

# THE SPATIAL ANALYSIS AND ACQUISITION OF PRECISION DIGITAL DATA DUE TO CULTURAL PROPERTIES

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## ABSTRACT

So as to succeed to the traditional culture of one nation and develop it, more scientific countermeasure for conservation and restoration about cultural properties is necessary.

This study is to measure of the bell of Sungduk, the Great which is the Korean representative temple bell founded in the 8th century precisely by using CRP technique and carry out the diverse spatial analyses on the basis of the data of this. For this, I planned the scheme for the prevention of slight shock of bell which may be caused in image acquisition processing, and established the plan, so that one may acquire the image of bell body and each pattern effectively by connecting the inside and outside of bell with same coordinate system. And, this researcher could carry out the analysis of spatial position relation about the figure engraving in relief, the creation of contour of 1mm, the analysis of longitudinal section and cross section about bell body, the calculation of specific gravity to use relation between weight and volume, the calculation of central axis, and the analysis of balanced beauty etc, from the digital data acquired by drawing image. As this could suggest the diverse spatial analysis schemes as well as the efficient method of data acquisition for the conservation and restoration of cultural properties, it is expected that this will be able to contribute toward the relevant study of archaeology and fine art history etc.

## 1. INTRODUCTION

The bell of Sungduk the Great is the representative temple bell of unified Shilla period which was manufactured in the 7th year of the King. Hyekong in Shilla. Then, the auxiliary value is very high, as it may be registered in UNESCO. But, it has passed through 1,200 years or more, many points at issues such as crevice and voiced sound etc. are being raised recently. So, the countermeasure preparation is required.

Therefore, in this study, this research was acquired the precise geometrical real measuring data for expressing the conservation state of present new bell with exact digital data and executed diverse analyses on the basis of the data.

### 1.1 CONTENTS AND METHOD OF STUDY

In this study, this research was acquired vector data by establishing same coordinates system about the new bell of Sungduk the Great which is original form and drawing acquired image. This research was tried to perform precise 3-dimensional location measurement and geometrical formation analysis by using vector data. This research was expressed each model with whole structures of same coordinates system by using bulsa-Walf 3-dimensional coordinates

transform method, after establishing 3D digital data by interpreting 28 models about the pattern of the bell body and the surface of the bell of Dangjwa, Beechonsang, Yuguwk, Yongnew, Sangdae and Hadae. For the analysis of diverse forms about the bell, this research was established base cap by creating 3-dimensional model(TIN) and performed the geometrical form analysis of section, surface volume, deflection and circular form etc. and the visual analysis of 3 dimensional perspective drawing, plane projection drawing, contour map and modeling etc. Thus, this findings will be applicable for the basic data for acoustic analysis study, casting technique study, and fine art history study etc., and the analysis technique to use image media will be able to be utilized widely for archaeological study and fine art history study etc. including the safety diagnosis for cultural properties protection.

Figure 1 shows the bell of Sungduk, and Figure 2 is the flowchart of study performance.

