6 Comparison of characters and other objects

The white box shows the final position of the servant kneeling under the stilt house after measurements are taken. Because it is located deeper than the depth of the room, additional rear grids were created using the same method as the floor grids (Fig. 7).

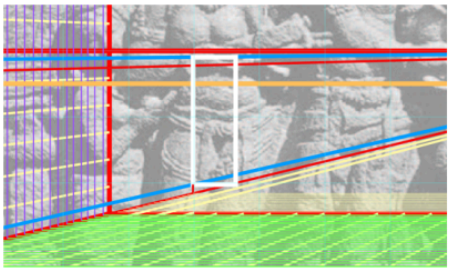

Figure 7 Additional grid

After making the additional grid, the number of grid squares counted from the horizontal line where the front kneeling person position is to the position of the white box.

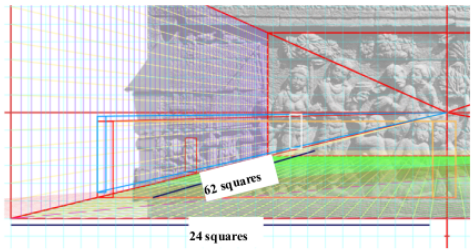

Figure 8 Determining the number of boxes between relief assets

The distance between the person used as a reference and the white box is 62 squares to the back and 24 squares to the left. So, the distance to the back is 62 x 16 cm, the result is 992 cm or 9.92 m. Meanwhile, the distance to the side is 24 x 16 cm, the result is 384 cm or 3.84 m. After finding the distance of the stilt house, the researchers then start to measure the distance of the ship using the same method.

The first step is determining the king as a reference for calculating distance, and one of the ship crew members who is seen standing on the ship. Create a box that corresponds to the height of each character. Drag the lines on both corners of the box until they reach the grid on the left wall of the room (Fig. 9).

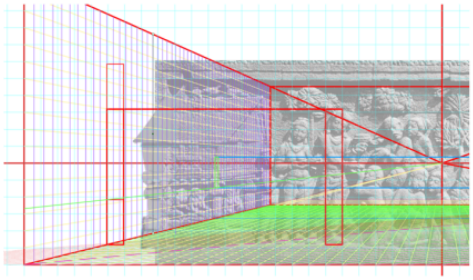

Figure 9 Determining the king as a reference for calculating distance

The second step is making a green line from the bottom left corner of the green box to the vanishing point. Then extend the line to the far left of the room. The green line intersects with the red box which represents the king's height. Create a new box with the same height as the king's height and place it above the intersection of the green line and the red box that was created. Thirdly step is drawing a straight line to the right according to the length and width of the box that has just been created. Make the same box on the right wall. From each corner of the box that just created, draw the lines to the vanishing point.

The researchers then use the green box to represent the crew of ship's height by duplicating the box and placing it on the red line that has just been made. The color of the box used is white to differentiate it from the green box. This white box is the result of the crew's position. Since the square is higher than the floor, a line is drawn from the bottom left corner of the white square to the floor of the room.

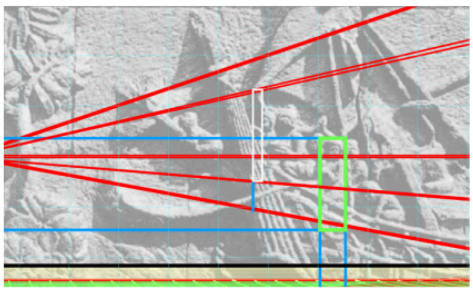

Figure 10 Representation of the crew of ship's height

At the intersection of the vertical blue line with the floor, a line is drawn to the vanishing point and extended to the right end. Because the white square is deeper than the original room depth, an additional floor grid is created at the rear using the same method as before. This process determines the position of the crew, which is located 38 squares to the right and 170 squares behind the king's standing position. Converting the grid to scale, the actual distances are 608 cm laterally (to the right) and 2,720 cm to the rear.

