

# Real-Time 3D Scanning Installation: A Case Study on the Digitization of Taiwanese Glove Puppetry

Wei-Chen Yen  
wilsonnosliw885@gmail.com  
Institute of Applied Arts  
National Yang Ming Chiao Tung University  
Hsinchu, Taiwan (R.O.C.)

Chun-Cheng Hsu\*  
cchsu@nycu.edu.tw  
Institute of Applied Arts  
National Yang Ming Chiao Tung University  
Hsinchu, Taiwan (R.O.C.)

## ABSTRACT

This research proposes a real-time 3D scanning installation to digitally record cultural heritage. There are relatively few solutions for performing real-time scanning of intangible forms of cultural heritage. We use Taiwan Budaixi Puppetry as an example, aiming to capture the valuable movements of the puppets. This research explores the potential of digital cultural heritage, offering new ways to preserve and interact with it.

## CCS CONCEPTS

• **Applied computing** → *Media arts*.

## KEYWORDS

Intangible Cultural Heritage, Digital Cultural Heritage, 3D Scan, Point Cloud, Puppetry, Budaixi

## ACM Reference Format:

Wei-Chen Yen and Chun-Cheng Hsu. 2024. Real-Time 3D Scanning Installation: A Case Study on the Digitization of Taiwanese Glove Puppetry. In *The 17th International Symposium on Visual Information Communication and Interaction (VINCI 2024)*, December 11–13, 2024, Hsinchu, Taiwan. ACM, New York, NY, USA, 2 pages. <https://doi.org/10.1145/3678698.3687203>

## 1 INTRODUCTION

The global convergence of cultures has led to the decline of traditional cultures. Our research proposes a method using 3D scanning technology to preserve cultural heritage. Cultural heritage can be classified into two primary categories: tangible, such as architectural ruins and historical artifacts, and intangible, such as folk dances, songs, music, and traditional crafts. Our preservation method focuses on the intangible category, particularly movements performed by the human body, such as a master performing traditional skills or unique behaviors specific to different cultures.

Our research targets Budaixi, a traditional puppetry form in Taiwan. The unique hand gestures used to manipulate the puppets in Budaixi represent a form of intangible cultural heritage. Preserving this intangible cultural heritage is challenging, which led UNESCO to announce the Convention for the Safeguarding of the Intangible

\*Corresponding Author

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

VINCI 2024, December 11–13, 2024, Hsinchu, Taiwan

© 2024 Copyright held by the owner/author(s).

ACM ISBN 979-8-4007-0967-8/24/12

<https://doi.org/10.1145/3678698.3687203>

Cultural Heritage in 2003 [4]. This convention aims to protect and promote intangible cultural heritage worldwide. Although Budaixi is not formally recognized as an intangible cultural heritage by UNESCO, it holds significant cultural importance in Taiwan and evokes many shared memories among the Taiwanese people.

## 2 THE INSTALLATION

In order to record the intangible cultural heritage, we focus on the time and movement associated with it. However, we have found that current technology offers limited options for capturing dynamic point cloud data. Most 3D scanners are designed to convert real objects into detailed but static digital forms. We are searching for a tool that can record dynamic 3D data of heritage. We discovered the Intel RealSense depth camera[3], which can record 3D volumetric reconstruction data and provide accurate measurements of object dimensions. Based on RealSense, we designed a multi-camera installation[2] involving using four D435 Realsense to collect point cloud data of cultural heritage.

Understanding the spatial limitations of the D435 RealSense camera is crucial for assessing the scale of the heritage we aim to document. According to the latest D400 Series Product Family Datasheet [1], the camera consists of a color camera and a depth camera, with the depth camera's field of view (FOV) being larger than that of the color camera in the D435 device. Based on our requirements, we chose to use the smaller resolution (640x480) of the camera, which allows us to capture both color and depth data in the point cloud. Additionally, this resolution increases the camera's FPS, providing more detailed temporal changes. As shown in Figure 1, we positioned the camera approximately 50 cm from the target to achieve optimal results.