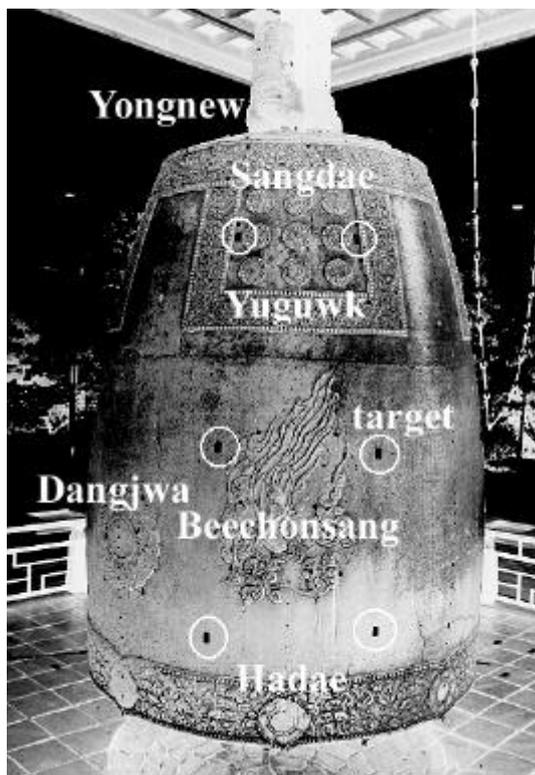


Figure 1. The Bell of Sungduk

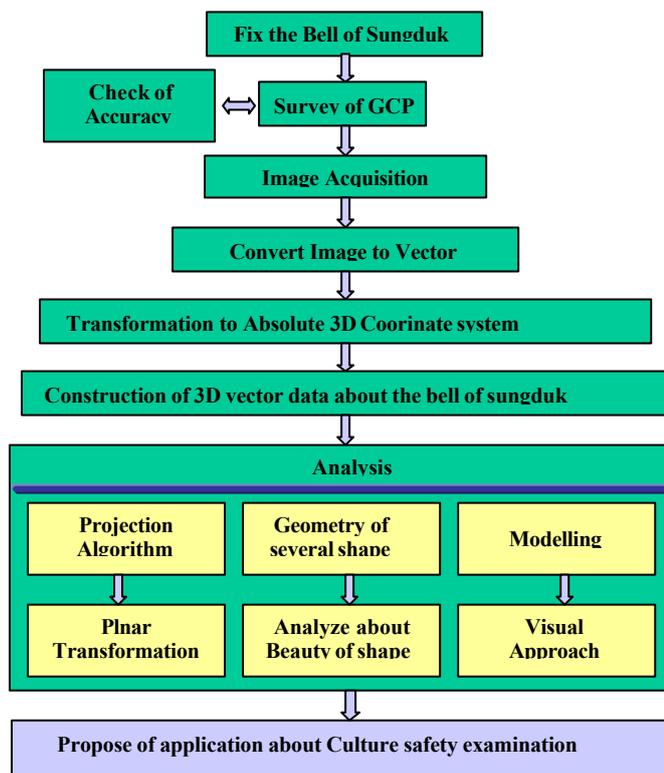


Figure 2. Flowchart

## 1.2 IMAGE ACQUISITION

This research was used the analysis technique to use image medium for the precise 3 dimensional location measurement about various patterns casted on the bell and the surface and for the analysis of digital data. For acquiring more precise vector data, this researcher acquired total 28 models such as 4 models of bellbody, 2 models of dangjwa, beechonsang, each 4 models of yuguwk, 4 models of upper region plane, 2 models of sangdae and 8 models of yongnew.

Table 1. Plan to take photographs of detail drawing about the bell of Sungduk

Pttern	Direction	Distance(m)	Height(m)	Overlap (%)	Baseline(m)	Focal length(mm)	Model Size(m)
Bell Body	N,S,E,W	5.50	1.30	60	2.54	100.60	1.92x2.52
Dangjwa	N,S	1.40	1.25		0.64	106.85	0.52x0.52
Sangdae	E	1.80	3.00		0.83	105.04	0.30x1.40
Hadae			0.30		0.64		0.40x1.00
Yuguwk	NE,SE,NW,SW	2.00	1.35		0.83		1.11x0.74
Beechonsang		1.35				0.65x1.06	
Youngnew	N,S,E,W	4.00	3.7	80	0.92	100.6	0.93x0.66
	N,S,E,W	0.70	4.7		0.30	35	0.50x0.35
Upper region plane	N,S,E,W	1.80	4.71	60	0.83	105.04	1.50x1.50

So as to extract precise vector data by applying the film-based photogrammetry to be based on film about the object that scale is big and treatment is difficult like the bell, image acquisition to be based on exact photography plan is important.

This research was acquired image by deciding the photography method to consider depth and interpretation range, so that improper time differential may not be generated at the part that undulations are serious and form is complex like as yongnew. In this study, this research was acquired image by changing f-stop and shutter speed about model into 8-22 and 1/60-1/8. Table 1 is what showed the minute photography plan for precise pattern analysis.

