Bringing the Museum to Life

How Augmented Reality (AR) can innovate the museum experience

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Intended Audience: Museum Directors, and Curators

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Executive Summary

Augmented Reality, also known as AR, is a live representation of a real-world environment that is superimposed with images, videos, text, or sounds. AR blurs the lines between reality, and virtual reality, and can be used in different contexts to bring objects, or scenes to life by overlaying videos, images, or text (Ding, "Augmented Reality in Museums"). The purpose of this white paper is to explain how AR works, how museums can benefit from acquiring this technology, and its potential drawbacks.

Problem Statement

Museums are institutions where people can explore objects of scientific, artistic, or historical significance. However, as society becomes increasingly digitalized, endless forms of entertainment make it difficult for traditional museums to compete for peoples' attention, and engagement. As a result, museums today are frequently associated with negative perceptions, such as boring, old, and overly academic (Zbuchea).

Proposed Solution

Museums and curators are full of knowledge and desire to engage people in a dialogue about historical objects, and artworks. Augmented Reality is a tool that has the potential to communicate this knowledge in an entertaining, and interactive way.

Background Information

What is Augmented Reality (AR)?

Augmented reality (AR) is an enhanced version of the real physical world that is achieved by digitally overlaying visual elements, sound, or other sensory stimuli to a user's smartphone, or tablet (Ding, 1). AR overlays can take two different forms, but this white paper will focus on Product overlay (see Table 1 Product vs Table-top overlay).

Example
Launched in 2016, Pokémon Go was an AR game where players caught and trained Pokémon characters in real life locations using the application on their smartphones. The app was downloaded 120 million times by 2020, showing that AR is accessible, and has the potential to reach a huge audience (Nestor).

Common Types of AR Overlays
Product overlay This overlay uses a "digital twin" that is overlaid onto a physical object (Castleberry-Hughes). **Example** A virtual X-ray of a human chest with a beating heart may be placed over an individual's chest.
Table-Top overlay This overlay does not need a physical object to overlay on, but instead is itself a virtual 3D model (Castleberry-Hughes). **Example** A virtual model of a car, or a floor house plan.

Table 1 Product vs Table-top overlay

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What is the difference between AR, VR, MR, XR?

Virtual Reality (VR), Mixed Reality (MR), and Extended Reality (XR) are terms that are often confused with AR. For an explanation on these differences, see the following Table 2 Defining VR, MR, and XR.

Virtual Reality (VR)	Mixed Reality (MR)	Extended Reality (XR)
VR fully immerses users by replacing the real world with an entirely virtual world. VR requires users to wear an eye-covering headset, and headphones to eliminate, and replace the real world (Tremosa).	MR superimposes digital elements into the real world, and allows users to interact with their physical environment simultaneously (Tremosa).	XR is an umbrella term that covers all technologies, including AR, MR, and VR, that alter reality by adding digital elements to the physical environment by any extent (Tremosa).

Table 2 Defining VR, MR, and XR.

How is an AR experience generated?

To generate an AR experience, the following processes are carried out:

1. Software designers use input devices such as cameras, mics, GPS, and compass present on a user's smartphone to determine their location, physical environment, and device orientation (see Figure 1 Diagram explaining how an AR experience).
2. The AR software processes, and compiles input information, and sends it to a remote cloud server as a "digital twin".
3. Images, videos, text, or sounds are overlayed onto the "digital twin".
4. The "digital twin" is rendered back to the user through their device, creating a virtually manipulated experience (Castleberry-Hughes).

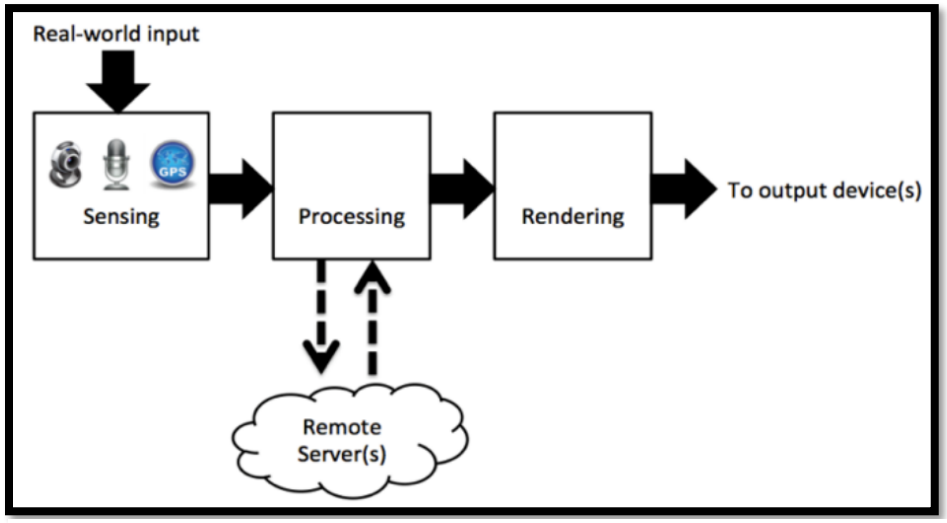

Figure 1 Diagram explaining how an AR experience is created
Source: Roesner et al.

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What are the potential benefits of using AR?

The following three case studies highlight the key benefits of implementing AR, particularly how it can be used to engage visitors of all ages, spark renewed interest to old exhibits, and solve practical problems.

