Augmented Reality Applications In The World Heritage Iwami Ginzan Silver Mine

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ABSTRACT

Although CG and AR techniques are inferior to actually reconstructing the excavated sites, they are an increasingly popular tool for people to view their world through the cameras of their smartphones and tablets while overlays of additional digital information augment that view. The techniques have distinct advantages in their abilities such as displaying a replicated reconstruction of the excavated scene with additional information in real space. AR also provides for quick and cost-effective information updates and, particularly, the ability to modify a excavation scene without damaging the remains.This article describes two types of positioning for augmented reality systems - marker and markerless (use of GPS) - to provide visitors a visual understanding, in real space on a PC (Windows) or tablet terminal (iOS, Android) environment, of information obtained from excavation about the site's remains augmented with historical background facts.

Keywords: Augmented Reality, marker, World Heritage Iwami Ginzan Silver Mine, mock-up model

1. INTRODUCTION

The Iwami Ginzan is a historic silver mine of great importance to Japan's cultural and industrial heritage. It was one of the world's top producing silver mines at its peak in the 17th century, supplying about a third of the world's silver production from the mountains of Shimane Prefecture, on the main island of Honshu. The mine site's significance was recognized in 2007, when it was inscribed on the World Heritage List as "Iwami Ginzan Silver Mine and its Cultural Landscape." It is Japan's 14th World Heritage Site and the first mining site to be inscribed in Asia.

Since then, the Iwami Ginzan World Heritage Center and local volunteers have collected valuable information about the mine site for visitor exhibits as part of rigorous efforts to boost tourism and convey the importance of preserving the nation's cultural assets. But the excavated edifices and artifacts of the large mines, smelting and refining sites and mining settlements that comprise the two-square-mile, heavily wooded heritage site are widely dispersed, making it difficult for tourists to see all the area's attractions during a short visit. There have also been many attempts to reconstruct the site's remains, but the costs for reconstruction and maintenance, and managing both, are too prohibitive.

To overcome these challenges, the authors of this article sought to provide visitors information from excavations at the Iwami Ginzan Silver Mine by combining computer-generated (CG) animation and contextual digital information using augmented reality (AR) technology.

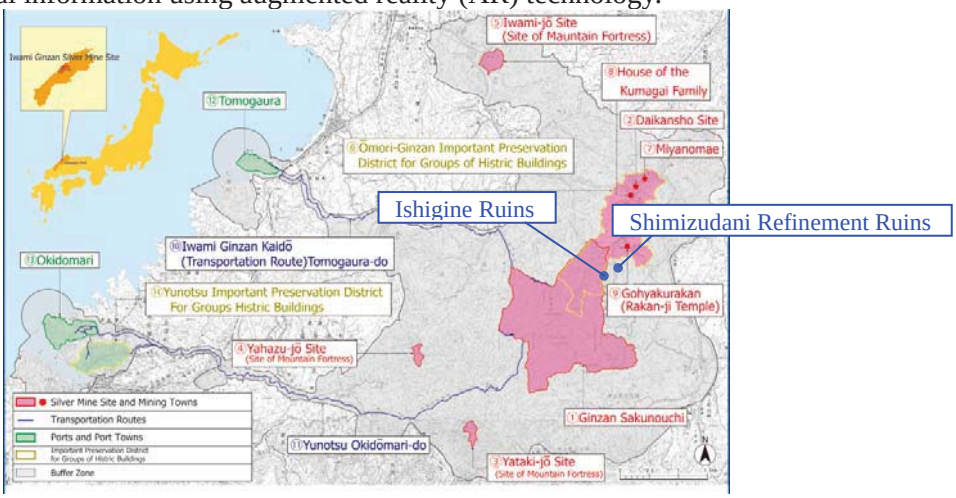

Figure 1. Map of the Iwami Ginzan Silver Mine Site

2. OUTLINE

2.1 Marker-type AR using the model (Shimizudani Refinement Ruins)

The Shimizudani Refinement Ruins are what is left of a refinery built in 1893 on the northern side of Mt. Sennoyama. It includes a miner's residence, a substation, a sifting area and a trolley track. The original construction also included eight layers of stone walls built at a height of about 100 feet and encompassing an area of nearly 75,000 square feet. Today, just a stone wall is left.

The authors used current drawings, documents and video production from the World Heritage Center and reproduced images of the original building using marker-based AR to display information for visitors in the real space by recognizing a marker (or target on the scene) through a tablet computer.

2.2 Markerless (GPS) AR (Ishigine Ruins)

The historic Ishigine Ruins were once a town with a silver refinement factory on flat terrain at the summit of Mt. Sennoyama. Archaeologists excavated a six-foot-wide road in the center of the valley revealing the remains of a tunnel and several buildings used to produce silver hundreds of years ago. Inside, they found a grinder to crush ore (called a Konashi) and gravity concentration (called Yuriwake) and silver refining furnaces.