### 1.3 ESTABLISHMENT OF COORDINATES SYSTEM AND MEASUREMENT OF DATUM POINT

For the geometrical form analysis of precise digital data and the framing of digital drawing about the bell of Sungduk the Great, this research was measured and constituted same coordinate system about the inside and outside surface of the bell. And, for preventing the tremor of object, this research was fixed 4 directions with strong wire of which thickness is 5mm. This research was established the right-angled coordinates system to lay the origin(0,0,0) of coordinates system at the south of temple bell make the East of +X side, the North of +Y side, and height direction of Z axis.

So as to execute the section analysis about 4 directions inside and outside the bell, this research was attached the belt-target for doing the section analysis perpendicularly on the surface of South-North direction, East-Western direction, South-Eastern and North-Western direction, and South-Western and North-Eastern direction inside the bell, and acquired 3 dimensional coordinates result of same coordinates system. Besides this research was acquired the result of datum point of same coordinates system by arranging the datum points by 6 points per the model for image interpretation and arranging 140 points or so about total 28 models.

## 2 ESTABLISHMENT OF DIGITAL DATA

This research was established 3 dimensional digital data about the bell after passing through the transform course for establishing all the elements in stereoscopy with the digital data of vector form by reproducing the geometrical condition to be same as the time of image acquisition. This research was used 3D Bursa-Walf transform method of MSPM(MGE Projection Manager) so as to locate the result drawn by each photo model on same coordinates system.

This research was constituted each model with the vector component of point and line and stored it with DGN pile to be MicroStation file. About each pattern located at same coordinate, this research was established the data base for the geometrical image analysis of the bell by creating 3D model (TIN) through using MSM (MGE Terrain Modeler). Figure 3 is showing the original image, digitizing result and modeling result acquired about beechonsang to be the representative pattern of the bell.

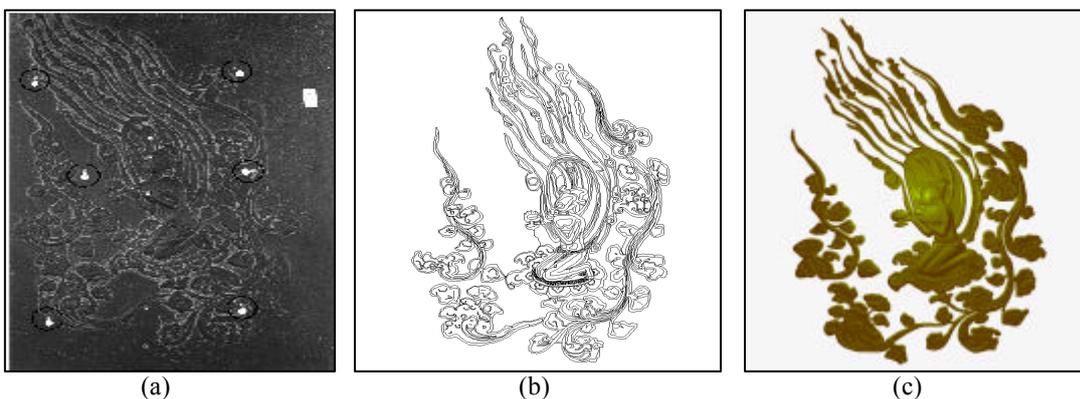


Figure 3. Show image of the Beechonsang : (a) original Image (b) Digitizing result (c) Modeling Result

## 3 ANALYSIS OF DIGITAL DATA

### 3.1 ANALYSIS OF AREA AND VOLUME

This research could obtain the area on XY plane by transforming 3D digital data into 2D and calculated volume by establishing DEM about the inside and outside of the bell. In the next Table 2 showed the numerical value to be more or less, the volume of North-Eastern direction and South-Western direction is greater than the volume of North-Western

direction and South-Eastern direction as the result that this research was calculated volume by classifying interpretation category into 4 directions through rotating by 90 ° from the center of the temple bell. This is because the section thickness of new bell was cast relatively thickly in the direction of North-East and South-West in comparison with the direction of North-West and South-East.