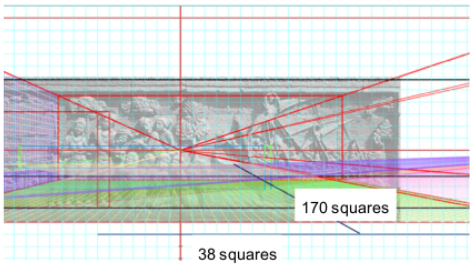

Figure 11 Distance between the king and ship crew

4 Analysis on Relief

a. Character Identification

There are characters, animals, and plants in this relief. The researchers have identified all the characters, animals, and plants which the researchers will describe as follows (as shown in Fig. 12 below).

In the shore area, there are 12 people seen.

1. The King

   This character is identified as a king, known for his long

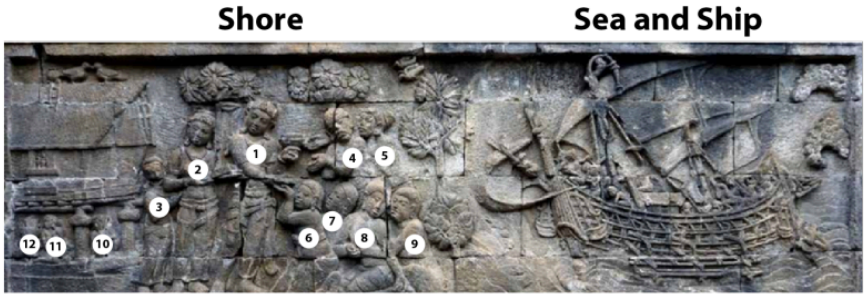

Figure 12 The "On Ship, on Shore" relief [28]

lower body garments and abundant jewelry. He is adorned with Jatamakuta, Hara, Udara Bandha, Keyura, Kankana, Katisutra, and Muktadama. The scene depicts him making offerings to the people before him, accompanied by a queen and prince.

2. The Queen

   This character is the queen because she wears a long cloth covering her lower body and a lot of jewelry. She is wearing Kiritamakuta, Hara, Udara bandha, Keyura, Kankana, Katisutra, Muktadama. She is accompanying the king.

3. The Prince

   The figure numbered 3 is the prince. He has a small body and standing behind the queen. He is also wearing a long cloth. It covers his lower body. This means that he is a noble.

4. Man with mustache, beard, and a fabric cloth wrapping his head

   This character is identified as a commoner, distinguished by his lack of jewelry and his gesture of bringing his hands together at chest level to receive offerings from the king.

5. Man with mustache and beard

   This character is also a commoner. He is not wearing any jewellery and appears to be receiving something from the king. He stretched his hand forward as if he was about to grab a gift from the king.

6. Kneeling woman with short hair

   This character is identified as an ordinary woman. She wears a tube-like garment and no jewelry. She kneels before the king and appears to be receiving something from him. She clasps her hands to accept the gift.

7. Kneeling woman with short hair

   This character appears to be an ordinary woman, similar to character number 6.

8. Kneeling man with short hair

   This character is identified as a commoner, distinguished by his lack of jewelry. This character is kneeling and talking to a man behind him.

9. Kneeling man with short hair

   Similar to character number 8, this is an ordinary man. This man is kneeling and talking to a man in front of him.

10. Female servant

    This character should be identified as a female servant who kneels behind the nobles. It is also described in the reference that the stilt house is a servant's dormitory [28]. The character numbered 11 and 12 are the same as character number 10.

