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Provost Undergraduate Research and Innovation (URI) Summer Fellowship Program Proposal

Augmented Reality Framework for Museum Exhibits

Abstract:

The United States faces a growing challenge engaging students in STEM education. Global comparisons of STEM secondary education performance place the United States in the bottom half with a steady decline [1]. Reasons for this vary, but one major recognized factor is the quality difference between multimedia experiences available for entertainment as compared to education [2]. Museum exhibits are public works intended to help engage visitors in scholarly and scientific inquiry using rich experiences. Unfortunately, many museums report historic lows in audience participation [3]. With many interactive experiences available to audiences, museums have to contend with the widening range of options publically available. Augmented Reality (AR) is a technology that takes the user's perspective of the physical space and superimposes computer-graphics to construct a composite view. Young audiences are likely to engage with new technologies and AR in public educational institutions can increase STEM interest [2]. This project will develop an AR application framework for museums for smartphone AR applications. Visitors using the applications can experience exhibits in new perspectives with deeper connections. The framework will provide developers a simplified approach to create AR applications for public exhibition. This project will be further refined using an existing collaboration with the Newark Museum.

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Background:

It is an ideal time to propose innovative technological solutions to improving STEM education in the U.S. as it pervades every aspect of people's lives while technological innovation is persistently venturing forward in an extreme rate. While it holds true that the United States holds a position in the leading thirteen nations globally in STEM education, it falls beneath into the base half, gradually decreasing in regards to the four-year statutory formal education. Experts have displayed that participants in correlation with STEM are comfortably accustomed to rich multimedia experiences and engrossed with top of the line technology [2]. Museums exist to implement rich experiences to portray the history of the world as a learning environment and so they are constantly attempting to utilize current technologies to better engage visitors. But with disappoint, there is information regarding the decline in interactive opportunities from museums [3]. With this intention, this project is designed to integrate more of the technologies that people are currently carrying and using for knowledge acquisition into the experiences that curators and librarians can create for the public. Augmented Reality (AR) is a technology that projects computer-generated images superimposing on the user's view of the physical world; It creates a mixed reality by blending the virtual world made from a computer with the perspective of the physical space. By utilizing AR technology, this project can incorporate what museums lack in interactivity and immerse children and young adults in STEM education. Thus, this will be contributing to the improvement of STEM education and increase America's standing in global comparisons. In order to determine success and failure, I will be teaming up with New Jersey's largest museum, the Newark museum, by examining their analytics on visitor engagement and how my AR application framework can be used to create AR applications to expand the quantity of guests per gallery. I will also be using multiple scholarly papers from The Cleveland Museum of Art (CMA), the museum that was awarded an NEA grant in 2018 for a fully immersive, interactive, and mixed reality space, about visitor engagement and removing the barriers of interactive experiences as well as the statistical information I have been provided through email from them in regards to visitor satisfaction, minutes of engagement with average CMA visitor, and their opinions on the beneficial aspects of using AR technology into their museum.

Significance:

A huge percentage of the nation's sustainable economic growth are from industrial activities in STEM-related fields. That industrialization is the core essence that can greatly improve our economic sustainability by creating more jobs with the division of labor of experts in specific fields. According to the Bureau of Labor Statistics in the U.S., 8.6 million STEM jobs were present in 2015 followed by computer and engineering fields encompassing 64% of those jobs [4]. By expanding our STEM education into an informal learning setting using AR, it will enhance our industrial activities and therefore lead to a rise in the nation's economic growth. In addition to the statistics presented by the U.S. Department of Labor, more than half of our economic and industrial development in the nation are from STEM-related fields whereas New Jersey has only 10% of its employment from STEM [4].

Museums would be a perfect target as they are an untapped resource for approaching the improvement of STEM education and attendance for these museums are high for families and young adults. Since museums are public institutions that serve society with their preserved resources, they are constantly attempting to employ high end technologies to better help museum goers obtain a stronger understanding of what is being observed. Providing high end technologies for visitors to connect with exhibits on a deeper level can greatly increase the number of visitors in museums. The problem is that most museums struggle with funds to incorporate these technologies; It would be too expensive for

them and therefore not a cost effective solution. A large proportion of museums in the nation would not be able to use AR because of high cost to implement research and development, money that museums do not generally have. However, this project serves as a solution for an affordable improvement on museums for interactive learning experiences that can also benefit STEM education. With an AR application framework, museum personnel who have no experience in AR development can produce AR applications for exhibits specific to them. Museums would benefit by creating a stronger immersive bond between the visitor and exhibition and escalate the number of visitors in their museum. This project will entail creating a framework for museums to follow in a cost efficient manner so that other museums around the world can incorporate AR technology into their exhibits to successfully get more visitors to interact and engage with the artworks.