This research could calculate the specific gravity of alloy from the weight of 18.9t and the volume of the temple bell which was calculated at July in 1997.

Table 2. Volume of the bell (m<sup>3</sup>)

SECTION	North-Eastern	South-Western	North-Western	South-Eastern	Total
VOLUME	0.51698	0.51356	0.46467	0.43908	1.93429

### 3.2 ANALYSIS OF SECTION

This research was performed the analysis of section about diverse patterns and that of section about 4 directions (South-Northern, East-Western, South-Eastern and North-Western, South -Western and North-Eastern) by using 3-dimensional model about the bell. Figure 4 about the bell is the result of section analysis about dangjwa out of the patterns of the bell, and figure 5 is the result that this research was analyzed the thickness of section of the direction of South and North at the interval of 20 cm toward upper direction.

Dangjwa in figure 4 is the result that this research was analyzed section at the interval of 10 cm respectively toward horizontal direction and vertical direction as the dangjwa located at Southern side. Then, we can see that the section of horizontal direction(3-3' section) and vertical direction(8-8' section) is symmetry generally. Figure 5 is the result that this research was analyzed the section of direction of South and North. Then, this research could know that the thickness of section located at the upper direction of 2.5m or so, from total lower end is thickest and that the upper direction section of 1.25m or so where dangjwa was located was cast most thickly. It is maintaining the uniform section thickness of 0.1m - 0.15m or so on the whole. We may presume that the section of left and right is forming symmetry form on the basis of central line and that it was cast by precise casting frame.

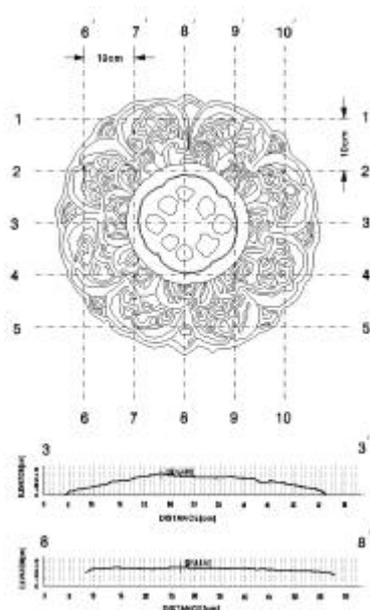


Figure 4. Cross section of the Dangjwa

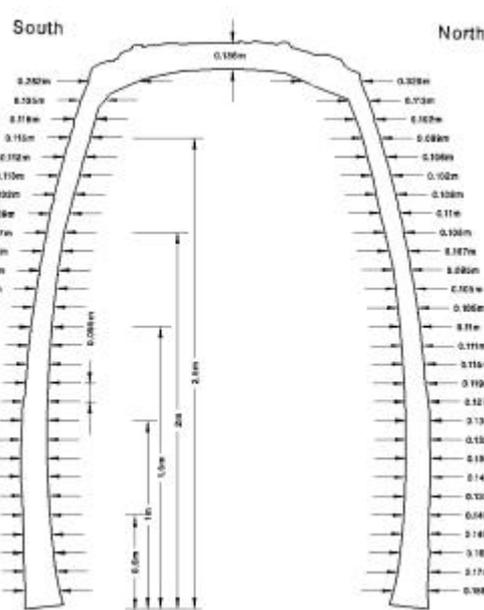


Figure 5. Profile of the bell (south-north direction)

### 3.3 ANALYSIS OF PATTERN

As the result that this research was tried to compare the geometrical location relation between the centers of two dangjwas being cast in the direction of South and North of the surface of the bell, the deviation of horizontal direction between dangjwa centers is 0.8 cm or so, and the deviation of vertical direction is 0.5 cm or so. Thus, if we consider measurement error, we can see that they are being cast at very exact position. As the result that this research was tried to overlap the beechonsang(NW-SE, NE-SW) of similar form, it showed that form or size was similar but that cast position is more or less different partially. With this, it can be interpreted that many casting frames were used by compounding them so as to form beechonsang.