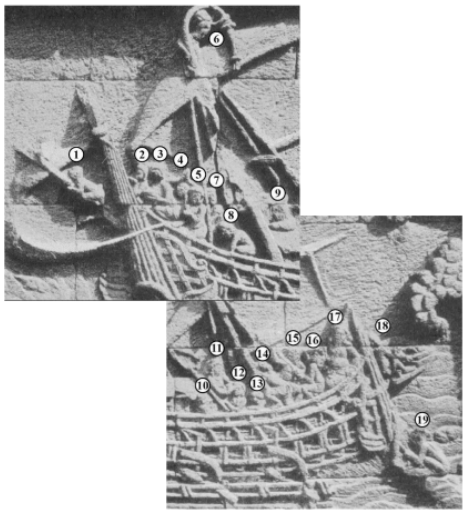

Figure 13 The "On Ship, on Shore" relief [28]

Secondly, there are 19 people on the ship (as seen in Fig. 13 above) [19]. Each of them has different social status and activities. The researchers follow the Inglis's identification and add missing identification based on the researchers' observation. The following is the explanation.

1. A boy is climbing on the bowsprit

   The boy is pressing his chest along the pole. His arms and legs hugging the pole. It seems like he is adjusting the bowsprit or fixing it.

2. A man facing the stem and have his hands together

3. A man with a beard holding a bowl

   The man holding a bowl with his left hand and his right hand turned towards the sea.

4. A man pressed his hands together over his head

   It seems like this man is praying to the gods. The man appears bald and he does not wear any jewelry.

5. A woman kneeling

   This character is not described in the referenced journal. Upon closer inspection, it appears to be a kneeling woman.

6. A man at the top of the main mast adjusting it.

   The man is at the top of the main mast adjusting the curved top. Both of his hand holding the curved top while his legs hugging the pole.

7. A man with mustache about to climb the main mast

   This character is not described in the journal referenced. Based on observations, it appears to be a mustachioed man preparing to climb the main mast.

8. A man prostrating or squatting

   This character is described in journals as bowing. However, closer inspection reveals that the man is squatting, rather than bowing.

9. A man sitting on top of the deckhouse

10. The man is sitting on top of the deckhouse and facing the other side of the ship. A man kneeling facing the nobleman

    The man's position is right aft of the deckhouse. He is facing to a nobleman. Although heavily eroded, the kneeling posture is still discernible.

11. The nobleman touching the head of an individual

    The nobleman is touching the head of an individual that is kneeling in front of him. This figure is a nobleman because he is wearing jewelry and his hair is rolled up.

12. A man kneeling facing the nobleman

    The man is kneeling and facing the nobleman. It seems like the nobleman gives his blessings to this man or something else.

13. A man with head on his hand looking at the sea

    This figure is not explained further in the journal researchers referencing to. The researchers try to observe this figure, it looks like a man looking at the sea with his head on his hand.

14. A man climbing the sail

    This man is climbing the back sail and his position is squatting position. His hands are holding onto the side of the pole.

15. A man with mustache and beard adjusting the sail with rope

    This man is pulling the sail rope to the backside of the ship. He turned his body, his right hand grabbing the upper rope, and his left hand grabbing the lower rope. He is helped by another figure nearby him.

16. A man staring at masthead and shading his eyes

    This man is helping the man who is pulling the sail rope. He holds the rope with his left hand and he is shading his eyes with his right hand, looking at the top of the sail.

17. A man that most likely is Hiru

    This man has long beard and mustache. His hair is rolled up high and he is wearing jewelry. He also has a fat body, leaning to the backside of the ship watching two men adjusting the back sail. From the journal researchers referencing to, it is said that this man is probably Hiru.

18. A man sitting on the projection at the stern

    This man is looking at the ocean behind the ship. He is holding a stick or long wood. The researchers observe this figure and it seems like this man is fishing because he is holding a stick or long wood with his right hand.

19. A man squatting on the rudder, apparently relieving himself

    This man is hanging on the rudder in a squatting posture. . In the journal researchers referencing to, it is said that this man is defecating.

b. Plants and Animals Identification

In the relief " On Ship, on Shore " there are also assets in the form of plants and animals that researchers can identify. This identification helps researchers to understand the environment in which this scene took place. Below is the explanation of the identification of plants in the relief.

