Decoding of Ancient Inscription using 3D Laser Scanner

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Abstract—This research studied 3D laser-scanning technology that used the depth of the inscription and high quality resolution by applying the modeling-technology. These methods are shown the improved readability of the ancient inscription by using scanning and modeling that considered the inscription’s properties and coloring system depends on the depth for improving the 3D modeling data. They applied 3D modeling data to unknown characters, then it amplified the readability and it caused to make narrow the range of decoding particular characters.

Keywords—epigraphy; rubbing; image processing; Laser Scanner

Introduction

Even the reading based on the rubbing shows the process was used since early days, it is pointed out that it had low resolution to compare with it oriented technology these days[1]. This research suggested using 3D data by laser scanner to improving the rate of reading, and it is composed of three steps: 1) it guaranteed the high quality of resolution that reader want, 2) if it was hard to read from step 1, 3D data distinguished the letter part and basis then amplified the depth of the letter to increase the probability of the reading, 3) though it was still hard to find, the range of the letter was narrow down by using the characteristics of the corresponded letter. Therefore it helped the reader deduce the context. This solution is applied to Sugbinggobi and Jungseongribi that had difficulties to decode them[2].

I. DECODING THE INSCRIPTION DEPTH INFORMATION

It is composed of 1)Using the 3d data 2)using the depth information, and 3)making inferences from the shape of the letters. All inscriptions classified to 1. Deciphered letter 2.inferenced letter by the shape 3) nominated letter having properties of the character’s type 4)deciphered letter from the context and 5) unknown letter.

At first step, using 3D data, scanned the object with laser and visualized the calculated 3D data in detail.

Second step, using the depth information ,which is the main point of the research, amplified the 3D data with low readability. It is classified to the decipher because the original 3D data was transformed by increasing the depth information range and inferred the most fitted letters through the whole context.

A. Setting gray level depends on the depth information

The gray level of $P_i$, scanned and modeled 3D point, was defined as $GL(P_i) = 255 \times (d_{max} - d_i) / d_{max}$.

For this equation, $d_{max}$ is defined the maximum depth point of $P_{max}$ and $d_i$ is the height of $P_i$. In other words, 0 , which is black color, is substituted to the largest depth point and base plane corresponded to 225, white color.
II. RE-USE UNREADABLE DATA WITH THE DEPTH INFORMATION

A. Extracting reference points for set standard plane
Set up the number of reference points, \( n \), at the place that not assumed by 3D data (Figure 2). For that \( n \), the minimum value of \( n \) is 3 and each standard point should place not projected or not caved in.

![Figure 2. Sampling of reference data](image)

After amplifying the depth of the points, proper colors were assigned at different level of depth to read the letter. Using the complementary color relation, it was focus on the visual effect. Figure 5 was read as “.library”.

B. Understanding the information by standard plane
First, the standard plane that had minimum distance which perpendicular with the number of points, \( n \), or included points where chosen near the letter. The polygon’s outline that all selected 3D, \( P_i, i = 1, \ldots, m \), if satisfied \( \theta > \theta^* \) is set by the dividing line. \( \theta \) is the angle between polygon and standard plane. The reader has to find optimal information area as changing the value of \( \theta^* \) like Figure 3(3). The points that were not appropriate for the data at the background moved parallel and arranged as the noise.

![Figure 3. Understanding the information region](image)

C. Amplification of the information area’s depth
To increase the visual readability, depth data of the information range is amplified. If \( d_i \) was the depth from the standard plane at \( P_i \), \( d_i \) would be amplified as \( d_i^* = d_i \times D \). Then they decoded with changed letters. \( D \) is a real number and larger than 1.

III. CONCLUSION
This 3D data method can contribute in the epigraphy as ensured the resolution and the readability due to variety of data method than the rubbing. This study is provided not only the probability of reading and decoding based on the depth information but also is predicted that can develop more as the research on information area that carved and textured on the background.

REFERENCES