## 3 RESULT OF SCANNING

The result of the scanning, which records static data, is shown in Figure 2. It depicts two puppets standing on a table. We use Unity 3D software as our data visualization platform to display the point cloud data. However, the point cloud data in Figure 2 still contains some noise and incorrect color shading. This was anticipated, as the depth camera we used is a consumer-level device, and the data has not yet undergone post-processing. What concerns us is that the point cloud visualization on the screen appears as a flat 2D image. To demonstrate that the point cloud data we recorded is indeed in 3D, we rotate the point cloud to show it from every angle, which makes the visual more solid.

Another result is dynamic data shown in Figure 3, which depicts a performer hiding under the table and manipulating the puppets. Unlike static data, this dynamic data allows you to see not only the

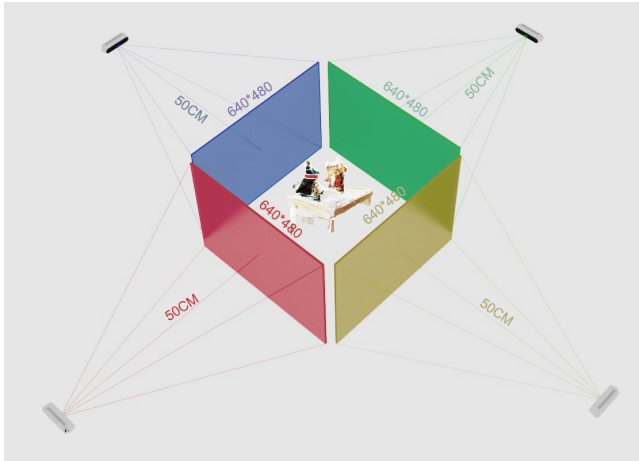


Figure 1: Scanning Space Built by Four RealSense

puppets themselves but also their movement and the passage of time captured in the data. By using this approach, we have successfully achieved our initial goal of recording intangible cultural heritage in digital form. Based on this approach, we can replay the performer's motions over and over again without any damage to the data.

This data can be displayed in 3D software. This allows it to be enhanced with visual effects or 3D models, such as a stage as its background or a particle system to make the movement of puppets more dynamic, as shown in Figure 4. This versatility enables the data to be used in various situations and different applications, effectively transforming cultural heritage. In its digital form, it gains greater value and visibility in the world.



Figure 2: static point cloud of Budaixi puppet

#### 4 FUTURE WORK

We have developed a system utilizing depth cameras that can record and process digital cultural heritage data. A distinctive feature of our device is its ability to capture dynamic events in real-time. In our future work, we aim to make this installation portable and deploy it in real cultural settings to identify issues and implement enhancements. Also, we intend to design a large-scale performance to showcase our findings and results, incorporating both the cultural heritage data and the installations we have created.



Figure 3: dynamic point cloud of Budaixi puppet



Figure 4: Enhance by Visual Effect and Background

#### REFERENCES

- [1] Intel Corporation. 2024. *Intel RealSense D400 Series Datasheet*. Technical Report Revision 018. [https://www.intelrealsense.com/download/21345/?tmstv=1711714489&\\_ga=2.227255261.1987310282.1716475101-1072150377.1710486704](https://www.intelrealsense.com/download/21345/?tmstv=1711714489&_ga=2.227255261.1987310282.1716475101-1072150377.1710486704) Pages 85-88.
- [2] Anders Grunnet-Jepsen, Paul Winer, Aki Takagi, John Sweetser, Kevin Zhao, Tri Khuong, Dan Nie, and John Woodfill. 2023. *Multi-Camera configurations - D400 Series Stereo Cameras*. <https://dev.intelrealsense.com/docs/multiple-depth-cameras-configuration>
- [3] Leonid Keselman, John Iselin Woodfill, Anders Grunnet-Jepsen, and Achintya Bhowmik. 2017. Intel realsense stereoscopic depth cameras. In *Proceedings of the IEEE conference on computer vision and pattern recognition workshops*. 1–10.
- [4] UNESCO. 2003. *Convention for the Safeguarding of the Intangible Cultural Heritage*. <https://ich.unesco.org/en/convention> Accessed: 2024-05-22.