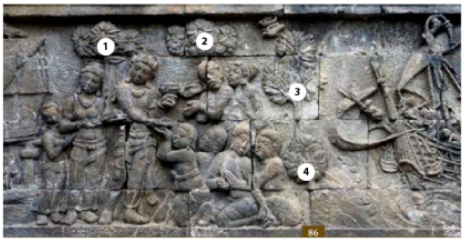

Figure 14 The plants and animals identification [28]

1. *Rhizophora mucronata*

   The researchers identify this tree as Rhizopora mucronata because its leaves have pointed tips and its body is rounded

Figure 15 Plants in reality

rounded, the shape of the fruit is round, slightly curved like a mango. In this relief, the fruit of the tree appears to be in the first stage of development, so the hypocotyl is not visible yet. Fig. 15a above is the real photo of the fruit [29].

2. *Calophyllum inophyllum* (nyamplung)

   This tree is identified as *Calophyllum inophyllum*, based on [30]. This plant usually grows on sandy beaches at an altitude of 0–200 meters above sea level and is tolerant of salt water. Original photos of the leaves and fruits are provided for comparison. As shown in Fig. 15b, the observed leaf and fruit shapes are very similar to those depicted in the relief [31].

3. *Bruguiera gymnorhiza*

   According to the leave shapes, this tree is *Bruguiera gymnorhiza* because the leaves have a pointed tip and are located opposite each other. The Fig. 15c is the real photo of the tree's leaves [32].

4. *Ceriops decandra*

   This tree is *Ceriops decandra*, This is indicated by the shape of the leaves have rounded tip and are located opposite each other. As seen in Fig. 15d is the real photo of the tree's leaves [33].

This section point outs the animals in the relief. The following explanation is the identification of animals in the relief.

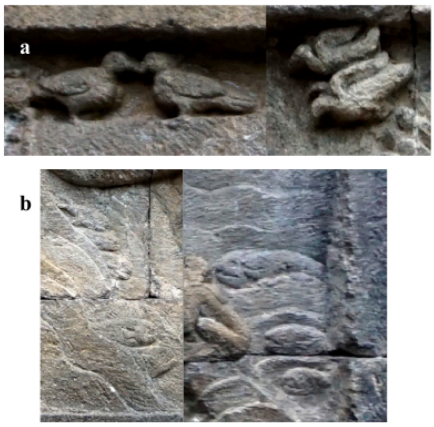

Figure 16 Animal in the relief

The animal in the photo above is a seagull (Fig. 16a). The researchers identify this animal as seagull because this bird's habitat is on the coast or shore. There are two birds on the roof of a stilt house and another two birds flying in the sky. The animal in the photo above is a fish (Fig. 16b). The researchers cannot identify the type of fish because the shape of the carving is so simple. These fish can be seen at the left and right ends of the sea.

c. Ship and other objects

This relief shows several ships and other objects in sufficient detail to support the storytelling in the scene. Below is the explanation of the identification of ship and other objects in the relief.

Figure 17 The relief inserts of the ship and sea waves

The researchers identify this object as the ship. This ship has two outriggers and three masts. The other objects are sea waves, which are carved in a wavy shape like water and are positioned at the bottom of the ship. [28].

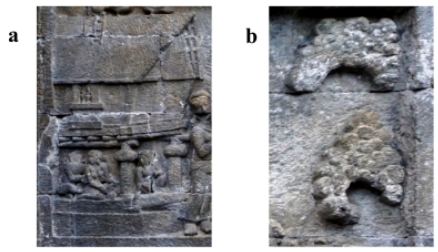

Figure 18 The relief inserts of the dormitory and the clouds

The researchers identify this object as the servant's dormitory (Fig. 18a). This servant's dormitory is mentioned in a study and is formed as a stilt house [28]. The researchers recognize this object as clouds because of its position in the sky and its resemblance to clouds (Fig. 18b).