Case Study 1: AR can engage visitors of all ages

The National Museum in Singapore (NMS) hosted an installation called Story of the Forest featuring three-dimensional animations of images from the William Farquhar Collection of Natural History Drawings. This installation uses AR so that visitors can hunt and catch plants, and animals, using the camera on their smartphones, within the paintings and learn more about them once they have been collected (see Figure 2 A person using their smartphone to hunt and catch an animal in "Story of the Forest" exhibit). MNS demonstrates how AR can be used to gamify learning experiences, and engage diverse groups of visitors in exciting new ways (Coats).

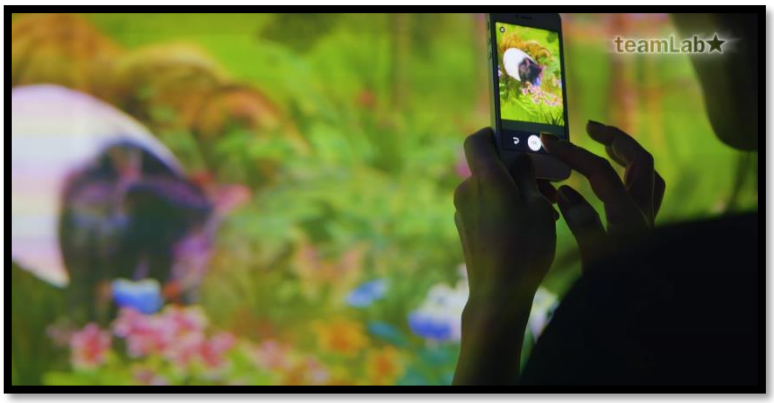

Figure 2 A person using their smartphone to hunt and catch an animal in "Story of the Forest" exhibit
Source: teamLab

Case Study 2: AR can spark renewed interest to old exhibits

The Smithsonian Institution in Washington D.C. used AR to renew one of their oldest, and most loved displays—the museum's Bone Hall. On show since 1881, the Bone Hall features skeletons of animals that once existed; however, using the museum's new AR app "Skin and Bone", visitors get to view superimposes images that reconstruct the creatures, how they would have looked over the bones, and how the animals would have moved (see Figure 3 AR overlay used on a tablet to reconstruct a fish). This gives visitors insight into the history of the pieces, encourages multi-sensory learning by bringing the displays to life, and gives visitors a reason to revisit older exhibits (Coats).

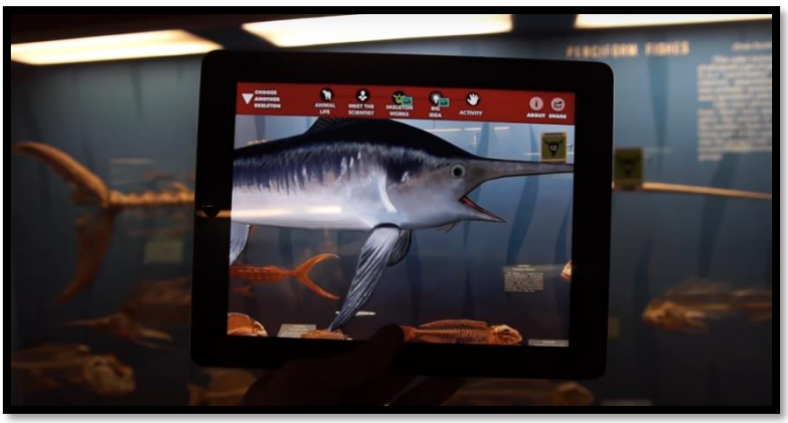

Figure 3 AR overlay used on a tablet to reconstruct a fish
Source: Smithsonian's National Museum of Natural History

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Case Study 3: AR can solve practical problems

The Latvian National Museum of Art (LNMA) in Riga used AR not as an entertainment solution, but to solve a real issue—the museum did not have enough tour guides. LNMA designed an AR solution that uses scannable QR codes throughout the museum to provide visitors with an in-depth tour directly from their smartphones, and at their own pace. AR features included overlays that informed visitors about architectural elements of the museum, its artworks, and the artists, or subjects depicted in their work (see Figure 4 AR informational overlay on a painting at LNMA). LNMA demonstrates how museums can use AR to overcome practical challenges ("Museum offers augmented reality exploration for engaging storytelling").

Figure 4 AR informational overlay on a painting at LNMA
Source: Overly app

Considerations for implementing AR

Development Costs

The cost needed to develop an AR application depends on the complexity of the idea, and what it needs in terms of technologies, skills, and time to become a reality (see Table 3 Components that determine development costs) (Golosovskaya).

Basic Design	Customized Design
• Costs USD$5,000 - $10,000 • Standard libraries • Integration of pre-developed third-party solutions • Simple feature list based on pre-set components • 'Standard' design	• Costs USD$300,000+ • Custom algorithms • Development of administration panel • Development of AR content management system • Custom-made features such as background music, chat, and videos. • Branded design

Table 3 Components that determine development costs

Privacy Concerns

AR works by using in-real time input from its users, and it is nearly impossible to anonymize AR tracking data because individuals have unique patterns of movement. This means that it is possible for hackers to look up information about these people, and places. The information obtained could lead to adverse actions that are illegal, or discriminatory. Museums should ensure data protection software are up to data, and comprehensive to prevent hackers from gaining access to people's personal information (Calo et al.).

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Negligence

AR software overlays information onto the world in real-time. If this information is incorrect or misleading, distracts a user, or places them in imminent danger, then any resulting injury may be grounds for a negligence claim (Calo et al.).

Conclusion

Augmented Reality (AR) has the potential to solve practical problems, and engage, entertain, and educate visitors in an interactive and fun way. The use of AR in museums around the world today demonstrate its success, and staying power. Although AR has many upsides, factors such as development costs, privacy, and negligence must be considered prior to its implementation.

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