

# Eight Immortals Metaverse

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The metaverse has gained popularity recently in many areas including social media, healthcare, education and manufacturing. Here researchers describe a cultural heritage metaverse for eight immortals.

Keywords: cultural heritage ; metaverse ; digital twin

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## 1. Introduction

Metaverse is in the limelight today since the rename of Facebook as Meta <sup>[1]</sup>. Microsoft announced its metaverse vision, according to its CEO Satya Nadella <sup>[2]</sup>: “The metaverse is not just transforming how we see the world. It’s changing how all of us actively participate in it”. NVIDIA <sup>[3]</sup> has its own metaverse, i.e., Omniverse, built in response to the rapid movement of metaverse research and development. Substantial efforts are being made across the planet, from industry to academia, in relevant research and development.

## 2. The Cultural Heritage of Eight Immortals

Haw Par Villa (Singapore), also known as Tiger Balm Gardens, was built in 1937 by Mr. Aw Boon Haw (Tiger) and Mr. Aw Boon Par (Leopard), as a venue for teaching traditional values. In the 1970s and 1980s, the villa became a popular site for day trips and school excursions, with a trail of the world’s only eclectic Chinese mythological park of its kind. Among over 1000 tasteful scenes in the villa, Eight Immortals is a group of sculptures designed to promote Taoism.

## 3. Eight Immortals Metaverse—The Four Major Elements

**Stories:** Eight Immortals Crossing the Sea (Eight Immortals, in short) is a legend of Taoism about a war between Eight Immortals and a Dragon King. While the Eight Immortals represent justice, the Dragon King followed by his army of shrimp soldiers and crab generals represents evil. These immortals cross the eastern sea with the aid of their magic powers, performing miracles with their treasures. The stories reflect the Taoist culture, with an emphasis on the spirit of justice defeating evil. The well-known legend is still widely circulated today through a saying: “Like Eight Immortals crossing the sea, each revealing divine powers”.

**Characters:** The Eight Immortals are Li Tieguai, Han Zhongli, Zhang Guolao, Lv Dongbin, He Xiangtu, Lan Caihe, Han Xiangzi and Cao Guojiu (**Figure 1**). The Dragon King of the eastern sea and its army are presented as the counterparts of the Eight Immortals. The Dragon King is a God of rain in charge of the weather control. The Dragon King is followed by an army of anthropomorphic monsters including Shrimp Soldiers, Crab Generals, Carp Monsters, Toad Monsters and Turtle Monsters (**Figure 2**).



**Figure 1.** Eight Immortals (dash circled).



**Figure 2.** Dragon King, Shrimp Soldier, Crab General, and other monsters.

**Instruments:** Eight Immortals each hold one or more instruments to support their magic powers (**Table 1**). Eight Immortals Crossing the Sea was first recorded in the ancient poetic drama Eight Immortals Crossing the Sea in Competition for Jade Plate, which was performed through traditional artistic forms such as opera singing, spoken parts and dancing. It became a popular Miscellaneous Drama with profound literary and artistic offshoots. Its flexible and diverse form of performance reflects not only the cultural background and aesthetics, but also the leisure interests of the public at that time. The instruments play their unique roles in the dramatic performance. For Dragon King and his army, these anthropomorphic characters are equipped with various weapons, typically swords and knives (**Figure 2**).

**Table 1.** Instruments of the Eight Immortals.

Immortal	Instrument
He Xiangu	Lotus flower
Cao Guojiu	A pair of jade plates
Li Tieguai	Iron Stick and Calabash bottle
Lan Caihe	Flower basket
Lu Dongbin	Sword
Han Xiangzi	Jade flute
Zhang Guolao	Donkey (also a character)
Zhongli Quan	Fan

**Medium:** Obviously, all Eight Immortals cultural have the sea as their major medium. Yet different forms of cultural heritage may have their own designs of this medium. For instance, the group sculptures Eight Immortals Crossing the Sea in Haw Par Villa are designed based on the Miscellaneous Drama. As such, the environment, including the costumes and scenes from the performance stage of this cultural phenomenon, are created differently.

## 4. Eight Immortals Metaverse—The Five-Dimensions

Singapore's theme park Haw Par Villa has a cultural heritage site, *Eight Immortals Crossing the Sea*, in the form of sculptures. As part of Taoism, there are many Eight Immortals-related works presented in different cultural styles. In the following, a metaverse for Eight Immortals is discussed from a dimensional perspective.

**Metaverse-1D for Eight Immortals (sequential):** Eight Immortals Crossing the Sea appeared first as sung opera. The related musical notes and song scripts are sequentially arranged in one direction to present the story of the war between the Eight Immortals and Dragon King. Han Xiangzi, one of the Eight Immortals, creates sequential musical information when playing the jade flute.

**Metaverse-2D for Eight Immortals (still planar):** There are a large number of Eight Immortals-related cultural artefacts in still, planar form including paintings, drawings, embroideries, photographs, etc. All these forms a metaverse-2D. **Figure 3** is an example of a painting of the Eight Immortals as part of this metaverse-2D.



**Figure 3.** A Painting of the Eight Immortals Crossing the Sea.

**Metaverse-3D for Eight Immortals (static 3D shape):** Similar to still planar cultural forms, there are many Eight Immortals sculptures, statues, etc., available in static solid form. This form of cultural heritage includes group sculptures, theme parks, museums, ruin heritage sites, and so on. Metaverse-3D should have all this included. **Figure 4** shows the group sculpture of the Eight Immortals in the Haw Par Villa.