5 Result

The researchers interpret the spatial layout and identify each element in relief. Then they implement it in 3D. Researchers implement the formal linear perspective calculation and use Blender 3D software to create the 3D world.

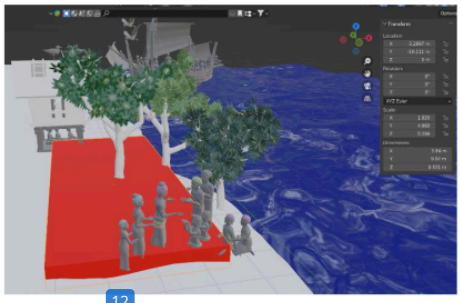

Figure 19 The red box represents the distance from the kneeling people to the stilt house

As seen in Fig 19. above, the red box represents the distance from the kneeling people in front of the king to the kneeling servant under the stilt house. The length and width of the box must correspond to the results of the formal linear perspective calculation. The right end of the box should be parallel to the kneeling figure in front of the king. The left end of the box, where the servant is located, can then be found accurately according to the formal linear perspective calculation.

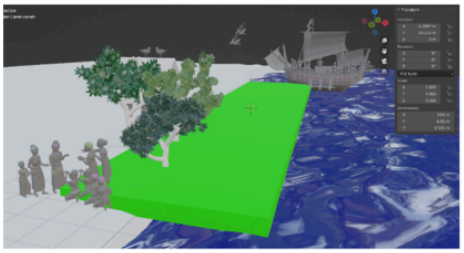

Figure 20 The green box represents the distance from the king position to the position of standing person on the ship

The green box in Fig. 20 represents the distance from the king position to the position of the standing person on the ship. The length and width of the box must be the formal linear perspective calculation results. The left end of the box must be parallel to the king position so that the right end of the box where the person standing on the ship is located can be found accurately according to the reference from the formal linear perspective calculation.

The following Fig. 21 is the comparison of the relief and result of 3D render assets of the "On Ship, on Shore" relief. This is a scene where the King meets the commoners on the shore. The comparison between the relief image and the 3D model rendering clearly shows how effective the FLP method is at interpreting 2D perspectives in 3D. It also demonstrates how well the spatial interpretation reflects the original composition in the 3D layout. Fig. 22 below shows the overall result of the 3D rendering of the relief asset "On Ship, on Shore".

Figure 21 Comparison of the relief and the 3D render assets

Figure 22 The result of 3D render assets of the "On Ship, on Shore" relief

6 Conclusion

Based on the results mentioned above, the researchers can compare the differences in spatial layout results between orthographic projection method and formal linear perspective method. In conclusion, the formal linear perspective is more effective at making use of back space than the orthographic projection method. The formal linear perspective method is a system of calculation that produces clear numbers to determine

distance. However, using the formal linear perspective method is not easy. It requires a long time to calculate the entire grid. The formal linear perspective method can only be used for reliefs depicting characters of different heights. Since this method uses a person's height as a reference point for measuring distances to objects. Therefore, the formal linear perspective method is less adaptable as the orthographic projection method. The orthographic projection method does not require variables. These can be used for size comparisons. This method can be used in any relief.

Further research is needed to find a 3D perspective interpretation method tailored to narrative storytelling in reliefs. It is hoped that this 3D interpretation method may evolve from the formal linear perspective approach, which is inherently more aligned with architectural interpretation.

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References

[1] Setiadi. Sopandi, *Sejarah Arsitektur: Sebuah Pengantar*. Jakarta: Gramedia Pustaka Utama, 2013.

[2] V. Lall, *The Golden Lands: Cambodia, Indonesia, Laos, Myanmar, Thailand & Vietnam (Architecture of the Buddhist World)*. Malaysia: JF Publishing, 2014.

[3] S. Panyadewa, *Misteri Borobudur: Candi Borobudur Bukan Peninggalan Nabi Sulaiman.* Jakarta: Dolphin, 2014.