### 3.4 3-DIMENSIONAL PERSPECTIVE DRAWING

This research was expressed the drawing result to be the vector about each pattern with whole structures by projecting and transforming it with same coordinates system and completed perspective drawing for adding the visual analysis effect of whole form. This research was executed the moving image analysis to use precise digital data by storing the image that this research was executed modeling by rotating view direction by  $10^\circ$  with the perspective drawing analysis in diverse directions as image.

### 3.5 ANALYSIS OF CONTOUR

As the sound of bell has something to do with the pattern of relief, the pattern of Yuguwk was used, so that it may control the sound of the bell. As the sound of the bell is different in accordance with the positions of dangjwa to be hit at the time of striking a bell, the analysis data to be able to know relative height value with the form by parts about patterns is required for precise sound analysis. For this, in this study, this researcher made out contour map on the basis of TIN model. Figure 6 is the result that this research was drew the contour map of 1mm about dangjwa. Then, this research could offer it as the basic data for fine art history study and sound analysis.



Figure 6. Contour of the Dangjwa

### 3.6 PROJECTION DRAWING OF PLAN

So as to execute the projection analysis of 2D plane about the surface of the temple bell, this research was projected and transformed by making the direction of bell circumference of X axis and the height direction of Y axis on the basis of lower end of the bell. As we may compare the relative position and form of each pattern on plan, it is considered that it will be utilized as the basic analysis data for the analysis of plastic beauty and the study of fine art history. Projection points are the defects of TIN. Then, this research was projected and transformed 3-dimensional coordinates of these points with 2 dimension. This research could make out the projection drawing of plan of figure 7 by storing the coordinates result of each edge point to constitute TIN with ASCII file and completing DGN file through using it as data file.

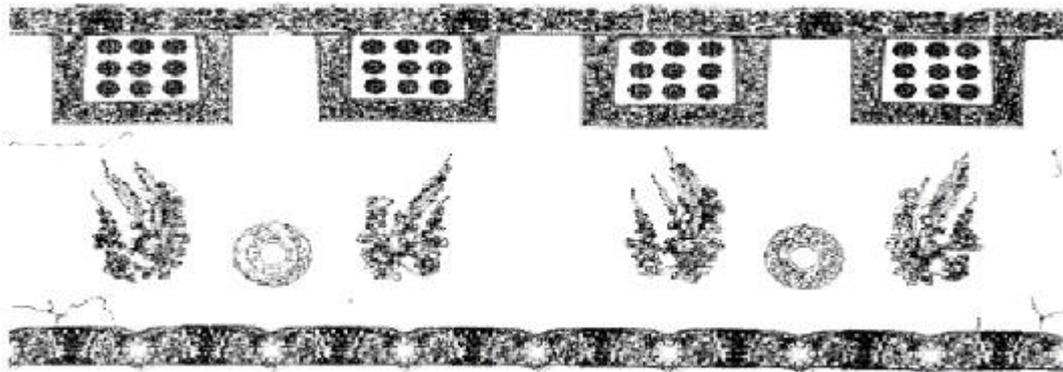


Figure 7. 2D Projection Map about the bell of Sungduk

## CONCLUSION

As the result that this result performed this study, this research could obtain the following conclusion.

1. The system for the efficient acquisition and analysis of precise 3 dimensional digital data which uses the technique of image analysis enables the geometrical position relation and quantitative analysis of diverse forms.
2. This research could perform the analysis of space such as section, area, volume, pattern and form etc. more scientifically by acquiring precise digital data and establishing 3-dimensional model(TIN) through image analysis.
3. This research could offer the basic data that utilization is possible for the study of analysis and the study on casting technique etc. about the temple bell by performing the precise geometrical position analysis and the form analysis and visual analysis of projection drawing of plan, 3-dimensional perspective drawing and modeling etc. about the bell of Sungduk the Great.
4. As this research could do the diverse form analysis and plastic beauty analysis about cultural properties that spatial analysis is required in the system for the acquisition and analysis of digital data to use the technique of image analysis, the application for the conservation and restoration of cultural properties is expected henceforth.

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