AR can attract and deliver a considerably more dynamic reaction from visitors from areas within the museum that lack interactivity. AR content accessible to guests can take into account levels of immersion that cannot be achieved due to the facilities structural designs that they may obstruct. By combining the real world with computer-generated images, it can shape people's perspective in which they analyze historical figures or fossilized animals from the distance past. For instance, Franklin Institute Museum in Philadelphia utilizes AR technology for application-based learning to take 2D images of the Terracotta army and create a 3D model on the screen of their phone in which people can observe [5]. Cleveland Museum of Art employs AR technology to scan portraits around the exhibit and project text on the camera of mobile devices to display more information regarding what is being scanned. This will create a stronger understanding and deeper connection with the user and the content being analyzed. The convenience of accessing more information by displaying 3D models in a virtual space makes AR an engaging learning experience perfectly suitable for a museum environment. These 3D models projected in a virtual space on top of the real world can provide the life cycle of withered buildings over time through animation, realistic sounds that may be heard from a particular setting, or 360 view of the 2D models that are often only seen in textbooks. The importance of the AR application framework is because museum personnel typically do not possess the skillsets to develop functional AR applications. They would need to understand programming structure, manipulation of three-dimensional objects, complex techniques for animation, along with many other complicated concepts that will take years to learn. The usage of a framework provides simplicity so people who are not familiar with development have to experience the level of difficulty for developing nor require an extensive knowledge of programming, animation, and many other complex cases. An AR framework will simplify the amount of work by providing generic functionality and a set standard method to deploy AR applications.

Project Design:

I have contacted the Newark Museum and asked about their interest in incorporating AR technology into their exhibits to further enhance learning experiences in the museum and possibly attract a greater number of visitor count. They are excited and look forward to working with me in hopes to become a better educational institution in the service of the public. I will be discussing with the Newark Museum what other museums have done with AR technology and implemented successfully such as The Cleveland Museum of Art, which I have been speaking to them regularly through email about using AR technology for visitor engagement and their analytics.

The AR application framework for museums will be a small toolset created in the Unity Game Engine, which is a software ran on a computer meant to develop three-dimensional and two-dimensional simulations for computer on mobile devices. After the AR application framework has

been made, it will need to be published on the Unity store for people to download. Simultaneously, the sample AR application will be in development using an existing exhibit from the Newark Museum, this will serve as the visual representation of how an AR application will be seen using the framework created. It will then be posted on the Google Playstore for people with a mobile smartphone to experience. The sample AR application will be made using the framework which is downloaded from the Unity store. After that is done, the construction of how to create an AR application using the framework will be displayed step-by-step with tutorials I will also be posting online, ensuring *not* to overlook a step and think "people should know how to do this part." People will be able to open the Unity software, download my framework from the Unity store for free, and start developing AR content for their museum by following the tutorials I provide online on Youtube.com. After the development process, publishing everything online for public download, and displaying it all to the Newark Museum, I will train the personnel at the Newark Museum in the framework to give them the ability to develop their own AR apps for new emerging exhibits at their museum.

Expected Outcomes and Deliverables:

Milestone	Deliverables
Week 1	Research the necessary elements an AR framework is going to need for museums and construct an outline to help with development
Week 2	Create the AR application framework using the Unity engine.
Week 3	Confirm with professor Nersesian the functionality and reliability of application.
Week 4	Use the AR application framework to create a sample AR application for one of the existing exhibits in the Newark Museum.
Week 5	Publish the sample AR application framework on the Unity store for people to publicly download for free.
Week 6	Publish the sample AR application on the Google Playstore as a free download.
Week 7	Conduct an outline pertaining to the number of tutorials needed and content required to simplify it enough where museum personnel can use.
Week 8	Create and upload tutorials on youtube.com with a step-by-step procedure on how to use the framework to develop AR applications for museums.
Week 9	Display to the Newark Museum the sample application regarding their exhibit, the AR framework, and the tutorials uploaded online.
Week 10	Train Newark Museum personnel on the framework for future emerging exhibits.

Bibliography

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