

# Digital Twin as A Mixed Reality Platform for Art Exhibition Curation

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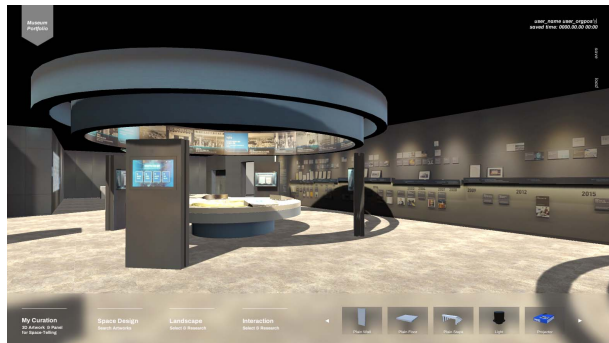


Figure 1: A runtime screenshot of our digital twin-based art exhibition curation system in Mixed Reality

## ABSTRACT

We present a digital twin-based Mixed Reality platform for arts curators. Despite the rising presence of exhibitions in varying digital formats, the virtual engagement of arts curators has been nearly disabled. To replicate and enhance the professional capability of arts curators in the virtual realm, our system integrates a digital twin art space and 3D authoring techniques, aided with spatial and semantic metadata. Our user evaluation proves the system's usability, and its capacity to support curatorial activities. With this, we aim to provide a groundwork to similar systems that also extend arts curator's creativity and outreach beyond time and space.

**Index Terms:** Virtual Curation—Digital Twin Museum—;—3D Authoring—Visualization design and evaluation methods—

## 1 INTRODUCTION

Art exhibitions in digital environment has been approached as a platform for extending arts professional's outreach beyond time and space. However, the direct engagement of arts curators – the de facto planner and maker of exhibitions – is nearly disabled in such virtual exhibitions. While a number of solutions support 3D authoring and visualization in Mixed Reality (MR) [1, 3]; only a little is explored in integrating a variety of curatorial activities on digital twin environment, which calls for a domain analysis from the artworld. Even less is explored in enhancing such activities with the digital twin metadata, such as spatial and semantic information on real arts spaces and artworks [2, 4, 5].

Based on a domain analysis, we propose a digital twin-based Mixed Reality platform for arts curators. The system supports curators' artistic practices with MR interfaces and authoring techniques, that are mediated with a set of digital twin metadata. Lastly, we conducted a user evaluation with 10 arts professionals. The results

prove that our *System* meets with user needs in light of enhancing the visualization and research capability of curators.

## 2 DOMAIN ANALYSIS

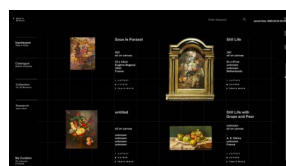
To define the roles and effects of curatorial activities on digital twin environment, we conducted expert interviews with 13 arts professionals. The participants have diverse experiences with exhibition-making, with their working experiences ranging from 2 years to more than 20 years.

The participants defined the major role of virtual curation in creating and simulating different versions of exhibitions. One participant envisioned that the virtual curation “can serve as archives to the process of making an exhibition, by which we can also concretize the planning itself”. Another participant stated that “being able to install artworks and simulate the view without having to visit the real space will enhance both the physical and financial efficiency.”

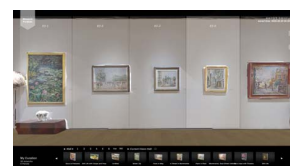
All of the participants confirmed that 3D computer graphics design are not conventionally included as a part of their curatorial practices. This implicates that a 3D interactive virtual curation system should be designed in a way that guarantees high usability for those who are unfamiliar with 2D or 3D CG softwares; and that does not require technical overload beyond the usual work scope of exhibition creators.

## 3 SYSTEM OVERVIEW

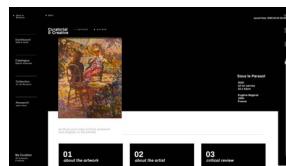
Based on the domain analysis, we propose an 3D interactive arts exhibition curation system in a digital twin-based MR environment. The *System* is implemented as a WebVR program, in collaboration with a group of digital twin technologists.



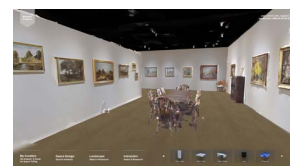
(a) A Catalogue of Artwork Metadata



(b) 3D Authoring in Spatial Units



(c) User-Generated Metadata



(d) Simulation of a Virtual Curation

Figure 2: The Interface Composition of *System* in Mixed Reality

## 3.1 Database and Interface for Digital Twin

We started building our digital twin database with a 3D reconstructed space of a university museum. We defined the 3D space in location units, such as indoor, outdoor, buildings, as well as in space spatial-semantic units, such as floors, rooms, and walls. For the metadata of 3D artworks, we categorized the types their semantic information

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into two : factual and user-generated. The metadata is mapped to corresponding visual properties, while retrieving their real-time position within the digital twin space.