[4] D. Joesoef, *Borobudur: Warisan Umat Manusia*. Jakarta: Kompas Media Nusantara, 2015.

[5] M. Soeroto, *Album Arsitektur Candi: Cagar Budaya Klasik Hindu Budha #1*. Jakarta: Myrtle Publishing, 2009.

[6] J. Fontein, *Entering the Dharmadhatu: a study of the Gandavyuha reliefs of Borobudur*. Leiden, The Netherlands.: Koninklijke Brill NV, 2012.

[7] J. Gifford, *Buddhist Practice and Visual Culture: The visual rhetoric of Borobudur*. New York: Routledge, 2011.

[8] Y. S. Martyastiadi, "Estetika Interaksi dalam Gim Virtual Reality Borobudur," Doctoral dissertation, Institut Seni Indonesia Yogyakarta, 2021.

[9] Ānandajoti, *Karmavibhanga: An Analysis of Deeds and Their Result (Telaah Perbuatan dan Akibatnya)*. Jakarta: Ehipassiko Foundation, 2020.

[10] D. E. Puspitasari, "Klasifikasi dan Jenis Tanaman pada Halaman Bangunan Suci Dalam Relief Candi Borobudur," *Jurnal Konservasi Cagar Budaya*, vol. 15, no. 2, pp. 59–78, Dec. 2021, doi: 10.33374/jurnalkonservasicagarbudaya.v15i2.263.

[11] Y. S. Martyastiadi, A. Akyuwen, S. Casande, and C. F. Setiyawan, "Virtualisasi relief candi Borobudur dalam perspektif trimatra," Tangerang, 2023.

[12] S. S. Leng, "Borobudur at The Crossroads," *The Jakarta Post*, 2009. [Online]. Available: https://www.thejakartapost.com/news/2009/02/22/borobudur-crossroads.html. [Accessed: June. 21, 2023].

[13] D. Lestari, "Selamatkan Borobudur dari Kerusakan," *Bisnis Indonesia*, p. SPEKTRUM, 2015. [Online]. Available: https://koran.bisnis.com/read/20150107/270/388473/spektrum-selamatkan-borobudur-dari-kerusakan. [Accessed: June. 21, 2023].

[14] N. Cahyandaru, A. Swastikawati, and H. Kusumawati, "Kajian Pengaruh Abu Vulkanik Terhadap Batu Candi Borobudur," *Jurnal Konservasi Cagar Budaya Borobudur*, vol. 6, no. 1, 2012.

[15] W. Kasiyati and Brahmantara, "Dampak Pemanasan Global Terhadap Keterawatan Candi Borobudur," *Jurnal Konservasi Cagar Budaya Borobudur*, vol. 4, no. 4, 2010.

[16] P. E. Debevec, C. J. Taylor, and J. Malik, "Modeling and Rendering Architecture from Photographs: A hybrid geometry-and image-based approach," in *Seminal Graphics Papers: Pushing the Boundaries*, vol. 2, New York: Association for Computing Machinery, 2023, ch. Imaging and Vision, pp. 465–474. doi: https://doi.org/10.1145/3596711.3596761.

[17] J. Pan *et al.*, "Reconstructing, Understanding, and Analyzing Relief-Type Cultural Heritage from a Single Old Photo," in *Proceedings of the 32nd ACM International Conference on Multimedia*, Association for Computing Machinery, Oct. 2024, pp. 7724–7733. [Online]. Available: https://doi.org/

[18] B. Batjargal *et al.*, "Developing A Multimodal Database Of Digital Archives For Cultural Heritage Sites – A Case Of Digitally Preserving The Borobudur Temple Of Indonesia," in *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, International Society for Photogrammetry and Remote Sensing, Dec. 2023, pp. 713–720. doi: 10.5194/isprs-archives-XLVIII-1-W2-2023-713-2023.