Using AR, the authors of the article reproduced one of the buildings (called Fukiya) with computer graphics that included depictions of workers from the mine's golden years. Using the tablet's GPS camera, coordinates were calculated and markerless AR was carried out. As a result, visitors were able to view images and animation explaining how the ancient structures were utilized to produce silver as well as sightseeing navigation tools.

Figure 2. Shimizudani Refinement Ruins

Figure 3. Ishigine Ruins

3. APPLICATION DEVELOPMENT

3.1 Marker-based AR

The workflow to create AR at the Shimizudani Refinement Ruins is described below:

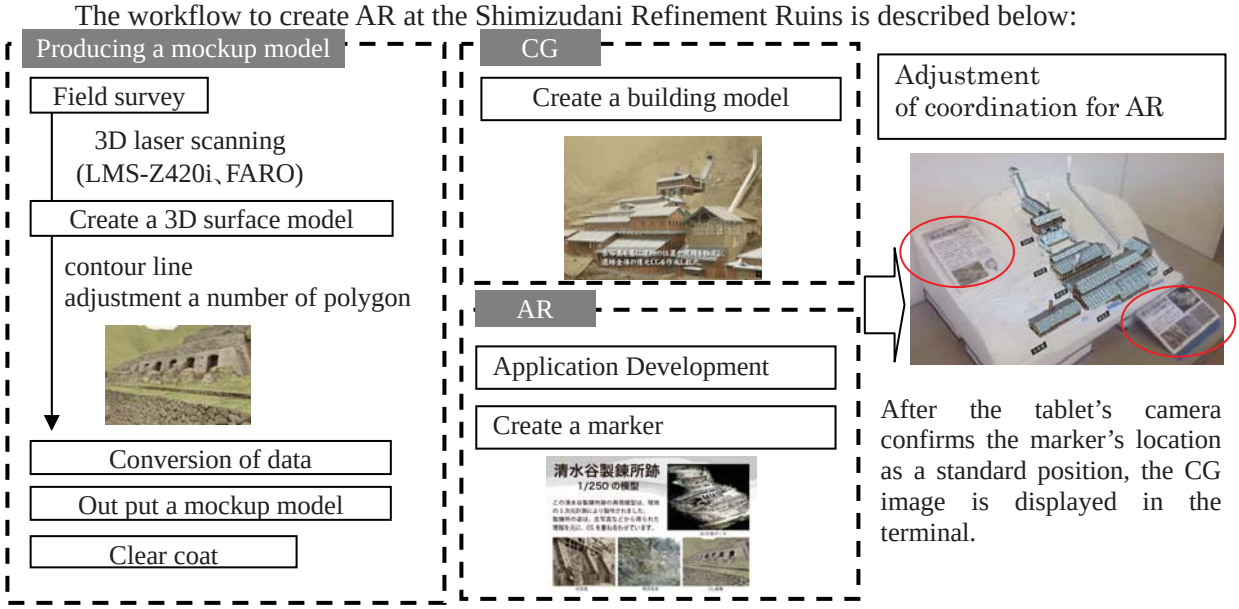

Figure 4. The workflow of Marker-based AR

3.1.1 Producing a mock-up model

Using data of the excavation scene captured by a laser scanner, the authors created a 3D surface model to accurately reproduce the topography and original stone walls of the Shimizudani Refinement Ruins. The 3D surface model was then transferred to a 3D printer, which spread thin layers of gypsum powder and adhesive to make a solid surface model.

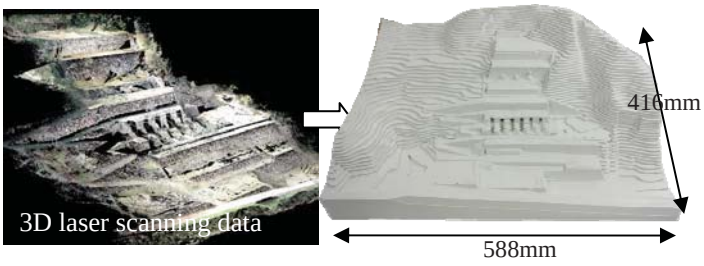

Figure 5. mock-up model

3.1.2 Production and adjustment of the marker

This marker-based positioning system requires locating predetermined coordinates of a target image, or marker, on the scene with the tablet's camera for positioning verification. In this case, a sign plate was the marker in the scene. The tablet's camera located and captured the marker's coordinates in the excavation scene, sending the captured image data back to the tablet to execute the augmented reality program's code.

Our AR application used an iPad tablet as the base terminal. Qualcomm's Vuforia AR software was chosen as the the image recognition software to recognize the marker and receive the camera's captured image data, which was converted into a 3DCG model by Autodesk's 3ds Max software. A customized REMO AR Viewer was used to view the 3D model as AR CG content on the iPad.

3.1.3 Adjustment of coordination for AR

After the tablet's camera confirms the marker's location as a standard position, the CG image is displayed in the terminal.