For instantiating and placing virtual objects and artworks, the main menu of the *System* provides the following functions. (1) *Catalogue* : a 2D catalogue of 3D artworks and its metadata (Fig. 2-a.), (2) *My Curation* : a collection of 3D artworks selected by users (Fig. 2-b.), (3) *Space Design* : 3D assets for spatial design, such as walls and lights, pre-registered by system builders (Fig. 1).

### 3.2 Space-Mediated Authoring and Simulation

Amongst the main functions, *My Curation* supports the 3D placement of objects in real-size spatial units (see Fig. 2-b.). Clicking on each enumerated wall button from the sub-menu interface, the user viewpoint changes frontally against the wall. Onto this wall, a placement guideline is provided in 1-meter-width unit of the wall. Based on this guideline, users can place virtual objects for initializing the 3D authoring. Once an object is placed within the grid-unit wall space, its relevant spatial data is mapped to the object, such as its position and rotation. Users can also fine-tune with the transformation with the gizmos of the selected object.

Users can simulate the 3D exhibition from audience's perspective. They can walk, run, or jump around with WASD and space bar keyboards and look around 360 degrees with mouse movements (see Fig. 2-d). The player's viewpoint can vary with mouse-scrolling among first-person, third-person, and bird-eye views.

### 3.3 Managing, Visualizing, Re-Using Metadata

The *Catalogue* interface shows a list of images of artworks and their caption information, which were pre-registered to the digital twin database (see Fig. 2-a). On *Learn More* button attached to each artwork in *Catalogue*, users can access, author, manage, and visualize information to an individual artwork on a separate panel (see Fig. 2-c). On this panel, users are provided with the 2D image and caption information of each artwork, and below them lie three text input windows for different types of curatorial writings : "*About the Artwork*", "*About the Artist*", and "*Critical Review*".

## 4 PRELIMINARY USER EVALUATION

To identify which components of *System* particularly meet with or fall short of the domain needs, we invited 10 arts professionals. The participants' average working years in the artworld approximated 7.1 years (SD = 5.26), with the number of their exhibition-making activities marking 10.5 (SD = 8.31) times. We asked them to create with our *System* at least 2 different versions of 3D exhibitions. Upon the completion of the task, the participants filled out Task Load Questionnaire in 7-Likert scale, and System Usability Scale (SUS) and User Experience questionnaires (UEQ) in 5-Likert scale, followed by individual interviews.

**Perceived Usability** We view that the learning curve of our *System* would require just a few hours for exploration with minimized number of mouse clicks. This expectation is supported by the results of the Task Load Questionnaire, which showed a low level of Frustration (Average = 2.1, SD = 1.5); and Required Effort (Average = 3.5, SD = 1.3). Another highlight is that the *System* is deemed efficient in creating a series of virtual exhibitions. In the SUS and UEQ results, the participants marked a high level of Performance (average = 4, SD = 0.81), with willingness to Frequent Usage (average = 3.7, SD = 0.8) of the system. These results ensure that *System* is easy-to-use, and can satisfy the users with the task outcomes conducted in given working hours. In the interview, the participants demonstrated a consensus on their preference of having all types of data, including 3D assets and factual metadata, pre-registered by technologists like our *System*, so that they can solely work on the 3D authoring and simulation for the sake of work-efficiency.

**Pre-Producer's Technical Supports** Documented by the Task Load Questionnaire results, our *System* demonstrates a low need of technical supports (average = 1.5, SD = 0.5) in using. In the follow-up interviews, the participants narrowed down the scope of possible technical supports into the construction of digital twin database and web server.

**3D Authoring with Metadata** The participants distinguished our *System*, in light of its capacity in improving user expression and creativity. One is the function for accessing the metadata in an organized manners like *Catalogue*; the other function is for generating text data into 3D texts and panels in the virtual space. The participants appreciated being able to generate their own contents with pre-registered metadata. While 6 of them showed more interest in generating and managing their own writings with the given semantic metadata; 4 of the participants wished for more design customization functionality, such as on 2D/3D panels and captions.

**Partial Automation for Spatial Disposition** The participants unanimously agreed that a highest degree of freedom in 3D placement of visual properties is a must. Most of the participants wished to have artworks displaced regardless the physics of buildings, such as colliders and boundary. However, they requested highly automated functions when it comes to some "*time-consuming*" spatial authoring, such as attaching artworks to walls, floors, ceiling, or placing multiple objects across multiple units of spaces.

**Needs in Digital Twins** All of the participants affirmed the need of using digital twin base, both in terms of their virtual curation and simulation. Requesting a tied-to-the-physical-site 3D spaces as a lieu for their virtual curation, 4 participants mentioned that "*virtual curation systems can be useful only when the virtual spaces are provided as a digital replica of real museum space, which professional curators are simulating exhibitions for.*"

## 5 CONCLUSION

We proposed a system for virtual curation in a digital twin-based MR environment. Specific components to the *System* encompassed 3D authoring and visualization with spatial and semantic metadata retrieved from a digital twin database. In a user evaluation, we observed and clarified how the *System* can augment arts curator's creativity and vocational capability. We suggest the findings as a groundwork to similar virtual curation systems.

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