**Figure 4.** Partial view of the group sculptures of the Eight Immortals in Haw Par Villa.

**Metaverse-4D for Eight Immortals (time-varying):** Unfortunately, static solid sculpture is not able to display time-varying information. For instance, dramatic plays based on the Eight Immortals are typically performed with the characters presenting their stories with different instruments and in different media. VRC solutions can be developed to create a virtual presence of the physical cultural form to overcome the non-time-varying limitation of some of the static solid forms. Storytelling can be used in VR, AR and MR to have time-varying features implemented. Metaverse-4D for Eight Immortals should include these time-varying forms.

**Metaverse-5D for Eight Immortals (application context):** Generation by generation, cultural representations of the Eight Immortals in linear, planar, solid, and time-varying forms have been developed. This Taoist legend has a long history evolving over various dynasties (Han, Tang, Song, Ming, etc.). It is important to highlight here that the development of the Eight Immortals culturally is sure to continue over the years. **Figure 5** shows six of the Eight Immortals developed by the team based on hip-hop culture. Metaverse-5D for Eight Immortals is basically a fusion of all the contexts for Eight Immortals Crossing the Sea.



**Figure 5.** Eight Immortals designed based on hip-hop culture.

## 5. Eight Immortals Metaverse–Mapping using Laser Scanning for Digitalization

A LiDAR scanner FARO is used to capture the sculpture of the Eight Immortals and its surroundings in Haw Par Villa. The rotational laser of the scanner measures the distance to objects and, together with the device's two rotational angle data, determines its coordinates in space, with integrated GPS. At different measurement speed and resolution, FARO can capture several million points with their (X, Y, Z) coordinates recorded. Color scans are created simultaneously during scanning with the help of the integrated camera. A high accuracy scan (~2 mm) requires about 30–40 min while a low one (5–10 mm) requires 5–10 min.

**Figure 6** shows the point cloud data and one of the corresponding pictures from the Eight Immortals laser scanned in the Haw Par Villa.



**Figure 6.** 3D point cloud and color picture of Eight Immortals in Haw Par Villa.

**Multi-scan Stitching:** Point cloud registration or stitching is an essential task, with multiple scans captured of the Eight Immortals sculptures. Basically, registration is used to estimate a rigid transformation for aligning the two scans, which can be done in two tasks: global registration and local registration. Global registration is to obtain a good initial alignment for arbitrary input poses (scans) of the same environment. Local registration is to refine the correspondences between the two globally registered scans and find the optimal transformations between them.

**Cleaning & Repairing:** After stitching, the point cloud may retain some features (**Figure 4**) such as nonuniform sampling, noise, outliers, misalignment, missing data, etc. It is thus required to preprocess the point cloud captured by cleaning and repairing algorithms based on the positions and color information of the point cloud data. After cleaning, the point cloud will also have some holes (parts missed) or ununiform density in some areas. Segmentation is performed using Cloud Compare before position repairing based on a feature-preserving point consolidation method.

**Level of Details (LOD):** Real-time rendering of large point clouds is often required in VRC, especially on personal mobile devices (e.g., for AR application). To accelerate this process, simplification of the point cloud is desired with acceptable quality of rendering. LOD technique is implemented to achieve real-time rendering for different VRC and metaverse applications.

**VRC and Metaverse Development:** **Figure 7** summarizes the entire process of metaverse building for the Eight Immortals cultural heritage, from laser scanning to VRC modeling and visualization to metaverse development. This



process is important for digitalization through the multi-dimensional approach developed (Figure 8).

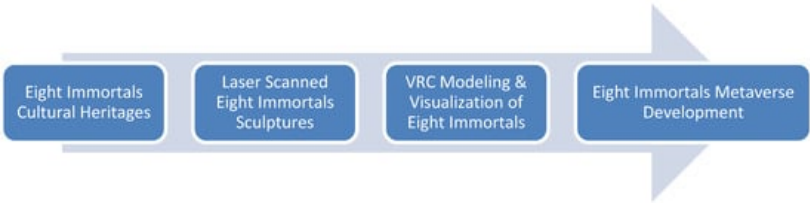


Figure 7. The process of turning Eight Immortals cultural heritage into an Eight Immortals metaverse.

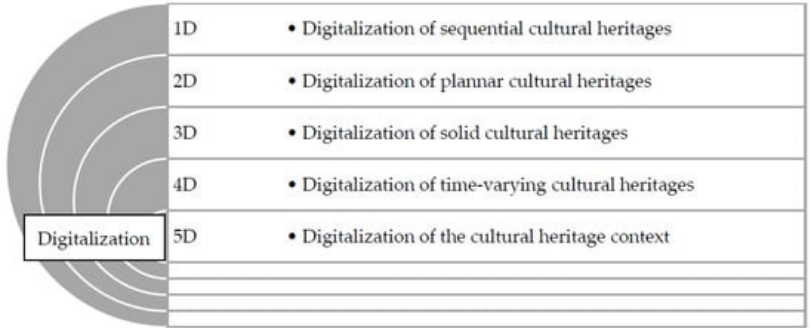


Figure 8. Digitalization of Cultural Heritages.

**Revitalization of Cultural Heritage using Metaverse Solutions:** Metaverse technology is making rapid advancements recently. The Eight Mortals metaverse can help promote, protect and preserve this form of cultural heritage. With the Eight Immortals metaverse developed, the ability to exhibit and monitor this piece of cultural heritage can be enhanced. A younger generation can learn about traditional culture and values through interactive and immersive play with the Eight Immortals metaverse.

References

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