4th grade

Figure 6. The result of evaluation

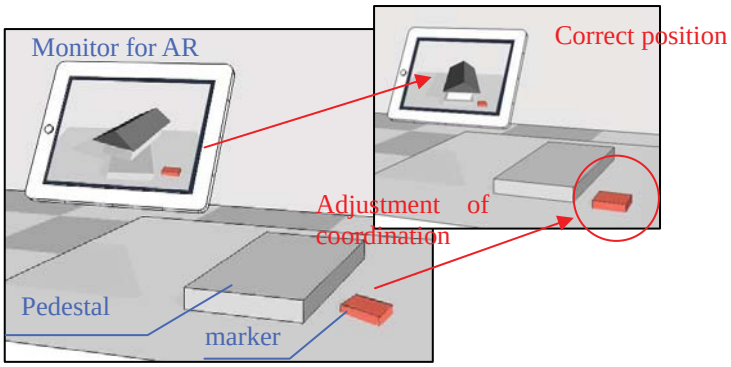

Figure 7. The relation between a marker and location

3.2 GPS-based AR

Based on information from the excavation, a CG image of the Fukiya building image is reconstructed virtually. In this virtual Fukiya building, CG workers are depicted using the ancient equipment and machinery to illustrate and explain the silver production process. The CG guide tool also uses dynamic animation in the scene to provide visitors with an enhanced view and more comprehensive explanation of Shimizudani Refinement.

3.2.1 Tablet position adjustment

This method uses GPS information received by tablet to determine a visitor's position. Because of the lower precision of GPS coordinate information of "altitude", some supplemented consideration is required especially for "altitude" from our experience. It was decided to input the visitor's height data into the calculation for more accurate positioning.

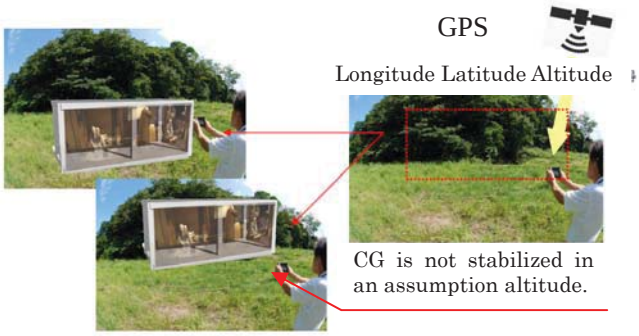

Figure 8. Altitude information from GPS

3.2.2 Contents production

In conjunction with a CG image depicting workers, we produced animation to view beforehand that further explains to visitors the work process at Fukiya.

3.2.3 Adjustment of coordination for AR

There are several factors that can affect the accuracy of a GPS signal including errors in calculating placement, errors in timing, the weather, and shifts in satellite orbits. Without the use of a marker, and to ensure the accuracy and precision of positioning, we repeated adjustment trials of coordination for AR.

Figure 9. Adjustment of coordination

Figure 10. The monitor of tablets(AR application)

4. SUMMARY AND FUTURE DEVELOPMENT

The Iwami Ginzan World Heritage Center has collected numerous artifacts and information for visitor exhibits at the historic silver mine. But the site's remains are spread out over a mountainous, two-square-mile area, making it challenging for visitors to get a full understanding of the importance of the site's cultural and industrial heritage. To solve the problem, two types of positioning for augmented reality systems - marker and markerless (use of GPS) - were created to provide visitors a visual understanding, in real space on a PC (Windows) or tablet terminal (iOS, Android) environment, of information obtained from excavation about the site's remains augmented with historical background. Currently, visitors have access to specially prepared tablet terminals at the site. Future plans include developing advanced AR technology so visitors can use their own tablets to access various tools and resources relating to the World Heritage Site, including a mapping application, guided tours and other information, all stored in one database.

To realize our goal, accurate positioning information is critical. Furthermore, we have to develop more attractive, visual content such as simulating the experience of being inside a cave using panoramic images, bird's-eye views of the mine using UAV data collection, and simulations in the virtual space using 3D laser-scanned data and panoramic images. We will continue our efforts to develop new AR technologies to convey the importance of Japan's cultural assets and values, particularly those of the Iwami Ginzan Silver Mine, more effectively to the next generation.

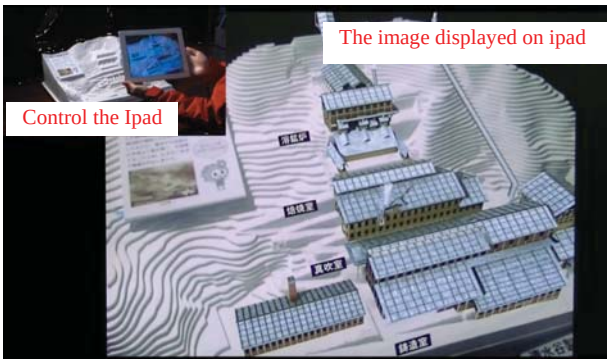

Figure 11. Marker-based AR

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[1] Iwami Ginzan Silver Mine and its Cultural Landscape: http://ginzan.city.ohda.lg.jp/wh/en/index.html (accessed on 31st August 2013).