[19] J. Liem, J. Kusnick, S. Beck, F. Windhager, and E. Mayr, "A Workflow Approach to Visualization-Based Storytelling with Cultural Heritage Data," in *Proceedings - 2023 IEEE 8th Workshop on Visualization for the Digital Humanities, VIS4DH 2023*, Institute of Electrical and Electronics Engineers Inc., 2023, pp. 13–17. doi: 10.1109/VIS4DH60378.2023.00008.

[20] S. Barzaghi, S. Colitti, A. Moretti, and G. Renda, "From Metadata to Storytelling: A Framework For 3D Cultural Heritage Visualization on RDF Data," 2025. doi: https://doi.org/10.48550/arXiv.2505.14328.

[21] F. Galeazzi, "3-D virtual replicas and simulations of the past: 'Real' or 'Fake' representations?," *Curr Anthropol*, vol. 59, no. 3, pp. 268–286, Jun. 2018, doi: 10.1086/697489.

[22] D. Aiello, S. Fai, and C. Santagati, "Virtual Museums as a Means For Promotion and Enhancement of Cultural Heritage," in *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, International Society for Photogrammetry and Remote Sensing, Aug. 2019, pp. 33–40. doi: 10.5194/isprs-archives-XLII-2-W15-33-2019.

[23] L. P. Tost and E. M. Champion, "A Critical Examination of

Presence Applied to Cultural Heritage," in *The 10th Annual International Workshop on Presence.*, Barcelona, Spain, 2007, pp. 245–256.

[24] The Drawing Database - Nothern Kentucky University, "FORMAL LINEAR PERSPECTIVE: SECTION ONE Exercise #12," Nothern Kentucky University.

[25] Fritz. Hohenberg, *Konstruktive Geometrie in der Technik*, 3rd ed. Springer-Verlag Wien, 1966. doi: https://doi.org/10.1007/978-3-7091-8148-5.

[26] A. N. Nandarini, A. Puspitasari, and A. Yudianto, "Differences of Height Estimation Using Karl Pearson Formulation and Calculation of Multiplication Factor Using Trotter and Glesser Formulation," 2021.

[27] S. Spencer, *ZBrush Character Creation: Advanced Digital Sculpting*, 2nd ed. Sybex, 2011.

[28] Ānandajoti, *Avadana: Tradisi Sang Bodhisattwa*. Jakarta: Ehipssiko Foundation, 2019.

[29] L. Baskorowati, S. Subagya, M. Mahmud, and M. Susanto, "Fenologi Pembungaan Rhizophora Mucronata Lamk. Di Hutan Mangrove Pasuruan, Jawa Timur (Flowering Fenology of Rhizophora Mucronata Lamk. at Mangrove Forest Pasuruan, East Java)," *Jurnal Penelitian Hutan Tanaman*, vol. 15, no. 2, Dec. 2018.

[30] B. Leksono, "Buah nyamplung (Calophyllum inophyllum) untuk ketahanan energi, pakan dan obat-obatan: peluang dan tantangan.," in *Seminar Nasional" Peranan dan Strategi Kebijakan Pemanfaatan Hasil Hutan Bukan Kayu (HHBK) dalam Meningkatkan Daya Guna Kawasan (Hutan)*, Nov. 2014, pp. 302–314.

[31] T. Yoga, "Mengenal Pohon Nyamplung, Alternatif Potensial Sebagai Bahan Baku Energi Terbarukan," https://malangterkini.pikiran-rakyat.com/sains/pr-1251360656/mengenal-pohon-nyamplung-alternatif-potensial-sebagai-bahan-baku-energi-terbarukan. [Accessed: May. 12, 2024].

[32] "Bruguiera gymnorhiza (L.) Lam.," https://www.nparks.gov.sg/florafaunaweb/flora/3/2/3260. [Accessed: April. 21, 2024].

[33] "Ceriops Decandra," https://t-2.tstatic.net/surabaya/foto/bank/images/mangrove-langka-di-bangkalan.jpg. [Accessed: April. 21, 2024].

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